NATURE

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

VOLUME IX.

NOVEMBER 1873 to APRIL 1874

"*To the solid ground*
Of Nature trusts the mind that builds for aye."—WORDSWORTH

London and New York:
MACMILLAN AND CO.
1874

LONDON
R. CLAY, SONS AND TAYLOR, PRINTERS
BREAD STREET HILL

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH

THURSDAY, NOVEMBER 6, 1873

THE GOVERNMENT AND OUR NATIONAL MUSEUMS

WE referred last week to the intention of the Government to transfer one of the Metropolitan Museums under the control of a responsible Minister of the Crown, to the fifty irresponsible Trustees of the British Museum, this step being contemplated without referring the question either for the opinion of the Science Commission, now inquiring into these subjects, or for the authority of Parliament. We have learnt since that the measures for effecting this change are in active progress. Lord Ripon and the Trustees of the British Museum having agreed that the transfer was to be made *if practicable*, Sir Francis Sandford, Mr. MacLeod, and Major Donnelly, on behalf of the Science and Art Department; and Messrs. Winter Jones, Franks and Newton, on behalf of the Trustees of the British Museum; are now busy as Commissioners to find out if the transfer *be practicable*, and they have been exploring the South Kensington Museum for this purpose during the last week, taking notes of its contents, inspecting its refreshment rooms, its waiting rooms and the like.

What the Commissioners will propose as practicable is of course known only to themselves, if it be known even to them. Thus much, however, is known: the South Kensington Museum must remain the head-quarters of Science and Art Teaching, unless that too is to be put under the Archbishop of Canterbury and his co-Trustees, and if not, then there must be a dual Government in one and the same building, unless Mr. Lowe's project be abandoned. Now the dual Government means that one officer will represent the Archbishop of Canterbury and his co-forty-nine trustees in the Museum, and another the Lord President of the Council. The officer representing the Department will take orders from the Lord President. The officer representing the Trustees must from time to time go to Mr. Winter Jones to ascertain what the fifty Trustees have decided, and to receive his instructions how their decision is to be interpreted. Mr. Winter Jones' labours, already said to be ill-remunerated, will be increased, and his well-known powers of organisation sorely taxed. If there be two things which nature puts in ferocious antagonism one to another, it is two public officers under different responsibilities. No envy, hatred, or malice like that between two public officers. How every officer adores the Treasury! how the Audit Office loves the Treasury! what models of civil Letters the Treasury always writes to the Officer of Works, and so on.

The public has had already a specimen of this kind of dual Government at the South Kensington Museum, which has had disastrous results for Science. When the "Boilers" were first erected in 1856, the Commissioners of Patents had assigned to them a portion at the south end of the building for exhibiting those Mechanical and Scientific objects, which under a fiction were supposed to have derived their origin in "Patents." It was necessary that the visitors to all parts of the "Boilers" and to the Picture Galleries should pass through the "Patent Division." The Lord President made sensible rules for admitting the public on three days, open from 10 A.M. to 10 P.M., and three days called "Students' days," when persons not students paid sixpence each, or ten shillings a year, the object being to have three days free from crowds and kept quiet for study. After a while the Commissioners of Patents were scandalised at thus receiving public money (they are the instruments for taking seventy thousand a year from Inventors and misapplying it to General Taxation) and they said they preferred crowds every day as the most convenient public arrangement. The authorities came to open discord on the point, and the matter could only be resolved by separating the "Patent" from the other collections. So the Patent Commissioners built a separate entrance for themselves. What has been the result? About eight millions of visitors to the South Kensington Museum who would otherwise have seen the "Patent Museum" have not done so, and the Commissioners have deprived themselves and their museum of the moral support of these great numbers. And what has been the result of this? The Chancellor of the Exchequer has been allowed

to sack more than a million of pounds sterling realised from the taxes imposed on inventors' patent fees, and has not allowed one farthing to be spent for the provision of a suitable building for the "Patent Museum." Anything more discreditable to the nation than the building now crowded with models cannot be conceived. Many of the passages are not eighteen inches wide! What the present Lord Chancellor, the head Patent Commissioner, would say if he were ever to see it, cannot easily be imagined. We advise his Lordship to hold a Board in the building as soon as possible. It will probably be the first Board of Patent Trustees that ever sat there. We are satisfied that the result would be that he would instantly cause the present exhibition to be closed, and adequate space found elsewhere. Then what have inventors got in return for the tax of a million drawn from them? And what may not invention have lost by this indefensible principle of taxation?

Here then is already a very practical illustration of dual government in the South Kensington Museum already; one part of that government being composed of Trustees, who, it is reported traditionally, have never once met as a Board in their own Museum to see what was imposed upon a suffering public, upon their responsibility. We do not believe such a state of things would have been suffered under South Kensington administration. Mr. Lowe, when Vice-President, of the Council would not have suffered it.

The indifference of the British Museum Trustees to some of the best interests of Science in their own museum has been denounced again and again by commissions and committees, who report and report, but make no impression on a corporation of fifty trustees. That alone is a reason why they should not be allowed to meddle with South Kensington.

Although, as we have stated, this proposal was made without reference either to the opinion of those to whom the interests of Science and Art are more precious than they are to the members of the present Government, or to the opinion of the House of Commons, we learn that Mr. Mundella has extracted a promise from Mr. Gladstone that nothing shall be decided until Parliament meets again. Mr. Gladstone is perhaps surprised that there is any public interest in the subject. In the meantime, to assist him to form a correct judgment, we advise every learned society, which takes any branch of Science under its care, to memorialise the Prime Minister, and point out the crying necessity of a Minister, who shall be responsible to Parliament for Science, among other matters, and for all museums; that to transfer a museum already so represented to irresponsible trustees is a step worthy of the Middle Ages; and finally, that while the South Kensington system represents everything that is best in the way of progress, so much, to say the least, cannot be urged in favour of the present management of the British Museum.

We can well understand the reason for the proposed change. It lies in the individual responsibility of a Minister and the energetic executive management which have raised in a few years the South Kensington Museum into an institution of which the nation has the greatest reason to be proud; which has made it the centre of the chief intellectual activity of the country, which has utilised its resources for the teaching of hundreds of thousands of our teeming populations. The British Museum Trustees have done none of these things; they have given no trouble; they have borne snubbing admirably when they *have* moved, which has not been often. They have, in fact, proved an admirable buffer between subordinates anxious for progress and the Government; and, further, they have not been represented in the Cabinet. The moral which the Government has drawn from these facts is, that the South Kensington energy should have such a buffer, and in the existing members of the British Museum have found one ready to their hand. Hence the proposal which, if we mistake not, will, when it is generally known, not find a single supporter out of the Cabinet. It is quite possible that already it finds not many supporters in it.

BAIN'S REVIEW OF "DARWIN ON EXPRESSION"

Review of "Darwin on Expression." Being a Postscript to "The Senses and the Intellect." By Alexander Bain, LL.D., Professor of Logic in the University of Aberdeen. (Longmans, Green, and Co.)

THERE is nothing in this Postscript to "The Senses and the Intellect" so important to psychology as the declaration and announcement contained in the following sentences: "In the present volume I have not made use of the principle of Evolution to explain either the complex Feelings or the complex Intellectual powers. I believe, however, that there is much to be said in behalf of the principle for both applications. In the third edition of 'The Emotions and the Will,' now in preparation, I intend to discuss it at full length." No man can claim to have done more for the study of psychology than Prof. Bain; and in now recognising the principle of evolution and in incorporating it with his system, he is doing the science the greatest possible service. This is more than in some quarters was ever hoped from Prof. Bain, and more than was ever feared by those of his disciples who—after the manner of disciples—have clung most tenaciously to the defects of his system.

Though accepting the principle of evolution, Prof. Bain does not, it would seem, always look at phenomena from the evolutionist's point of view, as we understand it. Thus, in speaking of the large extent to which Mr. Darwin uses the principle of inheritance to account for the phenomena of expression, he says:—"Wielding an instrument of such flexibility and range as the inheritance of acquired powers, a theorist can afford to dispense with the exhaustive consideration of what may be due to the primitive mechanism of the system; he is even tempted to slight the primitive capabilities, just as the disbeliever in evolution is apt to stretch a point in favour of these original capabilities." But whence the so-called "primitive mechanism" which is here made separate and distinct from, set over against the products of inheritance? is not the "primitive mechanism" the "original capabilities" of every creature the results of evolution?

Mr. Darwin is accused of not having given sufficient attention to "spontaneity of movements," which, according to Prof. Bain, "is a great fact of the constitution." Now it may be that a "readiness to pass into movement, in the absence of all stimulation whatever," is a fact of the constitution; but we fail to see that Prof. Bain has

given any proof that such is the case. He says :—"We may never in our waking hours be wholly free from the stimulation of the senses, but in the exuberance of nervous power, our activity is out of all proportion to the actual solicitation of the feelings." What is the right proportion of activity to feeling? the proportion that Prof. Bain takes as his standard by which to discover that at times our activity is out of all proportion to feeling. Is not the simple and the whole fact this, that the amount of bodily movement that goes along with a given amount of feeling is different in each individual, and in the same individual from hour to hour. He continues :—"The gesticulations and the carols of young and active animals are mere overflow of nervous energy ; and although they are very apt to concur with pleasing emotion, they have an independent source? their origin is more physical than mental." Is not the origin not of these only, but of all movements, entirely physical, though it is also a fact that some movements, and certainly these among the number, concur with pleasing emotion? Mr. Darwin has instanced the frisking of a horse when turned into an open field, as an example of joyful expression ; on which it is remarked, this "is almost pure spontaneity it does not necessarily express joy or pleasure at all. How curious! One must really be a psychologist before he can see common things in such an uncommon light. Perhaps no movement necessarily expresses any state of consciousness whatever: but no ploughboy, we venture to think, ever doubted that the frisking of his horse, when he turned it loose in the field, was an expression of delight. But, then, ploughboys have no theories about spontaneous activity. All mental states correspond to certain physical conditions; that "the nerve-centres and the muscles shall be fresh and vigorous" is the physical condition of much bodily activity, and at the same time of the pleasure that goes along therewith. Granting that "the kitten is not seriously in love with a worsted ball," it thoroughly enjoys the sport nevertheless. Its amusement being mere play does not preclude its being real pleasure. And if our memories can be trusted, the worsted balls of our childhood were far more delightful than the gold and substantial realities we seriously love in our old age. S.

"*LAHORE TO YARKAND*"

Lahore to Yarkand. By Geo. Henderson, M.D., and Allen O. Hume. (L. Reeve & Co.)

TO Mr. Forsyth, the able conductor of the expedition which they describe, the authors dedicate this handsome volume, which, instead of being a continuous narrative, is divided into three separate parts, each of which will appeal to a different class of readers. The description of the route, and the incidents encountered on it, are given by Dr. Henderson, who with Mr. Forsyth and Mr. Shaw were the only Europeans that went to Yarkand on this "friendly" visit, sent by our Government to the Atalik Ghazi; it occupies two-fifths of the work. The natural history of the living forms met with, mostly by Dr. Hume, fills about one-fourth; the rest consisting of meteorological observations taken by Dr. Henderson on the journey.

The difficulties that had to be encountered *en route* were many and severe; the desert nature of the road between the districts of Ladak and Yarkand made it almost necessary to discontinue the expedition, and the great heights that had to be surmounted put a check on rapid progress, in some parts rendering it impossible.

Several opportunities occurred for the observation of the physiological effects of higher altitudes and rapid changes of barometric pressure, one pass near Gnishu which had to be traversed, named Cayley's Pass after Dr. Cayley its discoverer, being 19,600 feet above the level of the sea. From Dr. Henderson's remarks, however, it appears that mountain sickness is not dependent on the rarity of the air alone, for during the time that the expedition was in the pass mentioned, no note was recorded of any of the number suffering from it, whilst previously, on the Chang-la, which is 18,000 feet, most of the camp suffered from severe headache, nausea, prostration of mind and body, together with irritability of stomach and temper; nevertheless observations at the time showed that the pulse was not unusually rapid and the respiration was but little, if at all, increased. The feeling of suffocation occasionally experienced on waking during the night usually passed off after a few deep inspirations had been made. It is much to be regretted that, with the opportunities of verifying and extending Dr. Marcet's observations on the effects of ascending and descending mountains, Dr. Henderson was not in a position to do so, which he undoubtedly would have done if he had been acquainted with them.

Shortly after leaving Patsalung, and when on the southern boundary of Hill Yarkand, "nearly ten miles of the way was over a plain about five miles wide, which was covered to a depth of many feet (in one place where cracks existed, to not less than twenty feet) with sulphate of magnesia (Epsom salts), pure and white as newly-fallen snow." This shows the abundance of a magnesian limestone in the surrounding higher ground, and as the water-supply of the city of Yarkand was from rivers which rose in this or similar hills, the author's remark that "about every third man we saw was afflicted with goître," is scarcely more than was to be expected, and we think that if, instead of making "over to the Dád Khwah a quantity of iodine, for the treatment of goître, at which he was very much pleased," he had proposed a change in the water-supply, the Yarkandis would have been the gainers in the long run.

As the Atalik Ghazi was away at the time Mr. Forsyth arrived at his destination, and as the latter had strict orders to return before winter, the mission was partially unsuccessful. The return journey being later in the year, the cold and discomfort were greater than on the march north; an idea may be formed of the acuteness of the cold from the author's note on the Sukat pass. "My ink was constantly hard frozen, and on several occasions when I thawed it before the fire and attempted to write in my pencil notes, it froze at once on the point of the pen. Several times I tried to photograph, and once or twice succeeded, but usually the tepid water used for washing the plate froze as I poured it from the jug, and instantly destroyed the picture."

The illustrations of scenery, which in many books of travel are but indifferently drawn, and disappointingly inaccurate, are in this work replaced by "heliotype prints"

from photographic negatives taken by Dr. Henderson himself, and nothing can, in most cases, be more satisfactory. What is wanted on such occasions is not only a picture, but a representation sufficiently full of detail to enable the reader by simple inspection to form a truthful idea of the country described. Such are found in the photographs of the Valley above Paskyum, and the fort and bridge over the Indus river at Kalsi, and others before us, which, from the contrasts of light and shade, and the evident glare, bring vividly before the mind the intensity of the heat, as well as the desolateness of the locality, a combination scarcely possible in any character of engraving.

The Natural History notes are mostly ornithological and botanical. In his *résumé* of the ornithological results of the expedition, Mr. Hume informs us that "altogether, 158 species were observed, but of these only 59 pertain to the ornithologically unknown hills and plains of Yarkand. . . . Of these fifty-nine species, 7, *Falco hendersoni* (? *F. milvipes*, of Hodgson), *Saxicola hendersoni*, *Suya albo superciliaris*, *Podoces hendersoni*, *P. humilis*, *Galerida magna*, and *Caccabis pallidus*, are probably new to Science." An excellent illustration, by Mr. Keulemans, is given of each of these new species, except the last, which is very closely allied to *C. chukar*, and the coloration of the drawing of *Sturnus nitens* (Hume) exemplifies very successfully the propriety of the specific name. Mr. Gould's description of *S. purpurascens* is compared with that of the new species, the former being absolutely speckless and much smaller. *Podoces hendersoni* and *P. humilis* are both new species of this genus, which the author, following Bonaparte, places with the Choughs and not with the Jays and Magpies, remarking, however, "remembering their ground-feeding, dust-loving habits, . . . I cannot avoid the suspicion that these birds may constitute a very aberrant form of the great Timaline group."

On the Chang-la pass above referred to, Mr. Shaw obtained a butterfly, which Mr. H. W. Bates places in the mountain genus *Mesapia*, naming it *M. shawii*; it closely resembles *M. peloria*. Several specimens of the moth, *Neorina shadula* were also obtained.

Dr. Hooker and Mr. Bentham have written the descriptions of the new species of flowering plants, which are figured; they include, from the Tamaricaceæ, *Hololachne shawiana*; from the Compositæ, *Iphiona radiata* and *Saussurea ovata*; and from the Apocynaceæ, *Apocynum hendersonii*. Dr. Dickie of Aberdeen describes the Algæ and Diatomaceæ, and has also named some new forms.

OUR BOOK SHELF

The Internal Parasites of our Domesticated Animals. By T. S. Cobbold, F.R.S. (The *Field* Office.)

In this short and concise work Dr. Cobbold has embodied a series of articles which have appeared from time to time in the *Field*. They, having been originally written for the perusal of the non-scientific public, are put in a simple and elementary manner, and much stress is laid on the practical bearing of the science of helminthology, the true value of which the author clearly shows to be but little appreciated by the growers of stock. Several excellent illustrations accompany the descriptions, which will greatly assist the amateur reader. The entozoa infesting the ox are first described,—flukes, tapeworms, and measle, together with round worms. The importance of more perfect sewage arrangements whereby the ejecta of one animal are not allowed to contaminate the ingesta of another, is laid great stress on. The great carelessness on this point in India evidently leads to the preponderance of parasitic diseases in that country, where the heat and attending thirst cause the frequently small supplies of water to be employed for drink when in a very unfit state, on account of the abundance of ova of parasites that it may contain. A description is also given of the manner in which the Burates or Cossacks of the region of Lake Baikal are nearly all infested with tapeworm, from the custom prevalent amongst them of eating their meat—the flesh of calves, sheep, camels, and horses—in an almost raw condition, and in enormous quantities. We think that there is one point in which this work is particularly suggestive. The great gaps there are in our knowledge of helminthology, such as the imperfect information that can be given as to the source of the liver fluke, must cause most readers who have opportunities at their disposal to wish to develop further a subject which has so many obvious practical bearings on the prosperity of this country; for England in the opinion of many competent authorities is developing more and more into a meat-producing and not seed-growing land. The parasites of the sheep, dog, hog, and cat are those which form the rest of this instructive little volume.

Chapters on Trees: a Popular Account of their Nature and Uses. By Mary and Elizabeth Kirby (London: Cassell, Petter, and Galpin.)

The Amateur's Greenhouse and Conservatory. By Shirley Hibberd. (London: Groombridge and Sons, 1873.)

We have here a brace of books on arboriculture and floriculture, each of which will be welcomed by a certain class of readers, and will fill a useful place in popular scientific literature. Both are written in an agreeable and attractive manner, and are bound and generally got up in a style to suit the drawing-room table. The authoress of the first (or authoresses, for though two names appear on the title-page, the pronoun used is sometimes the first person singular) must not be taken too implicitly as a guide in her scientific and structural details. Many of her statements are, to say the least, very doubtful, and bear the marks of a want of acquaintance with the recent results of botanical science. Passing by this defect, we have a great deal of interesting information and gossip about a great number of our forest-trees. There are also very good descriptions, forming the best part of the book, of many other trees of great economic value with which we are not so familiar, as the ebony, the camphor, the nutmeg-tree, &c. The illustrations—one full-sized one for every tree, besides smaller ones—are, with a few exceptions, excellent.

The second volume, like all Mr. Shirley Hibberd's, contains a great amount of practically useful information on the culture of plants. Indeed anyone who is interested in the matter will find here advice on almost every point connected with the construction and management of plant-houses, and with the selection, cultivation, and improvement of ornamental greenhouse and conservatory plants. There are a large number of woodcuts and some well-executed coloured plates. The book comes, however, more within the range of the gardener than of the scientific student.

Tenth Annual Report of the Belfast Naturalists' Field Club. (Belfast: 1873.)

We are glad to see from the Committee's report that the condition of this club is in every respect satisfactory, both as to numbers, finances, and, most important of all, amount and value of work done by the members. The

first part of the Report is concerned with the six summer excursions of the club in 1872, interesting accounts of the history, antiquities, and natural history of the various places visited being given. Of the papers contained in the volume, we mention the following :—" The Lignite of Antrim and their Relation to the True Coal," by Mr. William Gray, in which the author considers the subject both geologically and economically. The Rev. Dr. MacIlwaine, in a paper on " Life," gives an account of the various theories as to the nature of life held by philosophers from the earliest times to the present day. A different aspect of the same subject is discussed in Mr. Robert Smith's paper on " Darwinism," in which the author briefly sketches the nature of the Darwinian theory of development, and gives practical exemplifications of its working in every-day life. Mr. William Gray gives an entertaining account of some of the doings of the notorious " Flint Jack " in Ireland ; and the longest paper in the volume, by the Rev. Edmund M'Clure, is one of considerable ethnological value, on " Family Names as indicative of the Distribution of Races in Ireland." The Society offers a considerable number of prizes, competition for which will no doubt tend to encourage the practical study of the various subjects with which the Society is concerned. Altogether it seems to be in a thoroughly healthy condition.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Prof. Young and the Presence of Ruthenium in the Chromosphere.

I HAVE been asked by Prof. Young, of Dartmouth College (U.S.) to say, with reference to the statement made on p. 244 of the third edition of my "Spectrum Analysis" concerning the presence of Ruthenium (Ru) in the solar atmosphere, that possibly by a *lapsus calami* he may have written the symbol (Rb) when giving the information of his discovery to Dr. Huggins, from whom I received a note on the subject.

Although, in accordance with Prof. Young's desire, I make these remarks, I cannot help feeling that they are quite unnecessary, as no one who knows the careful exactitude of Prof. Young's work could for a moment suppose that he was capable of making a confusion between Rubidium and Ruthenium.

H. E. ROSCOE

Owens College, Manchester, Nov. 4

The Miller Casella Thermometer

I WAS surprised on reading Messrs. Negretti and Zambra's letter published in your journal of October 23.

I was under the impression that it had been conclusively established that the principle upon which the Casella-Miller or Miller-Casella Deep-Sea Thermometer is constructed is identical with the one originally made in 1857 by Messrs. Negretti and Zambra at the suggestion of Mr. Glaisher, F.R.S., by the late Admiral Fitz-Roy's directions for the Board of Trade.

I was present when Mr. Scott, F.R.S., Director of the Meteorological Department of the Board of Trade, read a paper upon the subject at the Meteorological Society, January 17, 1872 ; he said :—" I submitted one of these instruments, made for the late Admiral Fitz-Roy, to hydraulic pressure; it proved good and trustworthy. The history of these instruments was perfectly familiar to many gentlemen interested in deep-sea soundings in 1869."

I may add that I saw the original instrument at the Hydrographic Office ten years ago ; in justice I am bound to say that Messrs. Negretti and Zambra were the first manufacturers of a deep-sea thermometer unaffected by pressure.

208, Piccadilly, Oct. 29 P. PASTORELLI

Captain Hutton's "Rallus Modestus"

IN the notice of the current *Ibis*, which appeared in Vol. viii. p. 519, reference is made to a paper by Captain Hutton, contending for the validity of his *Rallus modestus*, as distinct from *R. dieffenbachii.*

The next number of the *Ibis* will contain my reply to Captain Hutton's communication. In the meantime I will merely state that the whole of his argument rests on the assumption that *Rallus dieffenbachii* and *R. philippensis* are the same, in which he is entirely mistaken.

It is a fallacy, therefore, to suppose that because he has shown his bird to be distinct from *Rallus philippensis*, with which he compares it, he has proved it to be distinct from *Rallus dieffenbachii*, which, by his own admission, he has never seen.

Oct. 18 WALTER L. BULLER

Flight of Birds

IN NATURE, vol. viii. p. 86, Mr. J. Guthrie calls attention to, and asks explanation of, a curious phenomenon in the flight of birds observed by him :—" In the face of a strong wind," he says, "the hawk remained *fixed in space* without fluttering a wing for at least two minutes. After a time it quietly changed its position a few feet with a slight motion of its wings, and then came to rest again as before, remaining as motionless as the rocks around it."

I have often observed the same phenomenon, but, until recently, not carefully enough to warrant any attempt at explanation, though always convinced that it was *not* due to any invisible vibratory motion of the wings, as suggested by Mr. Guthrie. During the past summer, however, while on a tour through the mountains of Oregon, I had a fine opportunity of watching very closely a large red-tailed hawk (*Buteo montanus*) while performing this wonderful feat, and of noting the conditions under which alone, I believe, it is possible. These conditions are precisely those described by Mr. Guthrie, viz., a *steady wind*, blowing across an *upward slope*, terminated by a ridge. For a half-hour I watched the hawk, with wings and tail widely expanded, but motionless, balancing himself in a fixed position for several minutes in the face of a strong wind ; then changing his position and again balancing, but always choosing his position just above the ridge.

I explain the phenomenon as follows :—The slope of the hill determines a slight *upward* direction to the wind. The bird inclines the plane of his expanded wings and tail very slightly *downwards*, but the inclination *is less than that of the wind.* Under these conditions it is evident that the tendency of gravity would be to carry the bird *forward and downward*, while the wind would carry him *backward and upward.* The bird skilfully adjusts the plane of his wings and tail, so that these two opposing forces shall exactly balance. He changes his place and position from time to time, not entirely voluntarily, but because the varying force or direction of the wind compels him to seek a new position of equilibrium. JOSEPH LE CONTE

Oakland, Cal., U.S., Sept. 19

Collective Instinct

IN response to the appeal which closes Mr. Buck's interesting letter (NATURE, vol. viii. p. 332), the following instance of " collective instinct" exhibited by an animal closely allied to the wolf, viz., the Indian jackal, deserves to be recorded. It was communicated to me by a gentleman (since deceased) on whose veracity I can depend. This gentleman was waiting in a tree to shoot tigers as they came to drink at a large lake (I forget the district) skirted by a dense jungle, when about midnight, a large Axis deer emerged from the latter, and went to the water's edge. Then it stopped and sniffed the air in the direction of the jungle, as if suspecting the presence of an enemy ; apparently satisfied, however, it began to drink, and continued to do so for a most inordinate length of time. When literally swollen with water it turned to go into the jungle, but was met upon its extreme margin by a jackal, which, with a sharp yelp, turned it again into the open. The deer seemed much startled, and ran along the shore for some distance, when it again attempted to enter the jungle, but was again met and driven back in the same manner. The night being calm, my friend could hear this process being repeated time after time—the yelps becoming successively fainter and fainter in the distance, until they became wholly inaudible. The stratagem thus employed was sufficiently evident. The lake having a long narrow shore intervening between it and the jungle, the jackals formed themselves in line along it, while concealed within the extreme edge of the cover;

and waited until the deer was water-logged. Their prey being thus rendered heavy and short-winded, would fall an easy victim if induced to run sufficiently far,—*i.e.* if prevented from entering the jungle. It was, of course, impossible to estimate the number of jackals engaged in this hunt, for it is not unlikely that, as soon as one had done duty at one place, it outran the deer to await it in the another.

A native servant, who accompanied my friend, told him that this was a stratagem habitually employed by the jackals in that place, and that they hunted in sufficient numbers "to leave nothing but the bones." As it is a stratagem which could only be effectual under the peculiar local conditions described, it must appear that this example of collective instinct is due to "separate expression," and not to "inherited habit."

Cases of collective instinct are not of infrequent occurrence among dogs. For the accuracy of the two following I can vouch. A small skye and a large mongrel were in the habit of hunting hares and rabbits upon their own account, the small dog having a good nose and the large one great fleetness. These qualities they combined in the most advantageous manner, the terrier driving the game from the cover towards his fleet-footed companion, which was waiting for it outside.

The second case is remarkable for a display of sly sagacity. A friend of mine in this neighbourhood had a small terrier and a large Newfoundland. One day a shepherd called upon him to say that his dogs had been seen worrying sheep the night before. The gentleman said there must be some mistake, as the Newfoundland had not been unchained. A few days afterwards the shepherd again called with the same complaint, vehemently asserting that he was positive as to the identity of the dogs. Consequently, the owner set one watch upon the kennel, and another outside the sheep-enclosure, directing them (in consequence of what the shepherd had told him) not to interfere with the action of the dogs. After this had been done for several nights in succession, the small dog was observed to come at daydawn to the place where the large one was chained: the latter immediately slipped his collar, and the two animals made straight for the sheep. Upon arriving at the enclosure the Newfoundland concealed himself behind a hedge, while the terrier drove the sheep towards his ambush, and the fate of one of them was quickly sealed. When their breakfast was finished the dogs returned home, and the large one, thrusting his head into his collar, lay down again as though nothing had happened. Why this animal should have chosen to hunt by stratagem prey which it could easily have run down, I cannot suggest; but there can be little doubt that so wise a dog must have had some good reason.

Dunskaith, Ross-shire, Aug. 18 GEORGE J. ROMANES

IN your number of August 14 (Vol. viii. p. 302) Mr. E. C. Buck alluded to the curious and interesting instances of instinct and gregarious action in lower animals, and mentioned that this action has been more particularly observed in the case of wolves in India. These remarks remind me of a curious instance of combined action between two foxes for the capture of their prey, which I witnessed myself more than once; and as similar proceedings, on the part of these animals have been so frequently observed in the hilly country of the department in which I reside, I cannot but conclude that the same habit will prevail among them, wherever they are found. The case is as follows:—One of the two foxes, in the pursuit of a rabbit or hare, continued yelping at short and regular intervals and thus drove the unsuspecting victim in the direction of the appointed bush, where the other fox was concealed and ready to seize its prey as soon as it came within its reach. The capture being effected, they generally divide the prey between them; but if the ambushed fox, in jumping at its prey, has not gained the end in view, the two baffled compeers alternately repeat many times the unsuccessful leap, in order probably to find out the cause of the miscarriage.

The above allusion to foxes leads me to mention another instance of the ingenuity of these animals, which is very remarkable, and one, I believe, which is but little known. On one occasion, in early life, when I happened to pass my College vacation at the Chapelle d'Angillon (Department of the Cher), my attention was attracted twice or three times, when rambling by the side of a small stream called the Petite-Saudre, by a floating mass of moss, which, when drawn to the bank, was found to be swarming with fleas. An old peasant of the neighbourhood, who observed my surprise, gave me the following explanation of the fact, the correctness of which, said he, he could warrant:—Foxes are much tormented with fleas, and when the infliction becomes severe, they gather, from the bark of trees, moss which they carry in their mouths to the side of a stream where the water deepens by degrees. Here, they enter the water, still carrying the moss in their mouths; and, going backwards beginning from the end of their tail, they advance by slow degrees, till the whole body of the animal, with the exception of the mouth, is entirely immersed. The fleas, during this proceeding, have rushed successively in rapid haste to the dry parts and finally to the moss, and the fox, when he has, according to his calculation, allowed sufficient time for all the fleas to take their departure, quietly opens his mouth. The floating moss, with its interesting freight, is carried away by the stream, and the animal finds its way back to the bank, with an evident feeling of much self-satisfaction at having thus freed himself from his tormentors.

Many persons, and very trustworthy ones, confirmed to me the old peasant's account.

Montpellier, Oct. 17 A. PALADILHE

Venomous Caterpillars

ONCE before I wrote to you on this subject, and had hoped that the entomological mountain had long since been safely delivered of its mouse. But from recent communications such appears not to be the case.

Any large caterpillar with tolerably stiff hairs that will not, in different degrees, affect tender skin when brought incautiously in contact, may probably be looked upon as a phenomenon. That any larva with stiff spines will occasion inconvenience by more violent contact is, I should think, evident to any thinking naturalist. That inflammatory symptoms will most probably follow in either case is also evident. The puncture made by a single steel filament would occasion little or no inconvenience; but if multitudes of these filaments were simultaneously directed on a limited surface of skin, the result would be very different. The best analogue of the irritation caused by larval hairs is, as I before hinted, to be found in that following the handling of certain boraginaceous plants—*Echium vulgare, Symphytum officinale*, &c.

Mr. Riley, the State Entomologist for Missouri, has, in his fifth annual report, devoted a chapter to this subject, and states that he is acquainted with fifteen indigenous larvæ having so-called urticating powers, and in every instance the action is mechanical. Those observers who place so much stress upon the fact of contact with a hairy larva causing pain should not let surprise get the better of their judgment; nor, in the case of those residing abroad, should they allow themselves to be influenced by native superstitions. The position is simply this: any hairy larva is likely to cause irritation mechanically, from particles of the numerous hairs piercing the skin; no case has yet been proved in which such irritation is the result of *venom*, such as that of *Urtica* among plants.

Lewisham, Oct. 10 R. MCLACHLAN

Harmonic Echoes

THE phenomenon mentioned by W. G. M. of notes higher in pitch than the sound producing them being reflected from railings, is not at all uncommon, and is very easy of explanation. Suppose a person standing close to a line of upright bars, the distance between the bars being . a . If he now makes any sharp sound, so as to propagate a single wave, this wave will be successively reflected by each of the bars; so that, in answer to the single wave he propagates, he will have an echo of the pitch corresponding to $\frac{V}{2a}$ vibrations per second (V being the velocity of sound). If, however, he stands at any distance, say κ, from the row of bars, he ought to get a slightly descending echo, as then each wave succeeds the last at a distance increased by twice the difference between $\sqrt{\kappa^2 + n^2 a^2}$ and $\sqrt{\kappa^2 + (n-1)^2 a^2}$, where n is the number of the bar measured from opposite the observer. ARNULPH MALLOCK

Brampford Speke, Oct. 13

Evolution as applied to the Chemical Elements

WHEN so little is really known about evolution, even in the sphere of organic matter, where this grand principle was first

prominently brought before our notice, it may perhaps seem premature to pursue its action further back in the history of the universe. However, it seems but natural that we should apply this hypothesis to explain the close connection that holds between certain of the so-called elements. Pre-supposing that this theory has not been discussed before, I will just mention the chief grounds for holding it, and leave the examination into its truth or falsity in the hands of more experienced chemists. Herbert Spencer defines evolution as the integration of matter at the expense of force; this integration being accompanied by a loss of polarity, and by specialisation in a certain direction. Thus much being granted let us see how far this change from simple to complex is traceable in the qualities of certain of the elements, as seen especially in those that fall under natural groups.

In the first place, we may call some of the metals more generalised than others. Thus all hydrogen salts are soluble in water; so, to a less extent, are those of lithium, sodium, and potassium; but as the atomic weight (or mass) increases, so the salts of those metals become less and less soluble. This is only true speaking generally, for we see that, in particular cases, the hydrate of barium is more soluble in water than that of calcium, &c. But, as a rule, the salts of barium are less soluble than those of strontium; these, again, than calcium salts. But, on the whole, we may say that with increase of atomic mass of the metals, their salts lose their general properties and become more and more specialised, the salts taking their character from the metal in combination.

Secondly, according to this hypothesis, increase of atomic mass should be accompanied by absorption of motion. Just as the very complex molecules, of which living organisms are built up, are deficient in polarising or crystallising force, so are also the more massive chemical atoms: for it is evident that the heavy atoms of lead and bismuth have far less of this force, called chemical affinity, than have the light sodium, or the still lighter hydrogen atoms. In colloid bodies, the atomic attractions are mostly used up in keeping together the comparatively great masses of the molecule: hence but little polarity, or attraction among the molecules themselves, is manifested, and the compounds from the union of these molecules are unstable. So, too, the more massive atoms of elements enter with more difficulty into combination, and the products formed are unstable. Thus, the chlorides of platinum, or the oxides of lead, &c., are less stable, and more difficult of formation, than the corresponding salts of potassium or magnesium. Whereas colloids and crystalloids readily unite together: this is paralleled by the strong affinity that hydrogen, or any metal, has for chlorine or oxygen. Here the metal is the light crystalloid, the non-metal, the colloid, so to speak. It is only with the more specialised of the metals, those which we have seen have massive atoms, that hydrogen will unite, viz., antimony and arsenic; and the compound it forms with the former is very unstable, whilst the hydride of bismuth is unknown. These compounds are not alloys like that of hydrogen with palladium, but they show the comparatively non-metallic nature of arsenic and antimony. This consideration leads us to suppose that the non-metals are still more highly evolved than the metals, and that in the special direction towards electro-negative polarity. Besides we know that the intermediate links differ in degree, not in kind.

The lessening of the atomic heat with increase of mass shows a further absorption of motion, besides the potential energy possessed by the more massive atoms. It might be objected that motion has never been extracted from these massive atoms; on the contrary, as a rule, the heat of combustion is greater as atoms of the element entering into combustion are lighter. But the molecules of organic matter must be decomposed by suitable means before they can do any work; just so with the elements, which receive their name for the very reason that, as far as we know, they are incapable of decomposition. Perhaps, indeed, the increase in the number of rays in the spectra of highly heated sulphur and nitrogen will be regarded as an instance of such motion.

Thirdly, if we look at the atomic weight of groups of the elements, it is seen that the increase of mass occurs by a simple proportion. Gladstone, Dumas, Odling and others have shown the close relation of the numbers for particular groups; whilst lately Mendelejeff has given out a law of periodical recurrence, connecting the properties and the atomic weight, either received or theoretical, of all known elementary bodies. Thus we have—

$$\begin{Bmatrix} \mathrm{Ca} = 40 \\ \mathrm{Ba} = 137 \end{Bmatrix} \mathrm{Sr} = \frac{40 + 137}{2} = \begin{matrix} 88{\cdot}5 \\ (\mathrm{Sr} = 87{\cdot}5) \end{matrix}$$

$$\begin{Bmatrix} \mathrm{Cl} = 35{\cdot}5 \\ \mathrm{I} = 127 \end{Bmatrix} \mathrm{Br} = \frac{35{\cdot}5 + 127}{2} = \begin{matrix} 81{\cdot}25 \\ (\mathrm{Br} = 81) \end{matrix}$$

$$\begin{Bmatrix} \mathrm{Li} = 7 \\ \mathrm{K} = 39{\cdot}1 \end{Bmatrix} \mathrm{Na} = \frac{7 + 39{\cdot}1}{2} = \begin{matrix} 23{\cdot}05 \\ (\mathrm{Na} = 23) \end{matrix}$$

These instances suffice to show how near the calculated atomic weights come to those found by experiment.

In the fourth place it is a significant fact, that the elements themselves become changed in properties under different circumstances; the allotropic forms that result may be said to correspond with "varieties" among organised bodies. In the case of the elements greater atomic mass was said to denote evolution; in the best known allotropic varieties we find change from the normal form to be accompanied by increased density. Thus ozone (allotropic oxygen) and red phosphorus have both a greater density than the usual forms of these bodies.

With greater evolution, the so-called elements become more electro-negative; so in these instances, ozone has a greater affinity for hydrogen and the metals than has oxygen, and amorphous phosphorus less affinity for oxygen than ordinary phosphorus.

The varieties of sulphur would seem to be exceptions, for they are of less density than the usual form; the specific gravity of crystallised sulphur is 2·05, that of plastic sulphur, 1·95. However Berthellot terms the crystallised octagonal variety, electro-negative, plastic sulphur, on the contrary, electro-positive. Hence the octagonal form is at once denser and more electro-negative, and should be regarded accordingly as more highly evolved.

In the fifth place, let us note some of the actions and reactions of matter and forces.

(*a*) Heat: In any organic group, generally speaking, the greater the vapour density, accompanying greater complexity, the higher is the boiling point. So it is with the elements, taken according to natural groups, the greater the atomic weight, the higher the fusing or boiling point. This is seen in the case of chlorine, bromine, and iodine; arsenic, antimony, and bismuth, &c. Exceptions to this rule are the three closely allied metals, zinc, cadmium, and mercury, the most volatile of which is the heaviest, the least volatile, the lightest. Again, the more complex the chemical constitution of bodies is, the worse, generally, do they conduct heat and electricity: so too the more highly evolved and massive the atoms, the worse conductors are they as a rule. This applies strictly only to groups, as calcium conducts better than barium or strontium, but silver, though heavier and of greater atomic weight, nearly five times better than calcium. The difference of conducting power between metals and non-metals is very apparent. Where the atomic mass is greater, as the body verges more towards the electro-negative, this loss of conductibility and the high fusing point is easily accounted for by the mechanics of motion. The heavier atom takes longer to communicate its motion in the one case; or is more difficult to move in the other.

Some natural groups of the elements offer good examples of what has just been stated, *e.g.*

	Atomic Weight	Specific gravity.	Solubility of Salts.	Electric conductivity.
Ca	40·0	1·5	Maximum.	22·14
Sr	87·5	2·5	—	6·71
Ba	137·0	4·5	Minimum.	Minimum.

	Atomic weight.	Physical state.	Chemical activity.	Vapour density.
Cl	35·5	Gas.	Maximum.	2·4
Br	81·0	Liquid.	—	5·4
I	127·0	Solid.	Minimum.	8·7

Hydrogen has the greatest conducting power of all gases. To the principle that lighter atoms have greater polarity or chemical affinity, Bunsen has found an exception, that cesium is heavier and yet more electro-positive than potassium or sodium.

The order of solubility or of chemical activity shows that chlorine and calcium are the more generalised of their respective groups, as we should expect.

(*b*) In the case of Light, not much can be said as yet: but with regard to radiation and absorption of radiant heat, Tyndall has shown that the complex molecules of organic vapours are the best radiators, and that uncombined atoms can hardly be said to radiate or absorb at all. So we see that the simple, "metallic" vapours radiate but ill, whilst the more complex atoms do not reflect, but rather absorb light and heat rays. Indeed, we may suppose, that as in the case of complex vapours, the more highly evolved atoms, requiring a greater supply of force, turn these rays that fall on them to account; whilst the metals dispense with them by reflecting them.

(*c*) The chief relations of electricity have already been alluded to. The chemical affinity between elements increases as they differ in electric polarity; and the more highly evolved, the more chlorous or electro-negative are they.

Lastly, late researches have shown that the elements nitrogen and sulphur at a high temperature, give more complex spectra. This fact, if it be a fact, has thrown some doubt on their claim to be regarded as absolute elements.

In explaining the phenomenon, we should probably consider the sulphur particle to be composed of several groupings of the ultimate element, which, driven apart by the action of heat, are made to vibrate separately with various velocities. Thus the allotropic form of oxygen, ozone, has been represented by a simple formula $\left.\begin{matrix}O\\O\end{matrix}\right\}O$, being made up, as it is supposed, of two groupings of the element oxygen, that being the ultimate atom.

The above statements seem to me to agree in showing, that if the hypothesis of evolution is tenable at all, it can be extended to explain all or nearly all the relations between the elements at present existing on this globe. C. T. BLANSHARD

Queen's College, Oxford

Ancient Balances

Apropos of Mr. Chisholm's interesting account of ancient weighing instruments, in your last number, I venture to call his attention to the representation of an equal-armed balance in an Egyptian papyrus of the nineteenth dynasty, about 1350 B.C. It is to be found in the celebrated "Ritual of the Dead," a hieroglyphical papyrus of Hunnefer, of the reign of Seti I. In the "Judgment Scene" the heart of the deceased is represented as being weighed in a balance in the Hall of Perfect Justice, and in the presence of Osiris. The balance is of the ordinary equal-beam construction, the final adjustment being attained by a sliding weight on one side of the beam, exactly like the "rider" on our exact balances. The papyrus may be seen in the British Museum. G. F. RODWELL

Brilliant Meteors

ON Saturday evening (Oct. 18), about half-past 8 o'clock, I observed, from Boltsburn, Durham, a meteor of considerable brilliancy in the north-western part of the sky; it shot downward from an elevation of about 40°, and left a streak of very red light on its path. The streak continued visible for nine or ten seconds. JOHN CURRY

Boltsburn, Oct. 20

LAST evening, October 26, when returning home I observed a brilliant meteor stream across the sky. It may be worth while to record it.

Not having my watch, I can only guess the time as about 8.20 P.M. The first appearance was like a flash of lightning intensely white, arresting attention at once. When observed it streamed from ξ Persei above Capella (in altitude) and disappeared in Lynx. For two-thirds of its course its light was very bright, and it left a brilliant train of sparks, but for the remaining third it merely showed its own single expiring light.

Later in the evening when observing with the telescope in Cepheus, two shooting stars crossed the field at different times, apparently from the same radiant. T. T. S.

Thruxton Rectory, Hereford

SIR HENRY HOLLAND

ALTHOUGH the late Sir Henry Holland, whose name has been familiar to the world during the greater part of the present century, cannot be regarded as a man eminent in scientific research, still, as a Fellow of the Royal Society of nearly sixty years' standing, as President of the Royal Institution, as one who was ever ready to contribute towards the advancement of scientific research, and as the friend of all the most eminent men of science of his time, which was a long one, we deem him worthy of more than a passing notice.

As much as for anything else, Sir Henry was known as an indefatigable traveller; his fondness for travelling, indeed, having led to the illness which was the immediate cause of his death on October 27 last, his 86th birthday. He had very early in his career deliberately determined to set aside two months each year for the purpose of indulging his favourite recreation. This year, immediately after his return from a visit to Russia, he set off for Naples in September last, staying a short time at Rome and Paris on his way home. He arrived in London on October 25, suffering from a slight cold, which was sufficient, notwithstanding the wonderful robustness of his constitution, to cut him off in two days. He began his travelling career by a visit to Iceland in 1810, since which he has explored almost every corner of Europe, and been eight times in America. In his "Recollections of Past Life," published in 1872, he speaks thus of his travels:—

"The Danube I have followed with scarcely an interruption, from its assumed sources at Donau-Eschingen to the Black Sea—the Rhine, now become so familiar to common travel, from the infant stream in the Alps to the 'bifidos tractus et juncta paludibus ora' which Claudius with singular local accuracy describes as the end of Stilicho's river journey. The St. Lawrence I have pursued uninterruptedly for nearly 2,000 miles of its lake and river course. The waters of the Upper Mississippi I have recently navigated for some hundred miles below the Falls of St. Anthony. The Ohio, Susquehanna, Potomac, and Connecticut rivers I have followed far towards their sources; and the Ottawa, grand in its scenery of waterfalls, lakes, forests, and mountain gorges, for 300 miles above Montreal. There has been pleasure to me also in touching upon some single point of a river, and watching the flow of waters which come from unknown springs or find their issue in some remote ocean or sea. I have felt this on the Nile at its time of highest inundation, in crossing the Volga when scarcely wider than the Thames at Oxford, and still more when near the sources of the streams that feed the Euphrates, south of Trebizond."

It was mainly on account of the reputation which even then he had achieved as a traveller, that he was elected a Fellow of the Royal Society in 1815.

Sir Henry was elected President of the Royal Institution in 1865, and took the very warmest interest in its success, and in the promotion of scientific research, being seldom or never absent from his post, doing much to popularise science among the upper classes, among whom, as our readers know, he was always a welcome guest. For fifteen years Sir Henry contributed 40*l*. annually to a fund specially set apart for the promotion of research, and was always ready to take by the hand promising young students who were diffident of their own abilities. Sir Henry himself never knew what it was to struggle, no man ever slid more easily into the highest professional and social position, and no man was ever probably less spoiled by his success. He counted from the very first among his patients, many of whom became his intimate friends, the highest in social and political rank both at home and abroad, and the most eminent in literature, science, and art, knew nearly everyone whose name during the last sixty years has been before the public, and was respected and loved by all with whom he came in contact. Sir Henry had naturally good abilities, great tact and knowledge of the world, a mind stored with knowledge gained from books, from travel, and from his intercourse with men, which, combined with his genial

bearing, rendered his society wonderfully delightful. As a physician, he was possessed of high skill.

Of Sir Henry's contributions to literature, his "Medical Notes and Reflections" (1839) and his "Chapters on Mental Physiology" (1852) are well known to the medical profession. He contributed a considerable number of articles to the *Edinburgh*, and other reviews, which, in 1862, were published as "Scientific Essays." In 1815, he published his celebrated "Travels in the Ionian Isles and Greece," of which a second edition appeared in 1819; a work abounding in classical, antiquarian, and statistical information, interspersed with interesting details respecting manners and customs, scenery and natural history. In 1816 he contributed to the "Philosophical Transactions" a memoir on the manufacture of sulphate of magnesia at Monte della Guardia, near Genoa, and afterwards papers to various other scientific journals. Last year he published his well-known "Recollections of Past Life," a volume which must long keep Sir Henry Holland's name alive. His memory will be cherished by all who knew him as something ever pleasant to recall.

The Royal Institution has thus, within a year, lost its Secretary and its President, not to mention the resignation of its Professor of Chemistry, who has not yet been replaced. Whoever is elected to fill the Presidential office will, we doubt not, keep up the traditions of the place, and do what in him lies to carry out the original design of the founders and donors of the Institution, never losing sight of the fact that above everything it is meant to be one of the few temples of original scientific research in the country. Its laboratories have recently been rebuilt, and we hope they will ever continue to be taken ample advantage of for purposes of study and research, not only by the earnest successors of the great men who have rendered them famous, but also by competent members, for whom they were originally equally intended by the enlightened and science-loving men to whom the conception of the Institution was originally due.

We conclude this notice by giving a few of the dates, in addition to those already given, which mark Sir Henry Holland's career. He was born at Knutsford, Cheshire, Oct. 27, 1787, and was educated at Newcastle-on-Tyne, and at the school of Dr. Estlin, near Bristol, where he became head boy. In 1804 and 1805 he attended Glasgow University, and in 1806 he entered the Medical School at Edinburgh, where he became acquainted with many of the notable men that then frequented "the grey metropolis of the north"—Sir Walter Scott, Brougham, Sydney Smith, Horner, Jeffery, Dugald Stewart, Sir William Hamilton. In 1816, after spending some time in travel, he established himself in London, and at once achieved high professional success. He became Physician in Ordinary to the late Prince Consort in 1840, and to the Queen in 1852; and next year was created baronet. Sir Henry was twice married, his second wife, who died in 1866, having been the daughter of his old friend Sydney Smith.

THE AMERICAN MUSEUM OF NATURAL HISTORY IN CENTRAL PARK, NEW YORK*

FOR many years a large number of the generous and public-spirited citizens of New York had long felt the need of a museum and library of natural history that should be on a scale commensurate with the wealth and importance of their metropolitan city, and would encourage and develop the study of natural history, advance the general knowledge of kindred subjects, and to this end furnish popular amusement and instruction. In 1868 a remarkable opportunity presented itself of securing a rare collection that would form an admirable nucleus for such a comprehensive museum. The most extensive dealer in specimens in the world, Edouard Verreaux, of Paris, suddenly died, leaving in the hands of his widow a collection, which, at the rates he was accustomed to sell specimens, would have brought over 500,000 francs, 100,000 dols. in gold . . . . Dying suddenly, he left the rich gatherings of an industrious lifetime seriously embarrassed with debt. This opportunity it was decided to try to improve, and a subscription of nearly 50,000 dols. was at once made up as a beginning, and since that time about 100,000 dols. have been contributed in money, though the present property of the institution, including the large donations of specimens which have been steadily coming in, could not be replaced, nor could other as interesting and valuable specimens for less than 250,000. A rare and nearly complete collection of American birds, and many fine birds of paradise and pheasants were first purchased by Mr. D. G. Elliott. While negotiations were about to be opened for the Verreaux collection, a second museum unexpectedly became available. Prince Maximilian of Neuwied on the Rhine above Bonn (not the Emperor Maximilian of Austria and Mexico) died, and the young son inheriting the estate had no scientific taste, and offered the results of his father's life-work for sale. The elder Prince, who formed the collection, passed 1815, 1816, and 1817 exploring Brazil from Rio up to Bahia, and of course a large proportion of the great collections he secured had never at that early date been seen by scientific men in Europe before, and were therefore types of new species.

This collection the American Museum purchased entire. An agreement was soon after made with Mme. Verreaux by which all the choice specimens in her cabinet not contained in the Elliott and Maximilian purchases were selected for the museum, and all these specimens have been safely received from Europe, and are now on public exhibition in Central Park. Large donations of shells, corals, and minerals have been received, and one collection of 20,000 insects. The liberal subscriptions first made induced the principal subscribers to consent to act as trustees for the fund and property acquired by it, and by a special Act of the Legislature they were created a body corporate—they and their successors to have entire and unrestricted control for ever over all the museum property. They have limited their number to twenty-five, and the survivors fill every vacancy, thus securing a fixed policy and stable character to the institution. An arrangement has been made between the trustees and the Department of Public Parks in New York by which the city may furnish lands and buildings, while the collections are to be bought and cared for by moneys contributed by the trustees themselves and the generous public. In pursuance of this plan, by which the authorities of the city and private citizens might cooperate toward the common end of establishing a large museum, 500,000 dols. were appropriated by the city to commence a suitable thoroughly fire-proof edifice, and the Department of Parks was authorised to set apart so much of the public lands under their control as they might deem proper and necessary for the proposed structure and its future extensions.

The great object of the museum is twofold. First, to interest and instruct the masses which already throng its halls, and occasionally number over 10,000 in a single day; and, secondly, and especially to render all the assistance possible to specialists. These wants are shown to be amply met by the large, palatial saloons for the public, and over the whole building a high Mansard story, containing spacious and well-lighted rooms with every modern convenience, where naturalists from every part of the country may pursue their favourite studies for any length of time, and be secure from all possible interruptions. The building will undoubtedly be ready for occupation in the spring of 1875.

* A Paper read by Albert L. Bickmore, Ph. D., Superintendent, at the Meeting of the American Association.

THE COMMON FROG *

III.

To prosecute successfully our inquiry "What is a Frog?" it will be well now to make acquaintance with the more remarkable forms contained in its *Order*, after which, by considering the other Batrachian orders, we may arrive at a certain appreciation of its *Class*.

The Frog's own genus (Rana), which contains about 40 species, has its head-quarters in the East Indies and in Africa, but extends over all the great regions of the

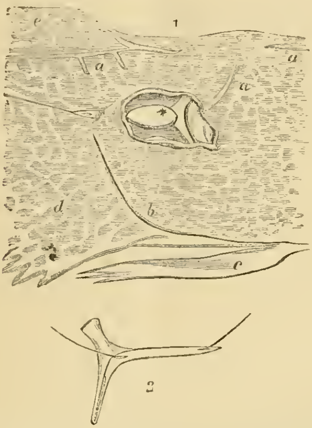


FIG. 7.—Poison Organ of *Thalassophryne reticulata* (after Günther). 1, Hinder half of the head with the venom-sac of the opercular apparatus *in situ*. * Place where the small opening in the sac has been observed. *a*, Lateral line and its branches; *b*, gill-opening; *c*, central fin; *d*, base of pectoral fin; *e*, base of dorsal fin. 2. Operculum, with the perforated spine.

world, except Australia, and parts more southerly still, and except countries situate above 66° north latitude. In South America, however, but a single species is as yet known to exist.

Amongst the largest species are *Rana tigrina*, of India and the Indian Archipelago, and the bull-frog (*R. Mugiens*)

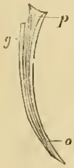


FIG. 8. FIG. 9.

FIG. 8.—Vertical, Longitudinal Section of the Poison-fang of a Serpent (after Owen). *g*, deep grove; *o*, its lower termination, which affords exit to the poison; *p*, pulp-cavity. FIG. 9.—Magnified Transverse Section of a Serpent's Poison-fang (after Owen) *g*, groove round which the substance of the tooth (containing *p*, the pulp-cavity) is bent; *j*, the point where the sides of the tooth meet and convert the "groove" into what is practically a central cavity.

of North America. The latter animal may often be seen in the Gardens of the Zoological Society, where it is fed on small birds—a sparrow being easily engulphed within its capacious jaws.

The Edible Frog, *par excellence* (*R. esculenta*), is found in England as well as on the Continent of Europe. It is as widely distributed over the old world as is *R. temporaria*, but it is unknown in America. It is easily to be discriminated from the common species (see Fig. 4 on p. 510) by the absence of that dark, sub-triangular patch which extends backwards from the eye in *R. temporaria*.

* Continued from vol. viii. p. 512.

The male of *R. esculenta* is further to be distinguished from the male of the common Frog by the fact of its having the floor of the mouth on each side, distensible as a pouch—the pouches, when distended, standing out on each side of the head. These pouches are called "vocal sacs," and no doubt aid in intensifying these animals' croak, which is so powerful that (on account of it and

FIG. 10.—The female of *Nototrema marsupiatum*, with the pouch partly cut open (after Gunther).

because of the country where they are common) they have been nicknamed "Cambridgeshire Nightingales." Specimens from Cambridgeshire are preserved in the British Museum.

A large South American Frog (*Ceratophrys cornuta*), which devours other smaller Frogs as well as small birds and beasts, is noteworthy on account of the singular bony

FIG. 11.—The Surinam Toad (*Pipa americana*).

plates which are enclosed in the skin of its back: a character which it shares with a small South American Toad (*Brachycephalus ephippium*), and which we shall hereafter see to be a point of special interest.

A Frog newly discovered* (of a new genus but one allied to *Rana*), called *Clinotarsus*,† has been

* The type of this genus is a species which was in my own collection (with no clue to the locality whence it originally came), but is now deposited in the British Museum. It was first described in the Proceedings of the Zoological Society for 1868, under the name *Pachybatrachus*.

† Proc. Zool. Soc., 1869.

(see Fig. 5, vol. viii. p. 511) represented, in the hope that by the wider circulation of a figure of it, it may be recognised, and its habitat so ascertained.

The common Toad (*Bufo vulgaris*) is as widely distributed over the earth's surface as is *Rana esculenta*. It is less aquatic than the frog, and more sluggish in its motions. In shape it resembles the frog, but is more swollen, with much shorter legs and a warty skin (see Fig. 6, vol. viii. p. 511). The toes are less webbed, and the margin of the upper jaw, as well as the lower, is entirely destitute of teeth. The jaws are similarly toothless in *all* toads.

The toad is provided with an oblong, elongated gland called *Parotoid*) behind each eye. These glands emit a milky secretion which is acrid and very unpleasant to the

Fig. 12.—*Dactylethra capensis.*

mouth of some carnivorous animals. Those who have observed a dog attacking a toad can hardly have failed to notice the disgust which the former animal seems to exhibit by the copious flow of its saliva, its many head-shakings, &c. The toad's secretion, however, cannot be said to be poisonous, and certainly it is not so in the mode in which the venom of serpents is poisonous, since a chicken may be inoculated with it, and yet appear to suffer no injury whatever beyond the infliction of the slight wound necessary for the performance of the opera-

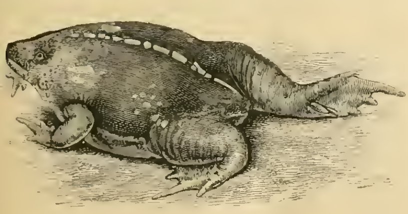


Fig. 13.—*Rhinophrynus dorsalis.*

tion. Nevertheless the secretion exercises a very decided effect upon certain animals, since the tadpoles both of frogs and of salamanders are very powerfully affected by being kept in the same water with a toad, if the latter be specially irritated in order to make it discharge its pungent and irritating secretion.

True poison and organs fitted both to inflict wounds and to convey the venom into them are not indeed found in any animals which are even near allies of the frogs and toads. Nevertheless a very perfect organ for both wounding and poisoning has been discovered by Dr. Günther to exist in a certain fish (*Thalassophryne reticulata*), belonging to a group which, on account of their superficial resemblances to frogs, are termed "Batrachoid."

He found in the fish no less than four spines each per-

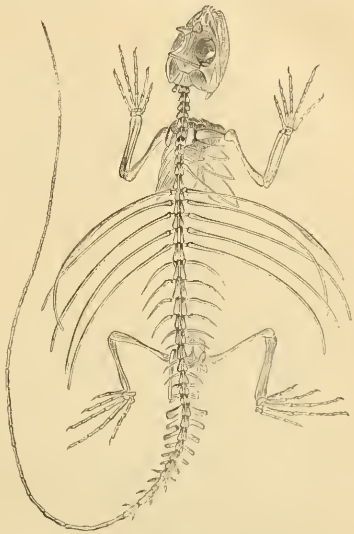


Fig. 14.—Skeleton of the Flying-dragon.
(Showing the elongated ribs which support the flitting organ.)

forated like the tooth of a viper, and each having a sac at its base. One such poison-spine was situated on each

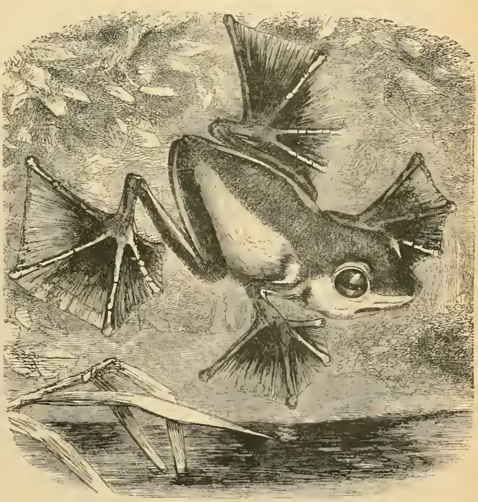


Fig. 15.—The Flying-frog (from Wallace's "Malay Archipelago")

side of the hinder part of the head in front of the gill opening. Two others were dorsal spines placed one behind the other on the mid-line of the back. These

poison-organs are probably only used for defence. They are formed, however, on the very same type as are the poison fangs of vipers. Unlike the latter, however, they are not modified teeth, nor are they situated within the mouth as they always are in poisonous serpents.

A Frog (*Pelobates fuscus*) which is common in France (and which is interesting on account of the form of its skull hereafter to be pointed out), though really harmless enough, has a singular power of making itself offensive.

Both males and females of this species utter a kind of croak, and both, if their thigh is pinched, produce a sound like the mewing of a cat. At the same time they emit a strong odour, which is like that of garlic, and becomes stronger as the animals are more disturbed. This emission not only affects the sense of smell, but even makes the eyes water as mustard or horseradish does.

This singular power, together with the acrid secretion of the toad, are the nearest approximation to venomous properties possessed by any members of the order, no toad—not even the giant of the order *Bufo agua*—being really poisonous.

A small Frog, by no means uncommon in France and Germany (*Alytes obstetricans*) has a very singular habit. The female lays its eggs (about sixty in number) in a long chain, the ova adhering successively to one another by their tenacious investment. The male twines this long chaplet round his thighs, so that he acquires the appearance of a courtier of the time of James I. arrayed in trunk hose or puffed breeches. Thus encumbered, he retires into some burrow (at least during the day) till the period when the young are ripe for quitting the egg Then he seeks water, into which he has not plunged many minutes when the young burst forth and swim away, and he, having disencumbered himself of the remains of the ova, resumes his normal appearance

Certain Frogs (forming a very large group) are termed Tree-frogs, from their adaptation to arboreal life by means of the dilatation of the ends of the digits into sucking discs, by which they can adhere to leaves. One of them, the common green Tree-frog (*Hyla arborea*) is spread over Europe, Asia, and Africa, in the same manner as *R. esculenta*, except that it is not found in the British Isles. A few toads also have the tips of their digits similarly dilated. Such, *e.g.*, is the case in the genera *Kaloula* of India, and *Brachymerus* of South Africa.

The female of a peculiar American Tree-frog (*Nototrema marsupiatum*) has a pouch extending over the whole of the back and opening posteriorly. Into this the eggs are introduced for shelter and protection. A dorsal pouch also exists in the allied American genus, *Opisthodelphys*. An American species of *Hylodes* has the habit of laying its eggs in trees singly in the axils of leaves, and the only water they can obtain is the drop or two which may from time to time be there retained.

A still more remarkable mode of protecting the egg is developed by the Great Toad of tropical America (*Pipa americana*). In this case the skin of the females' back at the laying season thickens greatly and becomes of quite a soft and loose texture. The male, as soon as the eggs are laid, takes them and imbeds them in this thick, soft skin, which closes over them. Each egg then undergoes its process of development so enclosed, and the tadpole stage is, in this animal, passed within the egg, so that the young toads emerge from the dorsal cells of the mother completely developed miniatures of the adult. As many as 120 of these dorsal cells have been counted on the back of a single individual.

The only instance of a similar cutaneous modification is that pointed out by Dr. Gunther * in the skin of the belly of the Siluroid fish, *Aspredo batrachus*. Here he found that "the whole lower surface of the belly, thorax, throat, and even a portion of the pectoral fins, showed numerous shallow, round impressions, to which a part of the ova still adhered." He concludes that "it is more than probable that towards the spawning time the skin of the lower parts becomes spongy, and that, after having deposited the eggs, the female attaches them to it by merely lying over them." "When the eggs are hatched the excrescences disappear, and the skin of the belly becomes smooth as before. Even in the highest class of animals (*Mammalia*) we are familiar, in the Kangaroo and Opossum order (*Marsupialia*), with a special external receptacle (the marsupial pouch) for the protection and secure development of the young; but nothing of the kind exists amongst birds or reptiles. In fishes, however, the male of the little Sea-horse (*Hippocampus*) is provided with a ventral pouch in which the eggs are sheltered, and the same class presents us with a mode of carrying the eggs still more bizarre than that of *Alytes obstetricans* just related. In the fish *Arius fissus* the male actually carries about the ova in the mouth, protected by the jaws, till relieved of the inconvenience by the hatching of the young fry.

* See Catalogue of the fishes in the British Museum, vol. v. p. 268.

A South African Toad (*Dactylethra capensis*) is interesting, as we shall hereafter see, on account of certain anatomical points in which it agrees with *Pipa*, and differs from all other Anoura. No interesting facts, however, are known as to its habits.

Another noteworthy form is the Mexican *Rhinophrynus dorsalis*, the exceptional characters of which are the tongue, which is free in front instead of behind, and the enormous spur-like tarsal tubercle.

Almost all Frogs and Toads pass the first stages of their existence in water, going through a free, tadpole stage, and all are more or less aquatic when adult. The only exceptions are *Pipa*, *Nototrema*, *Opisthodelphys*, and the *Hylodes* before referred to. Very many kinds, however, are, when adult, inhabitants of trees. The question may suggest itself to some, "Are there any which can be said in any sense to be aërial animals?" Birds are almost all capable of true flight, as also are those aërial existing beasts the Bats, and as were those extinct reptiles the Pterodactyles. Certain squirrels and opossums can take flitting jumps by means of an extension of the skin of the flank, and a similar, though much greater extension, supported by elongated freely ending ribs, is found in the little lizards (*Draco*) called Flying Dragons.

The class of Fishes supplies us, also, with an example of aërial locomotion in the well-known Flying Fish.

Since, then, every other class of vertebrate animals (Beasts, Birds, Reptiles and Fishes) presents us with more or fewer examples of the aërial species, we might perhaps expect that the Frog-class would also exhibit some forms fitted for progression through the air. We cannot say with certainty that such is the case; but Mr. Alfred Wallace, in his travels in the Malay Archipelago, encountered in Borneo a Tree-frog (*Rhacophorus*) to which he considers the term "flying" may fairly be applied, and of which he says, it "is the first instance known of a flying-frog." Of this animal he gives us the following account:—

"One of the most curious and interesting creatures which I met with in Borneo was a large tree-frog which was brought me by one of the Chinese workmen. He assured me that he had seen it come down, in a slanting direction, from a high tree as if it flew. On examining it I found the toes very long and fully webbed to their extremity, so that, when expanded, they offered a surface much larger than the body. The fore-legs were also bordered by a membrane, and the body was capable of considerable inflation. The back and limbs were of a very deep shining green colour, the under surface and the inner toes yellow, while the webs were black rayed with yellow. The body was about four inches long, while the webs of each hind foot, when fully expanded, covered

a surface of four square inches, and the webs of all the feet together about twelve square inches. As the extremities of the toes have dilated discs for adhesion, showing the creature to be a true tree-frog, it is difficult to imagine that this immense membrane of the toes can be for the purpose of swimming only, and the account of the Chinaman that it flew down from the tree becomes more credible."

The great group of Frogs and Toads, rich as it is in genera and species, and widely as it is diffused over the earth's surface, is one of singular uniformity of structure. The forms most aberrant from our type, the common frog, have now been noticed, except that perhaps the maximum respectively of obesity and slenderness may be referred to. In the former respect the Indian Toad *Glyphoglossus* may serve as an example, and for the latter may be selected *Hylorana jerboa*.

St. George Mivart

(*To be continued.*)

A FOSSIL SIRENIAN FROM THE RED CRAG OF SUFFOLK

At the opening meeting of the Geological Society, Prof. Flower communicated a description of a fine fragment of a skull of an animal of the order *Sirenia*, which is of great interest as affording the first recorded evidence of the former existence of animals of this remarkable group in Britain. The specimen forms part of the very rich collection of Crag fossils formed by the Rev. H. Canham, of Waldringfield, near Woodbridge. It was found in the so-called "coprolite" or bone-bed at the base of the Red crag, and presents the usual aspect of the mammalian remains from that bed, being heavily mineralised, of a rich dark brown colour, almost black in some parts, with the surface much worn and polished, and marked here and there with the characteristic round or oval shallow pits, the supposed *Pholas* boring.

The fragment consists of the anterior or facial portion of the cranium which has separated, probably before fossilisation, from the posterior part at the fronto-parietal suture, and in a line descending vertically therefrom. This portion has then been subjected to severe attrition, by which the greater part of the pre-maxillary rostrum, the orbital processes of the maxillaries, and other projecting parts have been removed. In consequence of this, what may be called the external features of the skull, which are especially necessary to determine its closer affinities, are greatly marred, though enough remains of its essential structure to pronounce with confidence as to its general relationship to known forms. Fortunately, the whole of the portion of the maxillæ in which the molar series of teeth are implanted is preserved; and though the teeth have fallen from the alveoli in the front part of the series, and in the posterior part are ground down to mere stumps, so that the form of the crowns cannot be ascertained in any, many important dental characters may still be deduced from the number, form, size and position of the sockets and roots that remain.

As the intensely hard, ivory-like rostra of the ziphioid Cetaceans, the tympanic bones of the Balænidæ, and the teeth of terrestrial mammals almost alone remain in these deposits to attest the former existence of their owners; it is, doubtless, to the extreme massiveness and density of the cranial bones, as characteristic of the order Sirenia, that we owe the preservation of so large a portion of the skull under the very unfavourable conditions to which it, in common with the other fossils of the formation, must have been exposed.

After a comparison of the characters of the cranium with those of the several existing and extinct members of the order, Prof. Flower referred it to the genus *Halitherium*, and showed its relationship to *H. Schinzi* of Kaup from the miocene of the Rhine basin, a formation, it will be remembered, in which several of the animals of the Red Crag bone-bed occur. It is, however, of larger size than that species, the teeth are larger, both absolutely and relatively to the cranium, and certain other differences occur, though the imperfect nature of the materials makes exact comparison of fossils only known from fragments not altogether easy or satisfactory. Believing, however, that it does not belong to either the above-mentioned, or any other of the hitherto described species of *Halitherium*, the specific name of *H. canhami* was proposed. It should be mentioned that there are six teeth in the maxillary or molar series on each side, all present at the same time, the first two with single roots, the third with two roots, and the last three with three roots, precisely resembling in form those of the molar teeth in the existing Manati.

ON THE STICK-FISH (Osteocella septentrionalis) AND ON THE HABITS OF SEA-PENS

Mr. Coote M. Chambers has most kindly presented to the British Museum a specimen of the Stick-fish, from English Bay, Burrard's Inlet, British America. The specimen was placed alive, immediately it was caught, into a tin tube, filled with a solution of arsenic and salt.

Mr. Chambers observes that the Stick-fish are only to be found in Burrard's Inlet, English Bay, British Columbia. "It has only one bone in it, and appears to live on suction, and is a great prey to dogfish." Further: "I would mention that in summer only can they be caught. They are found to the least depth of from 30 to 40 fathoms, they move about rapidly in the water, and when brought to the surface, move for a few seconds like a snake, then make a dart as swift as lightning, and disappear."—July 23, 1873.

Unfortunately the specimen did not arrive in a good state for exhibition. The greater part of the animal portion had been washed off, probably by the motion of the solution during the transit; only about a foot of the flesh, which was loose on the axis, and the thick, swollen, naked, club-shaped base without polypes remained; but it was in a sufficiently good state to afford the means of determining its zoological situation and of examining its microscopical and other zoological characters.

Mr. Chambers' specimen is the animal of the axis, or stick, that I described as *Osteocella septentrionalis* (Ann. and Mag. Nat. Hist. 1872, ix. p. 406), and it proves that the axis belongs to a kind of *Pennatula*, or Sea-pen, nearly allied to the long Sea-rushes named *Pavonarius quadrangularis*, found on the West Coast of Scotland, and is evidently the same animal as *Pavonaria blakei*, described by R. E. C. Stearns. The idea of its being a fish, which seems so generally entertained by the people of British Columbia, is clearly a mistake, though one of the observers sent a figure of the Sea-pen, with mouth and eyes like an eel (!), which is copied in Nature, vol. vi. p. 436.

Osteocella.—The complete polype-mass very closely resembles *Pavonaria quadrangularis*, as figured by Johnston ("British Zoophytes," t. xxxi.), from Prof. Edward Forbes' drawings; but the animal is entirely destitute of calcareous spicules, and the axis is cylindrical, hard, and polished.

Two days after I received this specimen, I received by post Mr. Stearn's description of the Stick-fish (*Pavonaria Blakei*), from the San Francisco *Mining and Scientific Press*, August 9, 1873.

The description of Mr. Stearn, made from a fresh animal, need not be repeated; but as he does not mention the microscopic structure, I sent a fragment of Mr. Chambers' specimen to Mr. Carter to be examined, who kindly writes:—"The fragment arrived safely, although

the Post-office tried to crush the box to the thickness of silver-paper. The bit contains no spicules, nothing but a mass of contorted tubes filled with small nuclei like ova. "The nuclei are about 1-600th of an inch in diameter, and I suppose they are in tubes. The part you sent was boiled in *Liquor potassæ*; that is how the structure alone came out, but there were no spicules in it, examined in this way or in water alone, but many fat globules, and a few sheaf-shaped calcareous concretions, common in all preparations of animal matter."—September 5, 1873.

The habits of *Pennatulidæ* are very imperfectly known and not at all understood. Dr. Johnston observes in the "British Zoophytes," vol. i. p. 160, that the fishermen believe that the common Sea Pens, which they call Coxcombs, "are fixed to the bottom with their ends immersed in the mud." The *Virgularia mirabilis* are believed by the fishermen to have one end erect in the mud, and *Pavonaria quadrangularis*, according to Profesor Forbes, "lives erect, its lower extremity, as it were, rooted in the slimy mud at a depth of from twelve to fifteen fathoms." Mr. Darwin, who observed a species on the coast of Patagonia, which he called *Virgularia patagonica*, says: "At low water hundreds of these zoophytes may be seen projecting like stubble, with the truncate end upwards a few inches above the surface of the muddy sand. When touched or pulled they suddenly drew themselves in with force so as nearly or quite to disappear. By this action the highly elastic axis must be bent at the lower extremity, where it is naturally slightly curved, and I imagine it is by this elasticity alone that the zoophyte is enabled to rise again through the mud."

Bohadsch, as quoted by Johnston, says that the *Pennatulæ* swim by means of their *pinnæ*, which they use in the same manner that fishes do their fins. Ellis says: "It is an animal that swims freely about in the sea, many of them having a muscular motion as they swim along." And in another place he tells us, that "these motions are effected by means of the pinnules or feather-like fins, these are evidently designed by nature to move the animal backwards and forwards in the sea, consequently to do the office of fins." Mr. Clifton describes the Australian species as swimming rapidly in shallow water; and the American naturalists all seem to agree that the Stick Fish, *Osteocella septentrionalis* of Burrard Inlet, which has only a slight crest of polyps, and not *pinnæ*, or fins, as Ellis calls them, swims about like a fish, and is eaten by the dog-fish.

There seems to be no doubt that the Sea-Pens and Sea-Rushes do live in groups together, erect, and sunk in the mud, and that they are sometimes found swimming free in the sea, but the question is, are the free specimens those that have been disturbed by the waves and currents, and do they afterwards affix themselves in the mud, or are they vagrant specimens that live for a time and then die or are eaten by fish, their struggling being mistaken for swimming? Dr. Johnston observes, that when the Sea-Pens are placed in a basin or plate of water, he never observed a change of position, but they remain in the same place and lie with the same side up or down just as they have been put in. That is my own experience even when they are placed in a deeper vessel, but this may arise from the animal having lost part of its vitality before it was taken.

It may be useful to give the synonyma of these animals.

Osteocella, Gray, Cat. Pennatulidæ, 1870, p. 40. Ann. and Mag. Nat Hist. 1872, ix. p. 405.

Pavonaria, sp. Stearns, *Mining and Scientific Press*. San Francisco, Aug. 9, 1873.

Verillia, Stearns, Californian Acad. Sci., Aug. 18, 1873.

1. *Osteocella cliftoni*, Gray, Cat. Pennatulidæ, 1870, p. 40; Ann. and Mag. Nat. Hist. 1872, ix. p. 406.

Hab., Western Australia (G. Clifton, Esq.), B.M.

2. *Osteocella septentrionalis*, Gray, Ann. and Mag. Nat. Hist. 1873, ix. p. 406 (style only).

"New Marine Animal," Sclater, Brit. Assoc., Aug. 20 1872; NATURE, vol. vi. p. 436 (with figure of fish, of which it is said to be the notochord).

"Axis of Pennatulid," H. N. Moseley, NATURE, Sept. 26, 1872, vol. vi. p. 432.

"Pennatulid," Dawson, NATURE, Oct. 24, 1872, vol. vi. p. 516; Whiteaves, Nat. Hist. Soc. Montreal, 1872.

"New Alcyonoid," Stearns, Proc. Cal. Acad. Sci., Feb. 1873, v. part 1, p. 7.

Pavonaria blakei, Stearns, *Mining and Scientific Press*, San Francisco, Aug. 9, 1873.

Verrillia blakei, Stearns, Proc. Acad. Cal. Acad. Sci., Aug. 18, 1873.

Hab., Gulf of Georgia, Barraud's Creek, near New Westminster, Washington Territory: Herd, Claudet, Doane, Stearns, Chambers. Fraser's River: Dick and Nelson. B.M.

Mr. Stearns's paper in the Proceedings of the Californian Academy of Sciences is a reprint of the paper in the San Francisco *Mining and Scientific Press*, with a few additions, and the addition of a new sub-genus, *Verrillia*, although he quotes *Osteocella*.

Since I have seen the proof of this paper, the Hon. Justice Crease has informed me that he has forwarded to me a series of the animals of *Osteocella*, and also an account of the animal from an examination of fresh examples by Dr. Moss; the latter has arrived, and I communicated it on September 25 to the Zoological Society; it is illustrated by figures. J. E. GRAY

THE RELATION OF MAN TO THE ICE-SHEET IN THE NORTH OF ENGLAND

IN the interesting review of Sir Charles Lyell's "Antiquity of Man," communicated to NATURE of Oct. 2, Mr. A. R. Wallace mentions the fact that "there is as yet no clear evidence that man lived in Europe before the Glacial Epoch, and even if he did so, the action of the ice-sheet would probably have obliterated all records of his existence." The fact was true when it appeared, but both the fact and the remark which follows it, may now have to undergo considerable modification. The Committee for the Exploration of the Victoria Cave, near Settle, Yorkshire, assisted by a grant from the British Association, have just made a discovery which may prove to be of the greatest importance not only to the geologists of Europe, but to all those who take an interest in the origin and early history of man.

In May 1872 the Committee were exploring a bone bed in the cave, which occurred at a considerable depth beneath other deposits. It was full of hyæna-dung, broken bones, and teeth. A quantity of these were sent to Mr. Busk for determination, and he kindly returned the following list:—

Elephas primigenius	*Rhinoceros tichorinus*
Ursus spelæus	*Bison*
Ursus priscus	*Cervus elaphus*
Hyæna spelæa	

These are well known to represent the fauna of the river gravels in the south of England. Among them was a bone which puzzled even Mr. Busk, and he has only now given his mature and definite opinion on the subject. He writes: "The bone is, I have now no doubt, human; a portion of an unusually clumsy fibula, and in that respect not unlike the same bone in the Mentone skeleton." When Mr. Busk has taken some time to consider the question there are few scientific men who will dispute his verdict. The occurrence of the bones of man with this group of animals is a new fact for this part of the kingdom, but one that might be expected from a similar co-existence in the south of England, in Kent's Cavern, Wookey Hole, and elsewhere.

But at Settle this discovery possesses a far greater

interest from the evidence there of the relation of these animals and man to the great ice-sheet. This hyæna-bed dips into the cave, and has been worked only a short distance from its mouth; but at the mouth itself, vertically under the farthest projection of the overhanging cliff, lies a bed of stiff glacial clay containing ice-scratched boulders. This bed dips outwards at an angle of about 40°, and evidently lies on the edges of the beds containing man and the older mammals. It has been suggested that it may have fallen from the cliff above, and therefore may not necessarily have come into its position in glacial times, but, on a careful consideration, this is quite impossible. Upon it lies a great thickness of talus or scree, which is made up of fragments of limestone split off from the cliff above by the frosts of successive winters. If all this were now removed it would be barely possible for the glacial drift to fall from the cliff above to its present position, but if all the talus were restored to the cliff, of which it forms the waste, such a fall would be impossible. It is quite clear, from the waste of the cliffs which has taken place since the glacial drift came where it now lies, that the cliff then projected many feet farther out and would prevent such a fall.

A strong argument lies also in the fact that the loose talus all lies above the drift and is quite free from mud, whereas all the deposits below it are heavily charged with it, and the mud is just such a fine impalpable stiff mud as would result from the grinding of glaciers and the flow of glacier water. It seems probable that the drift is really the remnant of a moraine lateral or *profonde*, left here by a glacier or an ice-sheet, and that the remains of the older mammals and of man disinterred from beneath it are of an age at any rate previous to the great ice-sheet of the Irish Sea basin. But there is another line of argument which tends to the same conclusion. Three years ago it was believed by most geologists that the fauna here disinterred had never existed in this particular area—and why? because their remains had never been found in any of the river deposits of the district. It was supposed that the great extension of the ice prevented their migration hither. It is clear, now that we have found these remains in caves, that they must have peopled the northern district at one time as thickly as they did the south of England, where their bones are so common in river gravel. But their remains in the northern district occur now only in caverns, and have been removed from the open country. When we compare this removal of the mammoth-fauna over certain districts with the presence of evidence of land glaciation on a great scale, we begin to see that they bear a definite relation to one another, and that the ice-sheet was the great "besom of destruction" which swept away all remains of the older inhabitants from those portions of the country adjacent to the great ice centres.*

Again, there is another matter relating to this question which has hardly received the attention which it deserves. This is the complete absence of palæolithic implements and the fauna which is usually associated with them in the river gravels of the south, over co-extensive areas of the north of England, indicating the removal of palæolithic man from those areas by the ice-sheet. If I am not much mistaken, this discovery at Settle may have an important bearing in several ways. It will carry back the proofs of the antiquity of man to a time previous to the ice sheet, that is to interglacial if not to preglacial times. It will corroborate the opinions expressed by Mr. Godwin Austen, Mr. James Geikie, and others, that the older valley gravels of the south of England are not of an age subsequent to the Till of the North. And it will give some support to the views of Messrs. Searles Wood and Harmer, that the Till of the north-west of England, though older than the great submergence, is probably of younger date than the greater part of the drifts of the east coast.

* *Geological Magazine*, vol. x. p. 140.

The Cave Committee will continue their work with redoubled vigour. It is much to be hoped that the scientific public will come to their assistance, and not let the expense of the undertaking fall, as now, almost entirely on the district of Craven.†

R. H. TIDDEMAN

† Messrs. Birkbeck and Co., Craven Bank, Settle, have kindly consented to receive subscriptions.

ATLANTIC FAUNA

LAST May the s.s. *Hibernia* belonging to the Telegraph Construction and Maintenance Company, was despatched to repair the French Atlantic Cable, in which a fault was indicated some 200 miles from Brest. A brief account of some of the animal forms obtained by me in that expedition may not be without interest to some of the readers of NATURE.

To Mr. R. London, superintending the expedition, I am greatly indebted for the many facilities that he afforded me, of obtaining specimens of the deep-sea fauna. The first cast was made about 100 miles nearly due west of Brest, at a depth of 83 fathoms. Here we found numerous valves of *Pecten*, a fine *Ophiocoma*, with rays nine inches in length, which when handled broke itself into numerous fragments, *Echinus lividus*, *Spatangus purpureus*, &c.

At the surface we obtained by means of a towing-net a great abundance of a minute Entomostracous crustacean of a greenish-blue colour, with deep sapphire eyes, a *Cydippe*, two species of *Idotea* and *Polybius Henslowii*.

On the Atlantic cable, which was raised to the surface at a point 112 miles west of Brest, were found numerous shells of a small boring mollusc, one of the *Pholadidæ*, apparently *Xylophaga*. The outer covering of the cable, consisting of tarred manilla hemp, was perforated in many places by the round holes which they had formed and in which their shells were found. In places they had penetrated the outer covering, and had passed between the iron wires to the gutta percha core, in which they had made numerous shallow indentations, but in no case had they penetrated this to any depth. This cable, it will be remembered, was laid in 1869.

We now steamed about 87 miles westward to the edge of the Little Sole Banks, where the water deepens from 90 to 480 fathoms within a distance of a few miles. Here the cable was again hooked and brought to the surface from a depth of about 300 fathoms. Adhering to its surface was a species of *Pycnogonum* in great abundance. The specimens lived for some time after being brought to the surface, and moved about sluggishly.

A few bright red anomourous crustaceans were also obtained. These were very active, and lived for some days in a bucket of water.

They had, while in confinement, a peculiar habit of drawing their claws over their head, antennæ, and eyes, which suggested the idea that they were confused and dazzled by the extraordinary amount of light to which they were exposed.

A species of *Tubularia* of great beauty grew abundantly in clusters on the cable, and throve well in confinement. The cable was thickly overgrown with *Sertularias* of various species, moored to which by their hinder legs a species of *Caprella*, diabolic in appearance, but sluggish and inactive in nature, abounded.

A few miles farther westward the cable was raised from a depth of 480 fathoms. *Sertularias*, *Tubularias*, *Caprella*, &c., were still abundant; but the *Pycnogonum* was conspicuous from its absence.

In the recent expedition in which the *Great Eastern* and *Hibernia* have been employed in endeavouring to repair the Atlantic Cable of 1865, the natural history results have been much more meagre. Perhaps the most interesting objects obtained are some fragments of rock,

consisting of Hornblende with interspersed crystals of quartz, found in lat. 51° 56′ N., long. 35° 45′ W., at a depth of about 1,760 fathoms.

FRED. P. JOHNSON.

NOTES

PROF. SYLVESTER has recently made a discovery which is likely to create some interest, not only amongst mathematicians, but also amongst mechanicians and instrument-makers. By means of a sort of lazy tongs he has succeeded in converting spherical motion into plane motion, a result, we believe, hitherto looked upon as unattainable. This discovery will form the subject of a communication which Mr. Sylvester is announced to lay before the London Mathematical Society at its Annual General Meeting on Thursday next (November 13).

THE two gentlemen recently elected to Science-Fellowships at Oxford, are remarkable instances of success attending most irregular and unusual undergraduate careers. Mr. Yule was at one time a boy at Magdalen College School, he obtained the Brackenbury Scholarship for Physical Science at Balliol College, but was obliged to throw it up after a short time, on account of his failure to pass the classical examinations of the University. He bethought him of the more merciful ordinances of the sister University, and having obtained a Scholarship at St. John's College, Cambridge, proceeded on his undergraduate course unchecked by the lessened barrier of the previous examination. After being placed senior in the Natural Sciences Tripos, he returns to Oxford, we may hope bringing treasures from the East—and at any rate ready to use his vote for the improvement of the Oxford Examination Statutes. Mr. Macdonald is an individual who has come as near as is possible to achieving the feat of being in two places at one time. In fact, theoretically, he has been in two places at one time. He had the great courage and energy whilst holding a position in the Education Office, to enter as an Undergraduate at Merton College, and by consent of the College authorities he kept his term by sleeping in Oxford, which place he left every morning during term, so as to be at his official post, returning in the evening in time for hall dinner. His office-holidays he employed in practical work in the Oxford laboratories, whilst analytical chemistry had to be studied in his own sitting-room, converted for the time into a workshop. Such a history makes it very certain that the examination system has not failed at Merton College to secure at any rate a most worthy recipient of the fellowship.

THE election to the two vacant Fellowships at Merton College, took place on Oct. 30, when the choice of the electors fell upon Mr. John Wesley Russell, Lecturer of Balliol College, as Mathematical Fellow; and Mr. Archibald Simon Lang Macdonald, Commoner of Merton College, as Natural Science Fellow. Mr. Russell was placed in the first class in Mathematics under Moderators, in Trinity Term, 1871; and Mr. Macdonald in the first class in Natural Science at the final examination, in Michaelmas Term, 1871.

WE are glad to be able to add St. John's College, Cambridge, to the list of those which have opened their Fellowships to Students of Natural Science. Since 1868, the College has given Exhibitions yearly, and Foundation Scholarships since 1870, for the encouragement of a knowledge of Physics, Chemistry, and Biology. On Monday last the Master and Seniors, in proof of their desire to place the Natural Sciences on the same footing as Classics and Mathematics, elected one of their scholars, Mr. A. H. Garrod, B.A., who was a Senior in the Natural Science Tripos of 1871, to a Fellowship.

ABOUT the end of January 1874, there will be an election to a scholarship in Natural Science at Exeter College, Oxford, candidates for which will be examined in biology, chemistry, and physics. Candidates are not expected to exhibit *special* knowledge of more than one of the above subjects, and preference will be given to a candidate who excels in biology, or one of its branches. The candidate selected will have to satisfy the college that he has sufficient classical and mathematical knowledge to pass responsions. There is no limit of age disqualifying candidates for this scholarship. The scholarship is of the annual value of 80*l.*, tenable for five years from matriculation. The scholar elected will have the use, during term, of a place in the histological laboratory of the college. For further information application should be made to Mr. E. Ray Lankester, Natural Science Lecturer, Exeter College.

MR. CHARLES J. F. YULE, of St. John's College, Cambridge, wishes us to state that he is not "the Cambridge B.A." whose letter appeared in last week's number.

AT the Commitia, held on Thursday, October 30, at the Royal College of Physicians, Dr. Robert Druitt was elected a Fellow of the College. The president announced that the Harveian Oration in the ensuing year would be delivered by Dr. Charles West. The Gulstonian Lectures will be delivered by Dr. J. F. Payne; the Croonian Lectures by Dr. Murchison; the Lumleian by Dr. Sibson.

WE regret to record the death, on Oct. 24, of Dr. Crace Calvert, F.R.S., F.C.S. The illness which caused it was contracted at Vienna, whither he had gone to act as juror in the International Exhibition. The *Journal of the Society of Arts* furnishes some particulars concerning the work of Dr. Calvert. As an analytical chemist his renown was European. He left England as a youth to pursue his education in France, and in the schools of that country secured many honours by the awards which he obtained. He subsequently pursued the study of chemistry, and was appointed assistant chemist at the Gobelin works, under his learned master, Chevreul. Soon after his return to England, he commenced reading a series of papers before the Society of Arts on chemistry applied to industry. At a later date, when the Society of Arts proposed to establish Cantor lectures, he gave the proposition his hearty support, and delivered two courses of lectures on "Chemistry applied to the Arts." He also delivered courses on "Synthesis and the Production of Organic Substances," on "Aniline and Coal Tar Colours," and on "Dyes and Dye-stuffs other than Aniline." In 1846 he settled in Manchester, and was soon after appointed Professor of Chemistry at the Royal Institution there. He was also for some time a lecturer at the Manchester School of Medicine. His connection with the Manchester Sanitary Association led him to hygienic investigations—one of the principal results of which was a patent for the application and preparation of carbolic acid. In scientific circles great interest attached to Dr. Calvert's protoplasmic investigations, some of the results of which were communicated in a paper read at the meeting of the British Association in Edinburgh some years ago, and afterwards published in the Transactions of the Royal Society. Dr. Calvert was a Fellow of the Royal Society of England, a Fellow of the Chemical Society, and an honorary Fellow of the Chemical Society of Paris. He was also a member of the Royal Academy of Turin, and of the Imperial Academy of St. Petersburg.

THE death is announced of Prof. J. A. F. Breithaupt, of Freiberg, the well-known Mineralogist, on October 22, at the age of 82 years.

Ocean Highways announces the death from scurvy on the Novaya Zemlya Coast, of the distinguished Norwegian Arctic Explorer, Captain Sivert Tobieson.

AT the meeting of the Royal Geographical Society last Monday, Sir Bartle Frere, the President, said that, though there

was no further news of Dr. Livingstone, the latest accounts of both the expeditions sent out in the hope of meeting him, tell of satisfactory progress. Of the West Coast Expedition under Lieutenant Grandy, R.N., the latest direct accounts state that the expedition had just left San Salvador, about June 16, in good health, so that we may one day hope to hear of their further progress in their search for tidings of Livingstone, and every step of their progress w ll add to our knowledge of that most interesting, but little known, region. Comparing Consul Newton's dates with those of Dr. Beke's Portuguese informant, published on Saturday last, Sir Bartle Frere thinks we must await some confirmation of the latter report before concluding that Lieutenant Grandy had turned back. The other expedition started under Lieutenant Cameron on the east coast, and notwithstanding all delays, Lieutenant Cameron made a fair start for the lake region ; and, by the latest accounts, was pushing on with every prospect of reaching a district where he was most likely to obtain tidings of Livingstone.—Mr. C. Markham, the Secretary, read a paper giving some interesting information connected with the voyage of the *Polaris* to the Arctic regions, and a discussion followed in which the desirability of another Arctic expedition was strongly urged, some of the members proposing that, if Government refused, the society itself should send one, but this view was controverted by Captain Sherard Osborne, who maintained that such an expedition, to be successful, should be under the auspices of the Government.

WE have great pleasure in calling attention to a series of science lectures for clerks and working-men, which are to take place in South Place Institution, Finsbury. The first three lectures, on November 4, 11, and 18, are by Prof. Duncan, F.R.S., on the Geological History of the Earth, and these are to be followed by others on Light, &c. The gentlemen who get up these lectures deserve great credit, as they expect to be considerably out of pocket in their endeavour to place science lectures by the most eminent scientific men within the reach of the classes mentioned, who, we hope, will take ample advantage of the opportunity. The charge for admission is almost nominal.

AMONG the Local Societies, concerning which we have received information since we published our list, is the "Junior Philosophical Society," a London Society which meets on the second and fourth Friday of each month from October to June, at 8 P.M. The Society seems earnestly bent on work in the way of reading papers, and occasional excursions, no member being admitted who does not prove his willingness to take his share in the work of the Society. Many of the papers to be read this winter are on important scientific questions ; and we would recommend the Society to the attention of those young men who are within convenient distance of the meeting-place, 6A, Victoria Street, Westminster.

HIS Excellency Senor Don Gregorio Beintes, Minister Plenipotentiary of the Republic of Paraguay, has appointed Mr. Charles Twite, M.E., late reporter to the Royal Commission on Mines, who explored the mineral resources of Siam ; M. Balanza, botanist, late Commissioner of the French Government to New Caledonia and Egypt ; and Mr. Keith Johnston, F.R.G.S., members of a scientific commission to inquire into and report on the natural resources of Paraguay. Dr. Leone Levi, F.S.S., Professor of Commercial Law in King's College, Consul-General of Paraguay in London, will edit the reports and exhibit them in relation to the economic condition of the country. Such reports will be published towards the end of next year.

THE Exhibition which will be held in Manchester, by the Society for the Promotion of Scientific Industry, of appliances for the Economical Consumption of Fuel, will be opened on December 18 next. In connection with this subject, a gentleman has placed a gold medal at the disposal of the Council of the Society for the best specimen of peat fuel that shall come nearest to coal in its use and character, special regard being had to its cheap and rapid production.

THE Council of the Institution of Civil Engineers have forwarded us a list of thirty-six subjects, on which they invite communications.

MR. ALBERT MÜLLER has sent us No. 2 of his "Contributions to Entomological Bibliography up to 1862 ;" further numbers will appear as materials accumulate. The list contains a great deal of information, and it will no doubt be valued by entomologists. It may be obtained from Mr. E. W. Janson, Museum-street.

THE Director of the Imperial Russian Telegraph has given his consent to the transmission, free of cost, within the boundaries of the Russian empire, of messages announcing new astronomical discoveries.

MR. JAMES DALLAS, of Benakandy, Cachar, writing us on the subject of inherited peculiarities, says that a friend of his has a black-and-tan English terrier dog, two inches of the end of whose tail is folded back so acutely as to come in contact with the upper portion. A pup, of which the dog is the undoubted father, has inherited the paternal peculiarity, with the difference that, instead of the end of the tail being turned up, it is turned down.

A SERIES of methodical observations on the various movements of a ship affected by waves was carried out on board the ship *Norfolk* during her last voyage from Melbourne to London. The observations during the voyage (from July 24 until October 16) were effected by self-registering instruments, under the care of Mr. W. T. Deverell, on behalf of Mr. Spencer Deverell, of Portland, Victoria, who has devoted many years' study to the mathematical investigations of the movements of ocean waves and to their action upon a floating body. A complete report will constitute no doubt a valuable contribution to naval literature.

IT is stated that the steamer *Tuscarora*, under the command of Capt. George E. Belknap, has lately been fitted up at San Francisco to undertake the labour of making soundings between the Pacific coast and Japan, in connection with the new cable route. On the detail of the *Juniata*, for service in the *Polaris* search, the sounding apparatus, which had been put on board for a similar service between New York and the West Indies, was transferred to the *Tuscarora*. This included a supply of new steel wire, with Sir William Thomson's patent reel. The vessel was to proceed early in July to Puget Sound, and thence, by way of the Aleutian Islands, to Hakodadi.

IT is stated by the *Australian and New Zealand Gazette*, that the Government has signified its willingness to grant a site for th proposed Adelaide university ; to give 10,000*l*. towards the cost of its erection, provided an equal amount is raised by private subscription ; and to provide an annual grant equal to 5 per cent. on other subscriptions.

THE great Exhibition of Vienna (we learn from the *Journal of the Society of Arts*) is to be commemorated by the establishment of an "Athenæum," as it is called, modelled after the Conservatoire des Arts et Metiers of Paris, and the Museum of Industry at Brussels, for the special instruction of workmen and small manufacturers. It is to be installed in the midst of the industrial quarters of the capital. A large quantity of drawings, designs, models, instruments, machines, tools, raw and partially manufactured materials, have been promised by exhibitors, and Baron Schwarz-Senborn, director of the exhibition, has presented a collection of between three and four thous and volumes of book

connected with industrial exhibitions. The establishment starts with a capital of more than 11,500*l*.

ON Sept. 1, an earthquake took place at 4.10 P.M. with slight shocks at Drama, in European Turkey. There was an earthquake at about 9 P.M. on Sept. 6, in Armenia, at Erzeroum, and elsewhere. Several shocks of earthquake were felt on Aug. 21, in the City of Guatemela, but very few houses were damaged.

La Nature records the recent death of M. Godard, senior, the oldest of French aëronauts.

THE additions to the Zoological Society's collection during the past week include a Bosman's Potto (*Perodicticus potto*) from Africa, and a Blue Magpie (*Cyanopolius cyanus*) from China, presented by Rev. A. W. Peter; two Ursine Dasyures (*Dasyurus ursinus*) from Australia, presented by the Acclimatisation Society of Victoria; an Alpine Marmot (*Arctomys marmotta*), an Inconvenient Curassow (*Crax incommoda*) from S. America, a Red-bellied Thrush (*Turdus rufiventris*), a Red Oven-bird (*Furnarius rufus*), and two Yellow Trupials (*Xanthosomus flavus*) from Buenos Ayres; a Hoffmann's Sloth (*Cholopus hoffmanni*) from Panama, purchased; a Sun Bittern (*Eurypyga helias*) from S. America, deposited.

THE SELECTION AND NOMENCLATURE OF DYNAMICAL AND ELECTRICAL UNITS*

WE consider that the most urgent portion of the task entrusted to us is that which concerns the selection and nomenclature of units of force and energy; and under this head we are prepared to offer a definite recommendation.

A more extensive and difficult part of our duty is the selection and nomenclature of electrical and magnetic units. Under this head we are prepared with a definite recommendation as regards selection, but with only an interim recommendation as regards nomenclature.

Up to the present time it has been necessary for every person who wishes to specify a magnitude in what is called "absolute" measure, to mention the three fundamental units of mass, length, and time, which he has chosen as the basis of his system. This necessity will be obviated, if one definite selection of three fundamental units be made once for all, and accepted by the general consent of scientific men. We are strongly of opinion that such a selection ought at once to be made, and to be so made that there will be no subsequent necessity for amending it.

We think that, in the selection of each kind of derived unit, all arbitrary multiplications and divisions by powers of ten, or other factors, must be rigorously avoided, and the whole system of fundamental units of force, work, electrostatic, and electromagnetic elements, must be fixed at one common level—that level, namely, which is determined by direct derivation from the three fundamental units once for all selected.

The carrying out of this resolution involves the adoption of some units which are excessively large or excessively small in comparison with the magnitudes which occur in practice; but a remedy for this inconvenience is provided by a method of denoting decimal multiples and sub-multiples, which has already been extensively adopted, and which we desire to recommend for general use.

On the initial question of the particular units of mass, length, and time, to be recommended as the basis of the whole system, a protracted discussion has been carried on, the principal point discussed being the claims of the gramme, the *metre* and the second, as against the gramme, the *centimetre*, and the second; the former combination having an advantage as regards the simplicity of the name *metre*, while the latter combination has the advantage of making the unit of mass practically identical with the mass of unit volume of water; in other words of making the value of the density of water practically equal to unity. We are now all but unanimous in regarding this latter element of simplicity as the more important of the two; and in support of this view we desire to quote the authority of Sir W. Thomson, who has for a long time insisted very strongly upon the necessity of employing units which conform to this condition.

We accordingly recommend the general adoption of the centimetre, the gramme, and the second, as the three fundamental units; and until such time as special names shall be appropriated to the units of electrical and magnetic magnitude hence derived, we recommend that they be distinguished from "absolute" units otherwise derived, by the letters "C. G. S." prefixed, these being the initial letters of the names of the three fundamental units.

Special names, if short and suitable, would, in the opinion of most of us, be better than the provisional designations "C. G. S. unit of . . . . . ." Several lists of names have already been suggested; and attentive consideration will be given to any further suggestions which we may receive from persons interested in electrical nomenclature.

The "ohm," as represented by the original standard coil, is approximately 10^9 C. G. S. units of resistance. The "volt" is approximately 10^8 C. G. S. units of electromotive force, and the "farad" is approximately $\frac{1}{10^9}$ of the C. G. S. unit of capacity.

For the expression of high decimal multiples and sub-multiples, we recommend the system introduced by Mr. G. J. Stoney—a system which has already been extensively employed for electrical purposes. It consists in denoting the exponent of the power of 10 which serves as multiplier, by an appended cardinal number if the exponent be positive, and by a prefixed ordinal number if the exponent be negative. Thus:—

10^9 grammes constitute a *gramme-nine*,

$\frac{1}{10^9}$ of a gramme constitutes a *ninth-gramme*.

The earth's circumference is approximately four metre-sevens, or four centimetre-nines.

For multiplication or division by a million, the prefixes *mega* * and *micro* may conveniently be employed, according to the present custom of electricians. Thus the *megohm* is a million ohms, and the *microfarad* is the millionth part of a farad. The prefix *mega* is equivalent to the affix *six*. The prefix *micro* is equivalent to the prefix *sixth*. The prefixes *kilo*, *hecto*, *deca*, *deci*, *centi*, *milli* can also be employed in their usual senses before all new names of units.

As regards the name to be given to the C. G. S. unit of force, we recommend that it be a derivative of the Greek δυναμις. The form *dynamy* appears to be the most satisfactory to etymologists. *Dynam* is equally intelligible, but awkward in sound to English ears. The shorter form *dyne*, though not fashioned according to strict rules of etymology, will probably be generally preferred in this country. Bearing in mind that it is desirable to construct a system with a view to its becoming international, we think that the termination of the word should, for the present, be left an open question. But we earnestly request that, whichever form of the word be employed, its meaning be strictly limited to the unit of force of the C. G. S. system; that is to say the force which, acting upon a gramme of matter for a second, generates a velocity of a centimetre per second.

The work done by this force, working through a centimetre, is the C. G. S. unit of work, and we propose to denote by it some derivative of the Greek ἔργον. The forms *ergon*, *ergal*, and *erg* have been suggested; but the second of these has been used in a different sense by Clausius. In this case also we propose for the present to leave the termination unsettled; and we request that the word *ergon* or *erg* be strictly limited to the C. G. S. unit of work, or what is, for purposes of measurement, equivalent to this, the C. G. S. unit of energy, energy being measured by the amount of work which it represents.

The C. G. S. unit of power is the power of doing work at the rate of one erg per second, and the power of an engine (under given conditions of working) can be specified in ergs per second.

For rough comparison with the vulgar (and variable) units based on terrestrial gravitation, the following statement will be useful:—

The weight of a gramme at any part of the earth's surface is about 980 dynes, or rather less than a kilodyne.

The weight of a kilogramme is rather less than a megadyne, being about 980,000 dynes.

Conversely, the dyne is about 1·02 times the weight of a milli-

* First Report of the British Association Committee on Units.

* Before a vowel, either *meg* or *megal* (as euphony may suggest), may employed instead of *mega*.

gramme at any part of the earth's surface, and the megadyne is about 1·02 times the weight of a kilogramme.

The kilogram-metre is rather less than the erg-eight, being about 98 million ergs.

The gramme-centimetre is rather less than the kilerg, being about 980 ergs.

For exact comparison, the value of g (the acceleration of a body falling in vacuo) at the station considered, must of course be known. In the above comparisons, it is taken as 980 C.G.S. units of acceleration.

One horse-power is about three quarters of an erg-ten per second. More nearly, it is 7·46 erg-nines per second, and one *force de cheval* is 7·36 erg-nines per second.

The mechanical equivalent of one gramme-degree (centigrade) of heat is 41·6 megalergs or 41,600,000 ergs.

SCIENTIFIC SERIALS

In the current number of the *Quarterly Journal of Microscopic Science*, Mr. E. T. Newton commences with a paper on he Structure of the Eye of the Lobster, his observation being the result of suggestions from Prof. Huxley. The structure of the eye is minutely discussed, and the accompanying illustrations are abundant. As a concluding remark, we read that "Notwithstanding all that has been written up to the present time concerning the mode of action of the compound arthropod eye, we are still unable satisfactorily to solve this difficult physiological problem."—A paper by Prof. Betz, of Kieff, on the methods of investigating the structure of the central nervous system in Man, will be found of special interest, the hardening, cutting, and tinting of specimens being discussed.—M. Pasteur's new contributions to the theory of Fermentation, are translated from the "Comptes Rendus," and Prof. H. L. Smith's paper on Archebiosis and Heterogenesis, is reprinted from the *Lens*.—A Résumé, by Mr. W. Archer, of recent observations on Parasitic Algæ, is followed by Dr. Klein's Contributions to the Anatomy of Auerbach's Plexus in the Frog and Toad, and this by a valuable series of observations by Prof. Lister on the Natural History of Bacteria, in which a study of the life of Bacteria under different circumstances as regards the fluid in which they grow, shows that their general appearance, size, and shape depend in great measure on the fluid in which they are growing, their removal from one to another fluid causing them to take on quite a different form, and their replacement the reassumption of the original condition. Many important facts are to be learned from this paper.—Mr. E. R. Lankester describes in detail the microscopic and spectroscopic appearances of a new Peach-coloured Bacterium, named by him *Bacterium rubescens*. The colouring matter he names Becterio-rubrin. This Bacterium does not generally occur in isolated plastids, but generally forming films, encrustations, or tufts. Most are aggregated in adherent masses, several excellent drawings of which accompany the paper.

The Journal of the Franklin Institute, Sept. 1873.—This number contains a useful paper by Mr. Hugo Bilgram, on the theory of steam governors.—In government reports on the decay and preservation of timber, Generals Cram and Gillmore recommend the Seely process as the best. It consists in subjecting the wood to a temperature above the boiling point of water, and below 300° Fahr. while immersed in a bath of creosote a sufficient length of time to expel the moisture. When the water is thus expelled the pores contain only steam; the hot oil is then quickly replaced by a bath of cold oil, by means of which change the steam in the pores of the wood is condensed, and a vacuum formed into which the oil is forced by atmospheric pressure and capillary attraction. Gen. Gillmore thinks a wooden platform, *thoroughly creosoted*, would last twenty to thirty years, and be better than a stone platform during that entire period.—An important paper by Prof. Thurston (extracted from the *Iron Age*), treats of the molecular changes produced in iron by variations of temperature.—Mr. Mott points out the conditions of good construction in lightning rods, and Dr. Feuchtwanger gives some information as to nickel and its uses in the arts, coinage, and nickel plating.—An oil discovery of unusually rich character is announced from the neighbourhood of Titusville, Pa.; the production of the new region being estimated at 30,000 barrels per day.

Der Naturforscher, September 1873.—We note, in this number, two striking observations in animal physiology. One of these refers to the torpedo, which has been a puzzle to physiologists, inasmuch as, while giving shocks strong enough to lame or kill another animal, its own muscles do not show the least contraction. Du Bois Reymond's hypothesis is, that while the stimulation to discharge goes forth from the central organ, the same organ sends out at the same time a counteractive influence through the nervous system, which neutralises the excitability of the nerves. M. Franz Boll took a recent opportunity of experimenting with the fish on the Italian coast, and, among other things, he tested this theory by cutting some nerves, and watching their muscles when he stimulated the electric nerves. The neutralising stimulation being thus cut off, the muscles should, he thought, contract, if the hyphothesis were true; and they did so, the muscles of the unsevered nerves remaining at rest. Still, he hardly thinks the experiment decisive, because nerves are more excitable after section.—The other observation is by Prof. Fick, who has found, by manometric measurement, a less pressure of blood in the left ventricle than in the aorta; 80 mm. of mercury in the one case, 104 to 128 in the other (in a dog). He supposes the blood, only partially filling the ventricle, at the apex, to be shot against the semilunar valves, forcing them open by its *vis viva*. In the neighbourhood of the valves the pressure must quickly rise. In short, as the author puts it, the blood is not pressed, but hurled (*geschleudert*) into the aorta.—There is a useful abstract of the chief points in a paper by Prof. Abbé (to Schulze's *Archiv*) on the capability of the microscope and its limits. He seeks to show, by physical deductions, that the limit of magnification is as good as reached, in our best systems. Some curious observations by M. van Tieghem are given in a note on the independence of the individual organs of the embryo of plants.—M. Ebermayer, we find, has been examining the influence of forests on ozone-contents of the air; he states there is more ozone in and near forests than in the open, but among the denser branches there is somewhat less than in the open closely bordering the forest; and in the tops of the trees there is more than in the lower parts.—Several French Academy notes are abstracted: on the magnetic force of annealed steel, on development of electricity in liquid mixtures, on the planet Mars, &c.; also Royal Society papers. Some meteorological observations as to distribution of heat in Switzerland deserve notice.

Bulletin Mensuel de la Société d'Acclimatation de Paris. August.—In a paper on the "Causes of the Depopulation of our Rivers," M. C. R. Wattel enters at length into the question of the French river fisheries, which will be read with interest by fish-culturists. Some interesting information as to the effect of navigation and trade on the rivers is given; but the great danger to the fisheries lies in the unrestricted destruction of immature breeding-fish: and M. Wattel recommends that steps should be taken to prevent over-fishing and to facilitate the erection of fishways on the rivers.—The notes of Dr. P. Marès on the acclimatisation of various sorts of Eucalyptus in Algeria, are interesting.—The results of the experiments to produce different coloured silks go to show that silk-worms fed on cherry-leaf produce a bright chromo-yellow-coloured silk, those on pear-leaves a darker shade of the same colour, those on apple-leaves a nearly white silk, but coarser than that of the silk-worms fed on mulberry-leaves.—An extract is given of a work by M. E. Perris, on "Birds and Insects," in which he considers the advisability of protecting small birds. M. Perris, granting all the birds are insectivorous, either continually or occasionally, acknowledges the good they may do, but doubts whether a large proportion of the insects destroyed are hurtful to man; and he raises the question whether, therefore, it is desirable to protect birds to kill what would otherwise do no harm.

The September number commences with a paper by the Secretary on some Australian vegetables, the introduction of which into Algeria is proposed.—An interesting paper on the breeding of ostriches in captivity is contributed by Capt. Crepu, who has kept several pairs of these birds. His observations throw much light on the natural history of the ostrich. M. Comber describes the mortality which has seized the deer and other animals in King Victor Emmanuel's park at La Mandria. The calamity is attributed partly to over-crowding and partly to the want of shelter and proper protection. In 1865, when the park and grounds were carefully cultivated, 13 deaths occurred. In 1873, the park being left in its natural state, 172 deaths are recorded.—An important paper on the production of milk is the

result of a conference at the Jardin d'Acclimatation in July, and appears opportunely at the present moment, when the subject is attracting so much public attention.—M. E. Perris continues his remarks on "Birds and Insects."

SOCIETIES AND ACADEMIES

MANCHESTER

Literary and Philosophical Society, October 7.—E. W. Binney, vice-president, in the chair.—"Atmospheric Refraction and the last rays of the Setting Sun," by Mr. D. Winstanley. It is recorded in the Proceedings of this Society that a letter dated from Southport and written by Dr. Joule was read at the meeting held on the 5th October, 1869. In that letter it is remarked that "Mr. Baxendell noticed the fact that at the moment of the departure of the sun below the horizon the last glimpse is coloured bluish green." Dr. Joule also observes that on two or three occasions he had himself noticed the phenomenon in question, and that "just at the upper edge where bands of the sun's disc are separated one after the other by refraction, each band becomes coloured blue just before it vanishes." During the past eighteen months the writer, from his residence in Blackpool, has had frequent opportunities of observing the setting sun, and has noticed the phenomenon of the final coloured ray certainly more than fifty times. To the naked eye its appearance has generally been that of a green spark of large size and great intensity, very similar to one of the effects seen when the sun shines upon a well-cut diamond. The colour, however, is by no means constant, being often, as in the case of Mr. Baxendell's observation, bluish green, and at times, as mentioned by Dr. Joule, quite blue. The period of its duration, too, is likewise variable. Sometimes it lasts but half a second, ordinarily perhaps a second and a quarter, and occasionally as much as two seconds and a half. When examined with the assistance of a telescope, it becomes evident that the green ray results at a certain stage of the solar obscuration, for it begins at the points or cusps of the visible segment of the sun, and when the "setting" is nearly complete, extends from both cusps to the central space between, where it produces the momentary and intense spark of coloured light visible to the unaided eye. From the fact of the green cusps being rounded I apprehend that irradiation contributes to the apparent magnitude of what is seen. The range of colour too as seen in the telescope is more varied, and the duration of the whole phenomenon more extended, than when the observation is made only with the naked eye. Respecting the increased range of colours seen when the phenomenon is observed with telescopic aid, I may mention that on the 28th of June the sea was calm and the sky quite cloudless at the setting of the sun. Of the final coloured rays fifteen diameters showed the first to be a full and splendid yellow, which was speedily followed by the usual green, and then for a second and a half by a full and perfect blue. Respecting the increased duration of the colour, I have found that when the atmosphere is sufficiently favourable to allow a power of sixty diameters being employed with a three-inch object-glass, the green effect is seen at that part of the sun's limb in contact with the horizon even when one half the sun is still unset, and of course from then till final disappearance. The different colours seen, together with the order of their appearance, are suggestive of the prismatic action of the atmosphere as the cause of their production, and the interception of the horizon or the cloud as the cause of their separation. Assuming the correctness of this view, it becomes evident that an artificial horizon would prove equally efficacious in separating the coloured bands, and also that if employed during an inspection of the sun's lower limb, the least refrangible end of the spectrum would be disclosed. By projecting a large image of the sun into a darkened room I was enabled to get the whole of the spectrum produced by the prismatic action of the atmosphere in a very satisfactory manner. In this case a semicircular diaphram was used, so placed that its straight edge divided the field of view into equal parts, from one of which it obscured the light. The diaphram was placed in the focus of the eyepiece, and by rotating it every portion of the sun's limb could be in turn examined, and that too in the centre of the field, so as to be equally subjected to the minimum of the peculiarities of the instrument. When the sun's lower limb was allowed to descend into the field of view the first rays were intensely red. After a momentary duration they gave place in succession to orange, yellow, and green, which were then lost in the ordinary refulgence of the sun. The upper limb gave green, blue, and finally purple, which latter colour I have thus far never seen upon the natural horizon. I apprehend that the results here given sufficiently prove that atmospheric refraction is the cause of the coloured rays seen at the moment of the sun's departure below the horizon.

Cambridge Philosophical Society, Oct. 20.—The following communications were made to the Society:—By Mr. J. C. W. Ellis, Sydney College: Mechanical means for obtaining the real roots of algebraical equations.—By Mr. A. Marshall, St. John's: Graphic representation by aid of a series of hyperbolas of some economic problems having reference to monopolies.—By Mr. H. H. Cunyngame, St. John's: A machine for constructing a series of rectangular hyperbolas with the same asymptotes.

PARIS

Academy of Sciences, October 27.—M. de Quatrefages, president, in the chair.—The following papers were read:—Sixth note on guano, by M. Chevreul.—Answer to Respighi's note on the magnitude and variation of the sun's diameter, by Father Secchi. The author defended his method from Respighi's criticisms as regards the effect of heat in distorting the image during the passage through the prisms. He found that the effect of heat on compound prisms was very considerable, and therefore used his object-glass prism; and stated that in a future letter he intended to show that there were true variations in the solar diameter.—On crystalline dissociation, by MM. Favre and Valson. The authors continued the account of their researches, the present portion of the paper dealing with the valuation of the work done in the various solutions.—Note on the tertiary supra-nummulitic formation of the Carcassone basin, by M. Leymerie.—On certain cases of human double monstrocity, by M. Roulin.—Note on the origin and method of development of omphalosic monsters, by M. C. Dareste.—New method of condensing liquifiable substances held in suspension by gases, a reply to M. Colladon, by MM. E. Pelouze and P. Audouin.—M. Guérin-Méneville sent a letter in which he asserted that the *Phylloxera* is not the cause, but a consequence of the vine disease.—Note on the swellings produced on vine rootlets by the *Phylloxera*, by M. Max. Cornu.—Results of experiments on the destruction of the *Phylloxera* by means of carbonic disulphide, by M. Bazille. The author found that this agent was very successful, and that the doses could be reduced considerably but that different soils require different doses.—On the action of the condenser on induction currents, by M. Lecocq de Boisbaudran.—On the purification of hydrogen, by M. Ch. Viollette.—On the Cape diamond fields, by M. Hugon.—On the sugar contained in vine-leaves, by M. A. Petit. The author found in 1 kilo of leaves as much as 33 grammes of cane sugar and 12 of glucose; this was, however, exceptional, the latter generally exceeding the former and the total quantity of both being less.—On the Rhizocephalous *Cirripedes*, by M. A. Giard.—On the irritability of stamens, by M. E. Heckel. The author has distinguished two orders of movement in these organs.

CONTENTS

THURSDAY, NOVEMBER 13, 1873

ON THE MEDICAL CURRICULUM

IN a recent number of this journal (NATURE, Oct. 2, 1873) we made some remarks on medical studies, which were intended more for students themselves than in any way to bear on the principles of medical education. To the latter subject special attention has just been directed by Prof. Huxley, who, as Lord Rector of the University of Aberdeen, has drawn up a series of propositions for the consideration of the Court at the next meeting in February or March, on which occasion he will deliver his inaugural address.

The following are the motions that the Lord Rector will propose :—

"I. That, in view of the amount and diversity of the knowledge which must be acquired by the student who aspires to become a properly qualified graduate in medicine; of the need recognised by all earnest teachers and students for the devotion of much time to practical discipline in the sciences of chemistry, anatomy, physiology, therapeutics, and pathology, which constitute the foundation of all rational medical practice; and of the relatively short period over which the medical curriculum extends—it is desirable to relieve that curriculum of everything which does not directly tend to prepare the student for the discharge of those highly responsible duties, his fitness for the performance of which is certified to the public by the diploma granted by the University.

"II. That it would be of great service to the student of medicine to have obtained, in the course of his preliminary education, a practical acquaintance with the methods and leading facts of the sciences comprehended by botany and natural history in the medical curriculum; but that, as the medical curriculum is at present arranged, the attendance of lectures upon, and the passing of examinations in, these subjects occupy time and energy which he has no right to withdraw from work which tends more directly to his proficiency in medicine.

"III. That it is desirable to revoke or alter ordinance No. 16, in so far as it requires a candidate for a degree in medicine to pass an examination in botany and zoology as part of the professional examination; and to provide, in lieu thereof, that the examination on these subjects shall, as far as possible, take place before the candidate has entered upon his medical curriculum.

"IV. That it is desirable to revoke or alter said ordinance No. 16, in so far as it requires candidates for the degree of doctor of medicine to have passed an examination in Greek, and that, in lieu thereof, either German or French be made a compulsory subject of examination for said degree, Greek remaining as one of the optional subjects."

In considering these points a review of the method by which the present position of the medical curriculum has been arrived at, will throw considerable light on the steps which ought to be taken for its improvement, and will show how subjects which have but an indirect bearing, or none at all, on medicine proper have been gradually made to form an element of the course of study, without any question having been asked as to whether their introduction does not bring its concomitant disadvantages.

The influence of Materia Medica seems to have been great in bringing about the present state of affairs. When Dr. Anthony Todd Thomson and Dr. Pereira, in their enthusiasm for their favourite subject, extended its limits so as to include a full account of the source and history of every one of the articles which were mentioned in the Pharmacopœia, and went so far as to give a full description of *Gallus bankiva*, together with all the steps in the development of its egg, simply because *Ovi vitellus* is an antidote against poisoning by corrosive sublimate, and is employed in the preparation of Mistura Spiritus Vini Gallici (egg flip), it is evident that as the sciences of zoology and botany became more profound, Materia Medica as a subject would proportionately expand. At last a time came when separate lectures had to be given on the above-mentioned kindred subjects, in order that those on Materia Medica might be more easily comprehended by the student; and, as might be expected, these independent lectures on zoology and botany, as those on chemistry had done before, became so complete in themselves, as to reduce the subject which had given rise to their introduction, to a simple formulary for the chemist, with references to the sources of the necessary scientific information. The introduction, however, of zoology and botany as separate independent elements of the curriculum, brought into the medical education a large mass of matter, which is very valuable no doubt in itself, but to the student entirely irrelevant; and as in the short pupilage of three or four years there is a much larger amount that ought to be learned than can be properly acquired in the time, it becomes a matter worth serious consideration, whether subjects which are not indispensable to a thorough training should be still taught and be required by the examining bodies. The question therefore resolves itself into the determination of whether the loss of time necessary for obtaining a superficial knowledge of a couple of sciences, is counteracted by the advantages of those sciences as a mental training and a basis for higher work? In an Introductory Lecture delivered some time ago at University College, Prof. Huxley throws the weight of his opinion in the scale against retaining the subjects which must be to him most dear, in the medical curriculum; and most will agree with him, notwithstanding the many difficulties in the way of an improved programme.

With regard to Prof. Huxley's fourth proposition, in which it is considered desirable to omit Greek from the preliminary examination, and substitute German or French in its place, the interest will not be so great to most, as that relating to the scientific qualifications that are necessary. The same conservative spirit which has prevented any reduction in the overloaded Biological portion of the curriculum, has, without question of any kind being asked, never even hinted at any change in the long-established and well-tried school-course, in which the at one time practically valuable and indispensable Greek and Latin are still retained, though of less importance at the present day. How many of our scientific men find that nothing deters them in every step of their work, more than a want of knowledge of the German language, now that the scientific activity of that country is so considerable and so rapidly increasing. There must be a change with the times, even in primary education, and we hardly think that in his introductory address to the King's College Medical Society on the 23rd of last month, Prof. Curnow put the case fairly when he disapproved of the substitution of German for Greek, because the one could be

mastered by a few months' residence in a neighbouring country, whilst the other had done more to develop true culture than almost all other writings since. It is not proposed simply to substitute German or French for Greek, the advantages to be derived from which are now fully absorbed into the spirit of the nation, but, by the change, to leave a sufficient time, in addition to the education in modern languages, for the study of the Natural Sciences during the school-boy period. That the dead languages form an excellent mental training no one doubts, but that Physics and Chemistry do the same is daily becoming more certain; and the time is not far hence when the facts and methods of Physiology and Comparative Anatomy will be so well known and assorted, that they may be placed in the same category.

THE SOUTHERN UPLANDS OF SCOTLAND*

THE range of hills, which in Scotland extends from the German Ocean to the Irish Sea, having a N.E. and S.W. direction, has been aptly designated the Southern Uplands. This range is nearly parallel in its course to that of the Highlands proper. It exhibits hills, some of which attain to an elevation approaching nearly 3,000 feet; but its physical features, although marked in many localities with scenes of great beauty, are devoid of the stern and rugged grandeur which characterises the more northerly mountains of Scotland. The hills of this range usually consist of rounded and grass-covered undulations, or long tracts of plateaux. They have been specially named the "pastoral district of Scotland," and their scenes have furnished subjects for many a pastoral song, and many a border ballad.

The Southern Uplands of Scotland are cut deeply into by some of the streams which flow into the Solway Firth, the Esk, the Annan, the Nith, the Urr, and the Dee being the most important of them. They are drained on the southward side by the Cree and the Luce; on the northward side they are the sources of the Ayr; and the Tweed and its tributaries drain a large portion of their north-east area.

In the early period of Scotch geology, the days of Playfair and Hutton, the Southern Uplands were regarded as affording no traces of the evidence of life in the rocks which compose them; and these rocks were referred to the "primary" group. It was not until the discovery of fossils in a limestone which occurs at Wrea in Peeblesshire, in their higher portion, by Sir James Hall, that the rocks which formed these hills were assigned to the "transition" age. The terms "primary" and "transition" have now ceased to be applicable to the nomenclature of geology; and the discovery by Prof. James Nicol in 1840, in the flaggy beds of Greiston in Peeblesshire, of graptolites, indicated the Silurian age of the strata here. Since the discovery of Nicol, several geologists have added greatly to our knowledge of the rocks which compose the Southern Uplands. Other bands of graptolites have been found richer in fossil contents than those first discovered; and these, along with a few other forms of organic remains, have still further confirmed the Silurian age of the great mass of strata which make up the hilly country in the South of Scotland.

The result of the observations made on the rocks of the Southern Uplands up to the period when they came under the notice of the Geological Survey of Scotland led to the conclusion that the lowest strata exhibited were referable to the Llandeilo age. That these Llandeilo rocks were succeeded by deposits containing fossils, as in the case of the Wrea limestone, indicating the horizon of the Bala or Caradoc rocks, was also known—and certain rocks which occur near the north-western margin of the area in the neighbourhood of Girvan in Ayrshire, have been referred by Sir Roderick Murchison to a still higher position in the Silurian series.

The labours of the Geological Survey of Scotland have not only confirmed these conclusions, but have added greatly to our knowledge of the nature of the Silurian rocks of the South of Scotland. They have also furnished subdivisions of these rocks, and a more ample account of their arrangement and fossil contents.

Every geologist familiar with the lower portions of the Silurian rocks of the Southern Uplands, the Llandeilo strata, had experienced great difficulty in recognising horizons, in this series, such as would enable him to divide these rocks into distinct portions. It is true that bands of anthracitic shale abounding in graptolites were, as regards their petrological nature, very distinct from the rocks in which they were intercalated. The great mass, however, of the Llandeilo beds of the Southern Uplands consist of rocks known in old petrological nomenclature as "greywackes"—a name which is still retained for want of a better—and as these rocks differed only in coarseness, and sometimes in colour, this circumstance rendered the division of the South of Scotland Silurian rocks into separate groups extremely difficult. And when it is added to this that contortions have greatly folded and denudations have largely planed off the edges of these rocks, the difficulty of making out distinct horizons among the Llandeilo strata of the South of Scotland becomes very apparent. It is only by a careful, continuous, and long series of observations recorded in maps large enough to show all the contortions, the ins and outs of the strata, that these rocks could be brought into subdivisions enabling them to be recognised. Such have been the work of the officers of the Geological Survey of Scotland; and now we have in the explanatory notes to some of the sheets which have been published, the results of their work recorded, and the subdivision of these Llandeilo rocks indicated.

The explanation to Sheet 15, published in 1871, which includes, among other matters, a description of the Llandeilo rocks occurring in that portion of the Southern Uplands occupied by the north-west part of Dumfriesshire, the south-west portion of Lanarkshire, and the south-east portion of Ayrshire, contains the results of the labours of the Survey among these rocks. There do not appear, in any portion of the South of Scotland Silurian strata, any rocks which appertain to an age older than the Llandeilo; and these Llandeilo rocks are referable only to the Upper Llandeilo series, the Lower Llandeilo or Shelve rocks of Murchison, the Arenig rocks or Skiddaw slates of Sedgwick, being unknown in the district. This Upper Llandeilo series exhibits itself in the

* Memoirs of the Geological Survey of Scotland, Sheets 1, 2, 3 and 15, &c. Explanations of, 1871, 1872, 1873.

form of an anticlinal axis near the southern border of the Silurian area. This axis can be well seen in Roxburghshire and Dumfriesshire, having a north-east and south-west direction. It has also been recognised by the officers of the Geological Survey in Wigtonshire; and the rocks which it exhibits, which are the lowest in the Southern Uplands, have been designated by Prof. Geikie the "Ardwell group." This group is made up of "hard, well-bedded greywackes and grits, with bands of hard shale or slate. These rocks have a prevailing reddish or brownish hue, especially on weathered surfaces."

As seen in Dumfriesshire and Roxburghshire these low rocks have the same aspect and nature. They have afforded, both in Wigtonshire and Dumfriesshire, markings which have considerable resemblance to the fossil described by McCoy as *Protovirgularia*, and in Roxburghshire they have yielded crustacean tracks, but no other traces of organic remains have been obtained from them.

Above the Ardwell group the officers of the Geological Survey recognise a mass of strata to which they have given the name of the "Lower or Moffat Shale group." This group is composed of "flaggy greywacke and grey shales," which are distinguished by the occurrence in them of several bands of black carbonaceous shales. These strata are well developed in the neighbourhood of Moffat, Dumfriesshire, from whence they derive their name. The black carbonaceous shales are very persistent, having been traced by the officers of the Survey from near Melrose to the western shores of Wigtonshire, "a distance of more than 100 miles." Three bands of carbonaceous shales can frequently be made out, but occasionally they come together so as to form one thick band. These bands are very prolific in graptolites. They have, from their carbonaceous aspect, induced many persons, under the guidance of "practical miners," to expend large sums of money in search after coal, and some of the spots where they have been worked are known under the name of "coal heughs."

Although the Moffat group is well developed through the greater portion of the Southern Uplands, it is on the coast of Wigtonshire that the best sections of the series can be seen. Here they are recognised resting on the Ardwell group, having at their base "grey and reddish shales, and clays, with calcareous bands and nodules, and enclosed bands of black shale, the lowest members being hard and flaggy." The second member of the Moffat group, as seen on the Wigtonshire coast, consists of black shales with intercalated clays, like the fire-clays of the coal-measures. Calcareous nodules and lenticular bands are also associated with the black shales, the whole being so intensely plicated as to render an attempt to determine their thickness extremely difficult. Upon the black shales well-bedded greywacke and grits occur with occasional shaly partings. These are succeeded by black shales so much jumbled and jointed, that their thickness cannot be made out. The next sequence consists of grey flagstones, flaggy sandstones, and grits, in beds of varying thickness up to 3 or 4 ft., with abundant partings of grey shale. To these succeed a thick band of finely laminated grey shale, 3 or 4 ft. Black shales, bands 12 to 18 ft. in thickness, occur next, and the highest members of the group consist of fissile shales.

The Moffat group, as represented in Wigtonshire, has a thickness of about 1,000 ft., of which more than half consists of flaggy greywacke beds. The underlying series, the Ardwell group, probably attains to a much greater thickness.

The third member of the Upper Llandeilo rocks of the Southern Uplands of Scotland, like the second, derives its name from Dumfriesshire. It is well exhibited in the hill called Queensberry, and has been designated the Queensberry grit group. The characters of this third member, as they are seen in Wigtonshire, "consist of greywacke and grits in massive courses, with occasional bands of grey and greenish shales." Massiveness and regularity of bedding and jointing are the characters of this group. The sandstones are often coarse; and sometimes even coarse conglomerates appear, in which some of the embedded fragments are sometimes from 2 ft. to 3 ft. in diameter, a feature which distinguishes the Queensberry group from all the other members of the Upper Llandeilo rocks of the South of Scotland. Fossils appear to be absent from this group, no trace of them having been met with in the three parallel bands which traverse Wigtonshire.

In the Dumfriesshire portion of the Upper Llandeilo area of the South of Scotland, there have been recognised, above the Queensberry grit group, black shales with graptolites, the thickness of which have not yet been ascertained. To these black shales the name of Hartfell group has been given. As the typical area where these rocks occur is in the higher part of the Annandale district, the sheets of which have not yet been published, we have at present no account of this group from the Geological Survey.

The Hartfell group is succeeded by the Daer group, which is made up of hard blue and purplish greywacke, and grey shales. It derives its name from a stream flowing from the north side of Queensberry into the Clyde. Its strata are greatly folded, and no reliable estimate can be formed of the thickness of the Daer group.

The Hartfell shales of the Daer group seem to thin out towards the south-west. They have not been distinctly recognised in Wigtonshire, where the Dalveen group, which in Dumfriesshire succeeds the Daer group, is seen resting conformably upon the Queensberry grits.

In Dumfriesshire the Dalveen group consists of fine blue and grey greywacke, and shales having no features distinguishing them from other members of the upper Llandeilo rocks. Their estimated thickness is about 2,900 ft. They are well exposed in Dalveen Pass, Dumfriesshire, whence their name, and in Dinabid Linn they are seen passing under a coarse pebbly rock, "Haggis Rock."

In Wigtonshire the lower part of the Dalveen group is seen overlying the Queensberry rocks south of Corsewell Lighthouse. Here its lower portion is remarkably shaly, but thick masses of greywacke also occur. Among the shaley beds are some bands worked at Cairn Ryan for slates. These slates have long been known as affording graptolites; and another thin band of black shale also containing the same fossils appears in this group in Wigtonshire.

In Dumfriesshire above the Dalveen group a series of

coarse and fine grits and greywacke, having red and green bands of flinty mudstone, conglomerate, and occasional breccia associated with them, occur—a persistent band of conglomerate containing quartz-rock pebbles, Lydian stone, and jasper characterise this group. The conglomerate, being locally known as "Haggis Rock," has furnished the name to the series, which is about 1,800 feet thick. The Haggis group in Dumfriesshire is seen striking across the river Afton, also, along the N.W. flanks of the Lowther hills, and elsewhere in this county. More to the north it can be recognised along the north-western margin of the Silurian area in Crawfordjohn, Lanarkshire. The Haggis rock is not persistent in its character. To the N.E. this conglomerate becomes much finer in grain, and passes "into a gritty greywacke." This group has hitherto yielded no fossils. In Wigtonshire the Haggis rock cannot be distinguished as a distinct series; its characteristic conglomerate being, as already seen, of local occurrence, it does not appear to manifest itself in the Silurians in the S.W. of Scotland.

(*To be continued.*)

LOCAL SCIENTIFIC SOCIETIES

IN very many ways has the general advance of intelligence, elevation of taste, and spread of education been shown during the present century, and more especially during the last thirty years; one of these ways is undoubtedly the increasingly rapid spread of Local Scientific Societies. What we mean by a "Local Scientific Society," as distinguished from the large Societies of London, is an association of individuals in a particular locality for the common study of one or more branches of science, by the reading of original papers, and what is perhaps of more importance, the actual investigation of the natural history—geology, zoology, botany, meteorology—and archæology of its district. Of the societies established within the last thirty years, nearly all are marked by these characteristics; such at all events is their professed object, and we are glad to say that, to judge from the special reports which we have received, and the numerous printed "Proceedings" of greater or less pretensions which are sent us from time to time, a very large proportion creditably carry out their programme.

In a number of the principal towns of England and Scotland associations exist, dating, some of them, from the end of last century, known as "Literary and Philosophical Societies," or by some similar title. These are generally comparatively wealthy, possessed of good buildings containing a library, museum, reading-rooms, lecture-hall, &c., with a large body of members belonging to the middle and upper classes. These, however, so far as their original objects are concerned, with one or two exceptions, scarcely come under the category of Local Scientific Societies, in the sense of the definition given above, though many of them, stimulated by the growing taste for Science, have recently added to their usual courses of lectures on literary subjects, others on subjects connected with Science, and have even organised classes for the study, under competent lecturers or teachers, of one or more branches of Science. In some instances, moreover, a few of the members of these respectable old associations have united to form societies of a kind which entitle them to be regarded as Local Scientific Societies, and even Field-Clubs. Still, all these older societies, as they existed previous to 1830, differed in many essential respects from the Local Societies and Field-Clubs which began to spring up about that time; even the well-known Literary and Philosophical Society of Manchester, quite on a par with some of the best London Societies, and which has produced original work of the highest value, has been all along confined to the learned and professional men of the city and neighbourhood, who have made use of the meetings of the Society for the purpose of making known the results of their independent scientific investigations.

So far as can be ascertained, the society just mentioned is the oldest provincial society which can be considered as in any way scientific, having been established in 1784, for the purpose of diffusing "literary and scientific intelligence, and of promoting the literary and scientific inquiries of learned men in the town and neighbourhood." "The results of its labours," Sir Walter Elliott says, in his valuable address to the Edinburgh Botanical Society, in 1870, on this subject, "were published in 'Memoirs,' the first volume of which appeared in 1785, at which time James Massey was president, and Thomas Barnes, D.D., and Thomas Henry, F.R.S., were Secretaries. Five volumes had appeared up to 1802. In 1805 a second series commenced under the Rev. John Walker, President, and John Hall and John Dalton, Secretaries, which had extended to five volumes more in 1860. A third series was commenced in 1862, and has reached volume xiii. The second series is enriched with many papers by Dalton, including the first development of the atomic theory." In 1858 a microscopical and natural history section was established; the latter, however, we regret to say, is since defunct.

The next society of this class in order of time was instituted at Perth in 1781, as the Perth Literary and Antiquarian Society; we need not say that, so far as eminence is concerned, it was never to be compared with the Manchester Society. It has never done scientific work of any value, though it possesses a handsome building, with a museum, devoted mostly to antiquities, but having a fine natural history collection as well, and a good library. Like many other societies of a similar kind, its building serves as a kind of meeting-place or club, where those members who have nothing to do can meet and have a gossip, and read the papers. This society has published only one volume of "Transactions" (in 1827), but so far as we know, they have now no transactions to record. A few years ago, as will be seen from our list in Vol. viii. p. 521, a Natural Science Society was established in the county, with Perth as its headquarters, which gives promise of being one of the best working Local Scientific Societies in the kingdom.

In 1801 a society of a similar kind was established in the sister kingdom, the Literary Society of Belfast, which has never done anything to call for note here. Previous to this, however, in 1793, the Newcastle-on-Tyne Literary and Philosophical Society was established, which, although it has published only one volume of memoirs, and is little more than the owner of an excellent public library, does good work by providing educational courses of lectures for in-

struction in mathematics, chemistry, and other branches of science as well as literature.

Up to 1830, about twenty other societies, more or less "Philosophical," which term seems then to have been thought a more dignified term than "Scientific," were instituted within the three kingdoms, including the Ashmolean Society of Oxford, and the Cambridge Philosophical Society. Of these, no less than six were in Yorkshire alone, a county, as we shall see, which continues to hold the foremost place, so far as number of scientific societies is concerned; the West Riding bristles with little Field Clubs. Among the best of the societies referred to is the Liverpool Literary and Philosophical Society, which, especially since its amalgamation in 1844 with the Natural Science Society, has done some excellent work, as can be seen from its voluminous "Proceedings," which contain papers that would do credit to any society. The Glasgow Philosophical Society is also one of high standing; and the Royal Geological Society of Cornwall, founded in 1814, which has done some good work in connection with the geology of the district. The Royal Institution of Cornwall is also one of the most creditable of these old societies, having been formed in 1818, for the advancement of knowledge of natural history, natural philosophy and antiquities, especially in their connection wlth Cornwall. Besides its valuable antiquarian work, it has pubished "The Cornish Fauna," a compendium of the natural history of the county.

The one of these older societies which in its object and work corresponds most nearly to our definition, is the Northumberland, Durham, and Newcastle Natural History Society, instituted at Newcastle-on-Tyne in 1829. Among its original members were Sir John and Sir Walter Trevelyan, and the late Albany Hancock, and both before and since its junction with the Tyneside Naturalists' Field Club, it has done much work of a kind similar to that which the recently established Field Clubs aim to do, having between 1831 and 1838 published two volumes containing valuable lists of the flora and fauna of Northumberland and Durham. This society, though somewhat crippled for want of funds, is still in a flourishing condition, and continues, in conjunction with the Tyneside Club, to publish in their Transactions, under the title of "Natural History Transactions of Northumberland and Durham," excellent lists of the fauna and flora, existing and fossil, of the district which it has adopted as its field for work. It possesses some splendid collections which the Newcastle College of Physical Science is generously allowed to use for purposes of study.

Had we space, others of these societies founded previous to 1830, as well as some of a more ambitious kind than the simple Field-Club, instituted since that time, could be named, which stimulated either by the example of the field-clubs, or more probably by the general advance of culture and the growing impressiveness of Science, have done much to foster a love for Science in their respective neighbourhoods and to investigate the natural history of their several districts. A large proportion of societies of this class are found in the south-west of England, in Devonshire and Cornwall: such are the Cornwall Polytechnic Society, the Devonshire and Cornwall Natural History Society, the Devonshire Association—a peripatetic Society founded in 1862 after the model of the British Association—the Royal Institution of South Wales (Swansea), and the Isle of Wight Philosophical and Literary Society. Others also we might mention at the other end of England, for an examination of our list shows that the activity of the country in this respect has been developed to the greatest extent in the north and south.

These societies, though differing in some essential respects from the simple Field-Club, yet in their own way do good and serviceable work by the establishment of museums, the encouragement of local exhibitions, the occasional publication of papers illustrative of the natural history and archæology of the district, and recently, what we deem of considerable importance, the institution of courses of lectures by eminent men of science, and the establishment of classes for the working and other classes who are engaged during the day. We would urge all of this class of association to bestir themselves to the performance of more thorough and more extended work in these directions, thereby not only doing a benefit to the members themselves, as well as to the cause of Science, but elevating the district in which they are located, and thus helping the country onward in the general march of improvement. By means especially of continuous series of lectures by eminent men of science and by well-organised systems of classes, the good that might be done by these institutions would, we believe, be inestimable; and now that the Science and Art Department offers such splendid facilities for the establishment of classes and museums in connection with any institution that chooses to take advantage of them, no local society of any pretensions need any longer be without the material of a comprehensive and high-class education for its members and those in its neighbourhood who are willing to be improved; only a lazy unwillingness to keep up with the rapid progress of the time can deprive a neighbourhood of these advantages. The Royal Cornwall Polytechnic Society, the first "Polytechnic" in the United Kingdom, is an example of what can be done in one way, by the establishment of lectures and classes, and by the institution of medals and money prizes for successful attempts to apply Science to industry. But a model which all literary and philosophic societies, *et hoc genus omne*, would do well to imitate, though they would find it difficult to rival, is the Birmingham and Midland Institute, an institute of which its originators may well be proud, and for the establishment of which they deserve the gratitude of the busy and important district in the midst of which it is planted. It scarcely comes within the scope of our subject, and we only mention it to show to the class of societies with which we are at present dealing, what they might hope to achieve if they only had the will and the generosity to bestir themselves and take the necessary steps. There is no reason why in every county town or other suitable place institutions of this kind should not be established, forming active centres of intellectual culture, and to which the smaller scientific societies of the surrounding districts might be affiliated without losing their independence and with very valuable results. We hope ere long to see this accomplished; and who are better fitted to take the initiative in the matter than those societies which pretend to represent the culture of the districts from which their members are drawn?

(*To be continued.*)

THORPE'S "QUANTITATIVE ANALYSIS"

Quantitative Chemical Analysis. By T. E. Thorpe, Ph.D., F.R.S.E., Professor of Chemistry, Andersonian University, Glasgow. (Longmans.)

WE welcome with pleasure a work which in the present state of our literature on Quantitative Chemical Analysis, may well be looked upon as a boon to the advanced chemical student. Fresenius's Quantitative Analysis has been so generally accepted by chemists as the standard book in this branch of Science, that we greatly regretted the unwarrantable liberties taken by the English editor in the late edition of our trusty author's work. The publishers, who did not, in justice to the accomplished author, recall that edition, may yet learn that the chemical public, at all events, know how to appreciate a good work on Quantitative Analysis. We confess to a feeling of relief, speaking as a teacher of chemical analysis, as we perused Mr. Thorpe's book; for although we have to differ from the author on some minor matters, we believe that this new work will speedily be found in the hands of every chemical student.

Our author has evidently felt what others have experienced before him, that Fresenius's Quantitative Analysis became with every new edition more and more unwieldy (we are speaking of the German editions), and that, at the commencement at least, a simpler guide to quantitative analysis might with advantage be placed in the hands of the student. As methods of analysis—especially volumetric methods—multiplied year after year, the teacher and the student looked to the master for some indications which methods should, under given circumstances, be adopted in preference to others. Mr. Thorpe has evidently been bent upon supplying this want. In the treatment of his subject he has followed the example set by Woehler in his "Practische Uebungen in der Chemischen Analyse," rather than that of Fresenius. It appears to us, however, that he has somewhat fallen into the other extreme, for, in the place of a series of carefully elaborated methods for the determination of each base and acid, he has contented himself with giving a few examples only of individual determinations, and has preferred to teach quantitative separations almost exclusively by describing, in language both terse and concise, a number of complex quantitative analyses, such as are likely to occur in practice. There is much to be said for this plan of teaching analysis, so to speak, *en bloc.* It involves, however, much repetition, or, at the very best, reference from one example to another, and leaves the student in considerable uncertainty whenever he has to break new ground. The aim of all quantitative teaching should be to enable the analyst to adopt or devise for himself correct methods of separation. The foundation for quantitative methods should, in fact, be laid by careful and accurate qualitative work. A good workable method may often be preferable to a more elaborate although more strictly accurate method.

In the endeavour to write as compactly as possible, the author has frequently over-estimated the mental powers and the chemical knowledge, say of second years' students, for whose use the work is apparently written, and has thus sacrificed clearness for briefness. We refer, for instance, to the methods given for the separation of iron, manganese, &c. in Spiegeleisen, condensed as it appears, from Fresenius, where the ammonium carbonate method occurs, but where it would be difficult for a student, without the teacher's assistance, to trace the chemical changes. There is too much of the *how* to do a thing, and too little of the *why* to do it throughout the work, to make it as useful to the beginner as it would otherwise be. Although the several methods for the separation of manganese from iron, &c., are to be found in different parts of the book, there are scarcely sufficient hints, why and under what circumstances and conditions the one method is to be used in preference of the other. The same applies to various other methods of separation. Well known and familiar chemical methods, again, are abandoned, occasionally, for new methods of at least questionable utility. We may mention, among such, the use of hydrochloric acid, as the starting-point in alkalimetry.

The same remark applies to the apparatus described and illustrated. The woodcut on p. 142 *ex. gr.*, illustrative of the method for taking the specific gravity of ammonia, looks startlingly elaborate. Much credit is due, however, to the author and his coadjutor, Mr. Dugald Clerk, for the care bestowed upon the preparation of the woodcuts. We consider them, for the most part, well selected and well executed. There is that pleasing evidence to the chemical eye, that the illustrations have originated in the laboratory, and that they depict apparatus which can be practically used, and are not merely put in to please and catch the eye. In fact, when we compare some high-priced books of the class, which it would not be difficult to enumerate, with the elegantly got-up and cheap volume of Mr. Thorpe, we can only congratulate him on the book he has produced.

If we may be allowed to tender advice, we should say:—Condense the part on the operations of weighing; enlarge the number of examples of simple gravimetric analysis, so as to include the more important acids and bases; draw a line between determinations usually required in analyses for practical or commercial purposes, and the more elaborate complete analysis of the same bodies; and last, but not least, explain more fully, why and when one method answers better than another—if only in compassion for the weaker analyst.

We cordially recommend the book, and hope to see these suggestions adopted in the next edition, for which in all likelihood we shall not have to wait long.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

The Management of the British Museum

I BEG to protest against the remarks upon the management of the British Museum contained in your article of November 6. The general question whether a public institution of the sort is best governed by a public official or by a body of Trustees, may very likely admit of much discussion, but the decision should not be prejudiced by totally ignoring the noble work which has been and is being done by the Museum. No scientific man surely can be ignorant that the British Museum exists not so much for the momentary amusement of gaping crowds of country people, who do not understand a single object on which they gaze, as for the promotion of scientific discovery, and the advancement of literary and historical inquiry. We are told about the indifference of the Museum Trustees to the best interests of science, but we are not reminded frequently enough that it is

almost impossible to carry out any scientific or literary inquiry in a complete manner, without resorting to the great national museum. There are doubtless many things which the Trustees have not done, but is it a slight matter that they have given us, on the whole, by far the most extensive and complete body of collections anywhere brought together in the world? The library and reading-room alone are enough to do honour to their management, and it is almost impossible to fathom the degree in which this library assists every kind of inquiry. When we are least aware, we are often enjoying the fruits of investigation in that library; the late Prof. Boole, for instance, spent the last few months of his life in the Museum, pursuing an exhaustive inquiry into previous writings on the subject of Differential Equations.

As regards the other collections, I presume that no one will call in question their enormous extent; and the fact that they are not adequately lodged and displayed as yet, is due to their very vastness, and to the fact that Government would not, until lately, afford the money for the new buildings. As regards the real interests of original inquiry, too, comparatively little harm is done by the want of room for exhibition, since *bonâ fide* scientific students can always obtain access to the collections.

I am far from denying that the officials who have conducted the South Kensington Museum have, by an enormous expenditure of public money, collected together a great quantity of beautiful objects of art, and have thus not only afforded opportunities for art study, but have made this museum a very agreeable and fashionable lounge. But I must protest against the notion, apparently countenanced in NATURE, that the scientific value and work of a national museum is to be measured by the number of millions of persons who saunter through the galleries. No doubt the utility of a museum in affording popular instruction and elevated amusement to large masses of people is very considerable, but this popular work is altogether of a different order from the strictly scientific object of collecting together all the products of intellect and of Nature. It is an unavoidable misfortune of the best and highest work in science that it is quite unobtrusive. The public is struck by the thousands who crowd the decorated galleries of South Kensington. There is nothing to attract public attention in the two or three hundred bookworms patiently plodding through the books in the Museum library, or the few students turning over the drawers of the zoological, botanical, mineralogical, numismatic, and other collections. But in NATURE, which has so powerfully advocated the necessity of promoting original research in this country, I should expect, more than anywhere else, to find a due appreciation of the noble work which is being carried out by the British Museum trustees, and by the staff of eminent scientific and literary men who are employed under their direction in promoting almost every branch of literature and science. We have heard many complaints of the apathy displayed by Government in the promotion of science. The existence of the British Museum is the best answer to that complaint. As regards those branches of science which demand the use of large collections, it may be regarded as the great national laboratory; and if scientific men do not make adequate use of it, that is their fault and not that of the trustees.

W. STANLEY JEVONS

[Our opinion of the immense importance to research of the collections of the British Museum is quite in accordance with the above letter of our esteemed correspondent, and if he will read the article again he will see nothing in it to indicate any difference of opinion. Indeed we regard the positions of the scientific men in the British Museum as positions of endowed research, and positions, moreover, which have amply justified it, miserable as the amount is in many cases. Our objection is to the existence of trustees not represented by a Minister, and to the action of the trustees, who have not expanded the area of the utility of the collections, and who have cared so little for the men of science working under them and the collections themselves that the former are underpaid and the latter are much less useful than they might be. Mr. Jevons concedes the whole point when he refers to the money so properly spent at South Kensington; for had the British Museum been under the same Minister, money would have been spent there too. The money must be spent unless we are to sink to the level of—well, let us say Morocco; and it is to prevent this that the proposed transfer has been suggested.—ED.]

On the Equilibrium of Temperature of a Gaseous Column subject to Gravity

IN NATURE, vol. viii. p. 486, Mr. Guthrie asks the question, "Is thre no possibility of testing the nature of thermal equilibrium of a column of still air?" I think to this question an answer may be given, which, though indirect and imperfect, will perhaps decide the controversy on the above subject.

If gravity causes in the temperature of a gaseous column the difference, which Mr. Guthrie thinks it does, that difference must be in proportion to the height of the column, and in inverse proportion to the specific heat of the gas. Hence it follows that, if two equal columns of different gases, both under the same thermal influence, are joined at their lower parts by a thermo-electric pile, the side of this pile, which is surrounded by the gas with the highest specific heat, must be constantly cooler than the other side. The result of my experiments respecting this, is the confirmation of Mr. Guthrie's opinion. The description of these experiments, and a theoretical treatise on the subject, have been in the hands of Prof. Poggendorff since the beginning of last June, and will be published in an early number of his *Annalen*.

I hope that my experiments will induce others to try them in the same or in another manner, in order to bring the question concerning the influence of gravity on the thermal equilibrium to a final decision. Should it prove in favour of Mr. Guthrie's theory, as I believe it will, this theory, represented till now only by a very small minority, although it was broached twenty years ago by Waterston,* will give rise to results† which may perhaps clear up many of our ideas about Kosmos.

The argument which Prof. Clerk-Maxwell has brought against Mr. Guthrie in NATURE, vol. viii. p. 85, does not appear to me to be generally correct. He says:—In a given horizontal stratum of a gaseous column subject to gravity, a greater number of molecules come from below than from above to strike those in the stratum, because the density of the gas is greater below than above. Certainly the number of molecules, which enter into such a stratum during a certain time, depends upon the density of the gas, but besides this, it depends upon the probability of entering into it, which exists for each molecule. Now, this probability is not only dependent upon the distance of a molecule from the stratum, upon its velocity, its direction and its encounters with other molecules, but also upon the very fact of its being above or below the stratum.

Gravity continually tends to diminish the distance between any horizontal stratum and each molecule which is above the stratum, and continually tends to increase the distance between the stratum and each molecule which is below. Hence it follows that the probability of entering into the stratum will be greater for a molecule which is above than for one below, if, in the case of both, all other circumstances are equal. For example, consider two molecules, which in a given moment move with the same velocity and in the same direction on the two sides of the stratum; if this direction is horizontal like the stratum, and if in the given moment the distances of the molecules from the stratum are both very small, in the next moment the molecule above the stratum will have entered into it, while that one below will have removed from it.

In the case of the density being greater below the stratum than above, more molecules would enter it from below, if gravity did not exist. But under the influence of gravity, the effects of the difference in density can be balanced by those of the above-mentioned difference in the probability, which exists for each molecule of entering into the stratum during a certain time. I even consider this last difference to be the dynamical cause of the difference in density.

Westend, near Berlin, Oct. 20 G. HANSEMANN

Periodicity of Rainfall

As far as my own figures are concerned, the reply to Mr. Meldrum's question is very easily afforded. I agree with him that it is undesirable to use averages deduced from groups of stations variable both in the number and locality of their components. The observations which I quoted were those of a single station, Halton, St. Philip, Barbadoes.

With respect to the general question, I regret being unable to share Mr. Meldrum's evident enthusiasm, and that a very different opinion has been published in the *Zeitschrift*, by Dr. Jelinek, one of the most eminent meteorologists of the present day. It may be convenient to some readers to be informed that an abstract of Dr. Jelinek's article is given in "British Rainfall, 1872," together with a general *résumé* of the state of the question up to the date of its publication.

Camden Square, Nov. 1 G. J. SYMONS

* In "On Dynamical Sequences of Kosmos."

† I have expounded some of these results in an abstract mechanical form in "Die Atome und ihre Bewegungen" (Cöln Lengfeld'sche Buchhandlung, 1871).

THE COMMON FROG*

IV.

HAVING now passed in review the greatest differences presented by the nearest allies of our common frog (the members namely of its own order), certain facts of interest present themselves respecting the geographical distribution of the group. These facts are interesting, because they point not only to the exceptional nature of the faunas of South America and of Australia, but also to a certain zoological affinity between those two regions of the earth, distinct as they are from one another. Thus, as has been mentioned, it is only in Australia and South America that the typical genus *Rana* is absolutely wanting. One genus of Tree-frogs, *Pelodryas*, is confined to Australia, but is closely resembled by another genus, *Phyllomedusa*, which is restricted to South America, and differs from the former only by the absence of a web between

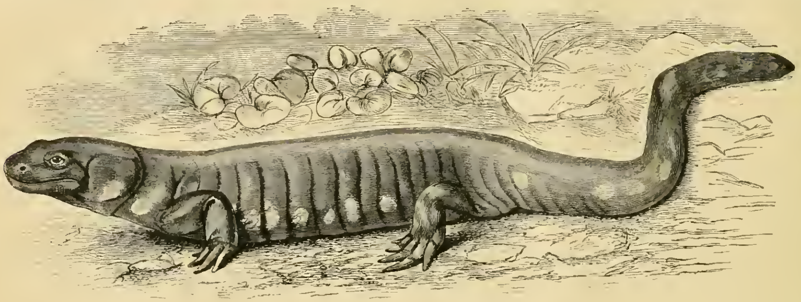


FIG. 16.—An American Eft of the genus *Amblystoma*.

the toes. It should be recollected that the primary subdivisions of a zoological order are termed *families*. One whole family, called *Cystignathidæ*, is (with the exception of two species) confined to Australia and America.

The typical Tree-frogs (*Hyla*) abound in South America and are also found in Australia, but not in India or in Africa south of the Sahara. On the other hand another genus of Tree-frogs (*Polypedates*), is found in India, Japan, and Madagascar, but not in either Australia or America.

The typical Toads (*Bufo*) have, however, their head-quarters in South America, yet are wanting in Australia,

FIG. 17.—The *Amphiuma*.

though they are found everywhere else where the order exists at all.

The earth's surface, considered as to its population of the frog and toad order, may be divided into three great regions. The first of these is composed of Europe, Northern Asia (with Japan and Chusan), North America, and Africa north of the Sahara. The second region consists of Africa south of the Sahara, Madagascar, India, and the Indian Archipelago. The third region is made up of South America and Australia, and the resemblance between these two parts of the earth's surface as to their frogs and toads is paralleled by that as to their

FIG. 18.—The *Proteus*.

mammalian faunas, since marsupial mammals (or pouched-beasts of the opossum kind), are strictly confined to Australia (and its islands) and America.

No Frog or Toad has yet been found in New Zealand.

Africa, considering its size and climate, is poor in species of *Anoura*.

We should be prepared for the fact that in South America Tree-frogs abound, since all kinds ot animals in that region assume an arboreal habit.

Monkeys are tree-livers all the world over, but nowhere are all the indigenous species so thoroughly arboreal as in tropical America. There alone do we find monkeys with a prehensile tail capable of serving as a fifth hand, and so affording greater security and facility to locomotion amidst the branches. Only there also do we find beasts so ex-

* Continued from p. 13.

clusively constructed to pass the whole of their lives in trees that they can move along the ground only with difficulty—such is the case with the sloths. Porcupines, which in the old world have short tails, in the new world have long and prehensile ones. An animal allied to the Badger—the Kinkajou (*Cercoleptes caudivolvulus*)—similarly acquires in South America a long and prehensile caudal appendage. Even the Fowl and Peacock Order of Birds becomes in South America more strictly arboreal than elsewhere (being represented by the Curassows), and the very geese find there a congener (*Palamedia*) specially adapted to dwell in trees and destitute (like the frog *Phyllomedusa* before mentioned) of a web-like membrane between the toes.

We have now advanced a further stage in seeking a reply to the question, "What is a Frog?" We have now viewed it in the light to be derived from a consideration of the more noteworthy forms of the frog's order.

We may next inquire what are its next nearest allies? What other animals of the class Batrachia constitute an order which approaches nearest to the frog's order *Anoura*?

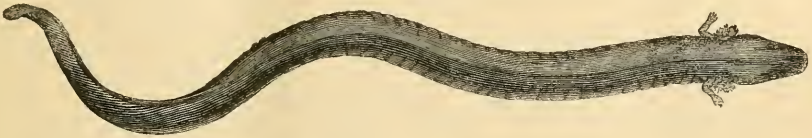


FIG. 19.—The *Siren*.

Almost every pond in England which harbours frogs, harbours also those little four-legged, long-tailed, soft skinned creatures termed *Efts* or *Newts* (of the genus *Triton*) familiar to every schoolboy.

These Newts which are thus by circumstances placed actually in juxtaposition with the frog are also zoologically his nearest allies outside his own (frog and toad) order. Like the frog they undergo a metamorphosis, at first appearing as Eft-tadpoles (with elongated external gills, but devoid of limbs), subsequently losing the gills and acquiring limbs. Efts, as is manifest, are widely and strangely different in form from frogs and toads.

Thus is justified the assertion before made as to the far less exceptional form of the human body than that of the frog. For when, amongst Mammalia, we go outside that *order* to which Man belongs, we find in his *class* other creatures (insect-eating, flesh-eating, and of the squirrel kind) which more or less closely resemble some of the lower members of man's order. When, however, amongst Batrachia, we go outside that *order* to which the frog belongs, we find in his *class* no creatures whatever which present anything like such an approximation to any members of the frog's order as is presented by the mammals above referred to certain members of man's order.

FIG 20—*Menobranchus*.

The Efts (or Newts) with their allies—hereinafter noticed—constitute the second order *Urodela* of the class Batrachia.

This order is very unlike the first and already described order (*Anoura*), in that it is composed of creatures which in many respects are strangely divergent; and though most of the species more or less resemble our own Efts (or Newts) in shape, yet the *Urodela* are very far from constituting such a homogeneous group as are the *Anoura*.

It will be well now to review some of the more striking forms contained in the order.

The Land Eft (*Salamandra*), though common in Holland and France (as well as the rest of Europe), is unknown in this country.

Genera allied to the European genera *Triton* and *Salamandra*, and to the American genus *Amblystoma*, may have the body and tail more and more elongated and the legs reduced, as in *Spelerpes*, *Chioglopa*, and *Œdipina*, till they attain the condition of *Batrachoceps*. The greatest excess of this development, however, is found in the North American genus *Amphiuma*, the minute limbs of which have either three or two toes, according to the species. These creatures are called by the negroes "Congo Snake," and are quite erroneously regarded as venomous.

The largest existing Urodele—the gigantic Salamander (*Cryptobranchus*)—is found in Japan, where it attains a length of 5 or 6 feet. A closely allied species inhabits China, and during the tertiary period one also inhabited Europe, the fossil skeleton of which being strangely supposed to be that of an antediluvian man received the curious appellation, "Homo diluvii testis."

In *Cryptobranchus* (as in all the Urodela yet enumerated except *Amphiuma*), though the young have gill openings and external gills, the adults are devoid of both.

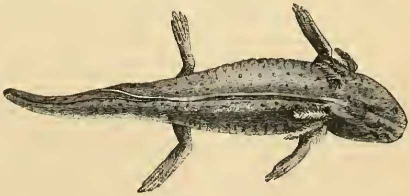


FIG. 21.—The Axolotl.

In a North American genus, however (*Menopoma*), which, though smaller in size, closely resembles Cryptobranchus in figure, there is a permanent gill opening, though the gills themselves disappear in the adult, and the same is the case with *Amphiuma*. Thus in these animals the metamorphosis is less complete.

In the subterranean caverns of Southern Austria (Carniola and Istria) is found the *Proteus*. This is an elongated Urodele, with slender limbs, and but two toes

to each hind foot. Passing its whole life in perpetual darkness, it is blind and colourless, except the external gills, which are red. This animal retains during the whole of life not only the gill aperture on each side, but also the external plumose gills which are transitory in the Anoura and in all the Urodela hitherto mentioned. Here then we first meet with an animal which may be said to be a permanent and persistent Tadpole, yet rather like an Eft-tadpole than like that of the Frog.

A North American Urodele, misnamed (for it is silent enough) *Siren*, also presents us with permanent external gills, and it offers another interesting resemblance to the tadpole of the frog in that it is furnished throughout life with a horny beak. It has also another remarkable character in which it stands alone in its class. Hitherto every relative of the frog has had, like it, four limbs in the adult condition. In the Siren, however, we for the first time make acquaintance with a creature belonging to the class (though not to the *order*) of frogs and toads, which is devoid altogether of hinder (or pelvic) limbs, being in this respect like the whales and porcupines amongst beasts, and like the little lizard, *Chirotes*, amongst reptiles.

Another North American Urodele, *Menobranchus*, possesses throughout the whole of life both gill openings and external gills. But it is furnished with four limbs, and in other respects more or less resembles in appearance, as it does in size, the genus *Menopoma* before noticed.

Finally there is a genus of this order (*Urodela*) which has of late presented circumstances of peculiar interest. This is the Axolotl of Mexico, which was long considered by Cuvier to be a large Eft-tadpole, possessing as it does permanent gills and gill-openings, with some other characters common to the Eft-tadpole stage of existence. At length, however, its mature condition was considered to be established by the discovery that it possesses perfect powers of reproducing its kind.

For some years, individuals of this species have been preserved in the Jardin des Plantes at Paris, and a few years ago one individual amongst others there kept was observed, to the astonishment of its guardian, to have transformed itself into a creature of quite another genus—the genus *Amblystoma*, one rich in American species, Since then several other species have transformed themselves, but without affording any clue as to the conditions which determine this change—a change remarkable indeed, resulting as it does not merely in the loss of gills and the closing up of the gill-openings, but in remarkable changes with respect to the skull, the dentition, and other important structures.

There is, moreover, another and very singular fact connected with this transformation. It is that no one of the individuals transformed (although we must suppose that by such transformation it has attained its highest development and perfection) has ever yet reproduced its kind, and this in spite of every effort made to promote reproduction by experiments as to diet and as to putting together males and females both transformed, also transformed males with females untransformed, and males untransformed with females transformed. Indeed, the sexual organs seem even to become atrophied in these transformed individuals. Moreover, all this time the untransformed individuals have gone on bringing forth young with the utmost fecundity, no care or trouble on the part of their guardians being required to effect it.

A fact more noteworthy could hardly be imagined in support of the view of specific genesis put forward recently.* Here we have a rapid and extreme transformation taking place according to an unknown internal law of the species which transforms itself. No one, moreover, has been able to detect the conditions which determine such transformation (though it takes place under the eyes, and in the midst of the experiments of its observers). This latter fact affords abundant evidence how obscure and recondite may be the conditions which determine the transformations of specific genesis, and how utterly futile are observations as to an apparent homogeneity of readily appreciable conditions. They are so since it seems to be just such recondite ones which really determine the changes just referred to, and probably, therefore, other changes analogous to them.

* See Genesis of Species, chap. xi.

It may be a question whether the genus *Menobranchus* may not also be a persistent larval * form, and one which now never attains its once adult form. If so, it is most probable that its lost state was similar to that of the exclusively American genus *Spelerpes*, the larva of which *Menobranchus* much resembles. With respect to *Proteus* and *Siren* no conjecture of the kind can yet be made.

Individuals belonging to the common English species (*Triton cristatus*) occasionally retain some of the external characters of immaturity, in spite of having attained reproductive capability; and a European species (*Triton alpertris*) often matures the generative elements while still, as to external appearance, more or less in its tadpole stage of existence. The adult condition, however, is normally and generally attained by it.

The geographical distribution of the *Urodela* is very remarkable. North America is the head-quarters of the order, and, with rare and trifling exceptions, the whole are confined to the Northern hemisphere. The exceptions are certain forms which extend down the Andes into South America, and one or two species of *Amblystoma*, which similarly descend along the highlands of South Eastern Asia. Urodeles are absolutely wanting in Hindostan, Africa south of the Sahara, the Indian Archipelago, Australia, and New Zealand. As might be expected, that part of Asia which is nearest to North America, namely China and Japan, is the region of the old world most richly peopled by species of *Urodela*. Altogether the world's surface may be divided according to its Urodele population into three regions. The first will comprise Europe, Africa north of the Sahara, and North Western Asia. The second will include Japan and Eastern Asia. The third will be formed by North America, with a slight extension southwards into South America—a division which by no means coincides with that indicated by the *Anoura*.

The above two orders (*Anoura* and *Urodela*) comprise all the animals most nearly allied to the common frog, of all those outside its own order. There is, however, another small ordinal group of animals which remains to be here noted, because of all existing creatures they come nearest to the frog, after the *Urodela*.

(*To be continued.*)

INAUGURATION OF THE LINNEAN SOCIETY'S NEW ROOMS

Opening Address by the President

IT is now seventeen years since the Government first recognised the claims of our Society to encouragement and assistance on the part of the State, as one which devoted itself to scientific pursuits unremunerative to its members, but tending directly or indirectly to public benefit; and since then a sense of the justness of such claims on the part of pure natural science has become gradually more general. We are no longer in the days when a Peter Pindar could turn the Royal Society and its president into ridicule as boiling fleas to ascertain whether they turned red like lobsters. The *Times*, instead of a short leader dismissing the British Association meetings in a similar strain of banter, devotes daily, during the time of its session, half a dozen columns to the details of its proceedings. And our own department in natural science is now admitted to be one of the most im-

* The young of the Frog or Eft is called a larva.

portant branches of general science, specially important in its relation to our material prosperity. Our food and raiment, the essentials of life, are derived exclusively from the animal and vegetable kingdoms, and biological products contribute largely to many of our luxuries, whilst on the other hand some of the greatest calamities with which we are afflicted are due to the rapid development of animal or vegetable life. Many are the associations, under Government as well as individual patronage, devoted to the improvement and increase of useful animals and plants; and of late attention has been also devoted to the arrest of the ravages of the noxious ones, the balance of natural selection being disturbed by the interference of agriculture and animal education. The due study of the means of restoring this balance, of turning it more and more in our favour, of calling in to our aid more and more of the hitherto neglected available species, or of the hitherto latent properties of those already in use, of checking the progress of blights and murrains, requires a thorough knowledge of the animals and plants themselves, and that thorough knowledge can only be obtained by that scientific study not only of particular animals and plants supposed *a priori* to be useful or noxious, but of *all* animals and plants, which it is the special province of our Society to promote. And in this respect I think it will be generally admitted that we have not been neglectful of our duty, and that we have done our part in rendering effective the support we have of late years received from Government as well as from individuals, and in establishing a sound claim for its increased continuance. Besides the aid afforded to scientific researches by our largely augmented library, the great value of the papers published in the recent volumes of our Transactions and Journal has been acknowledged abroad as well as at home. It is in our Society, for instance, that the great Darwinian theories were first promulgated; and it must be recollected that the five or six hundred copies of our publications regularly sent out, place the researches they exhibit at once at the disposal of the leading followers of the science in all parts of the world. It is true that these great additions to our efficiency are not entirely due to Government patronage, but are the direct results of the reforms introduced by Dr. Hooker in 1855. Those reforms, however, would have lost much of their effect had we remained confined to our old quarters in Soho Square. Cramped for space in those obscure and dingy rooms, it required a strong devotion to science to induce an adequate attendance at our meetings; and saddled with a heavy rent, we could neither purchase books for our library nor find room on our shelves for those presented to us.

In the spring of 1856, however, an opening was made for our obtaining rooms in Burlington House. I was then on the Council, and joined heartily in the conviction of the importance of availing ourselves of the opportunity, notwithstanding the heavy expense it might entail, which I felt confident we could cover by a subscription amongst our fellows. Our President undertook the preliminary negotiations, and at the meeting of our Council on June 11 a letter was officially communicated to us addressed by the Secretary of the Treasury to the President of the Royal Society, allowing the temporary location in Burlington House of the Linnean and Chemical Societies with the Royal Society, upon certain conditions; those which affected us being, that the Royal Society should be put in possession of the main building of Burlington House on the understanding that they would, in communication with the Linnean and Chemical Societies, assign suitable accommodation therein for those bodies, and that the Fellows of the three societies should have mutual access to their three libraries for purposes of reference. Our Society, at a special general meeting held on the 17th of the same month, authorised the Council to take the necessary steps for carrying out the proposal of the Government, and in the following February 1857 the Royal Society assigned to us the rooms which we have since occupied under the above conditions. A subscription was organised which ultimately amounted to nearly 1,100*l.*, sufficient to defray all expenses of parting with our old rooms and fitting up the new ones, with a very small surplus, which was carried to the general account. In the same month of February I was associated with our then active and zealous President and Secretary, and with Mr. Wilson Saunders as a Removal Committee, and on Tuesday June 2 the Society was enabled for the first time to meet in their new rooms.

Our position, however, although so great an improvement upon Soho Square, was not yet quite satisfactory. It was provisional only, and under the wing, as it were, of the Royal Society, and liable at any time to be exchanged for a worse or a better one as the case might turn out. This uncertainty is now removed. The Government, rightly understanding the relations which ought to prevail with the scientific societies judged to be deserving of their support, obtained from Parliament adequate means for providing ample accommodation to the six societies here located, without reserving any right of interference with or control over their scientific operations. Thus our new quarters have assumed a permanent and independent character, the rooms have been built and fitted up expressly for our Society, and, having followed out all the arrangements, I feel bound to acknowledge the effective manner in which the liberal intentions of Government have been promoted and carried out in detail by the architects, Mr. Barry and the late Mr. Bankes. When the plans for the new building were first being prepared, some six or seven years since, we were applied to for particulars of the accommodation we should require for our library and meetings, for the transaction of the business of the Society and for the residence of our librarian and porter. We were not consulted, it is true, about the general arrangements in relation to the other societies, and we have to regret the cessation of that close juxtaposition and intimate intercourse with the Royal Society which was so agreeable to us, but in all other respects our requisitions were fully complied with in the plans prepared and sent to us for approval, and the only alteration since made has been the curtailment of a portion of the basement premises in favour of the post-office, which rather inconveniently limits the stowage room for our stock of Transactions. With this sole exception we have the space we asked for, and the bookshelves and such other fittings as have been provided by Government have been worked out in the most satisfactory manner.

Our removal here has necessarily been attended with considerable expense, the precise amount of which cannot yet be calculated, but it will probably exceed 600*l.* The Council have, however, not thought it necessary to call for any special subscription. The investments made during the past year have been partially with a view to the present occasion, and the gradually increasing sale of our publications and general appreciation of the value of our labours has been so far adding to our receipts that we closed last session with a much larger balance in hand than usual, and we hope to clear ourselves of the liabilities we are incurring, without reducing our invested funds much below 2000*l.* At the same time, we must not conceal from ourselves that we shall be called upon for a considerable increase in our expenditure. Our enlarged accommodation, combined with high prices, will add much to our household expenses. We are threatened with a repeal of the Act which exempts us from parochial rates. Nearly the whole of our library having within the last three weeks passed through my hands, I have become convinced that it will require a large outlay in binding, as well as in filling up gaps to render it really efficient. And, above all, we must bear in mind that the chief means we have of promoting the scientific objects for

which we are associated, the only way in which we can render them available to our numerous Fellows resident in our colonies, is through our publications, and heavy as have been of late years our printer's and artists' bills, they will and ought to become heavier and heavier still. To render fully available the assistance we have received from Government, we require continued and increased support from our Fellows, and from the scientific public. We reckon already among our Fellows the great majority of those who have acquired a name in zoology, or botany, and I sincerely hope that all men of means who take a sincere interest in biological pursuits will think it a pleasure as well as a duty to contribute directly or indirectly to the support of the Linnean Society of London.

With regard to future arrangements in the new phases of life into which the Society has entered, the Council has kept in view three great objects, the endeavour to render our Meetings attractive, the extended usefulness of our library, and the steady maintenance of our publications. On meeting-nights the library will be open at 7 o'clock, the chair will be taken in the meeting-room at 8 o'clock, as at present, and after the meeting the Fellows will adjourn to tea in the Council Room upstairs, opposite to, and in direct communication with the library. The extended shelf-room in the library has enabled a classification of the books which will render those most frequently consulted much more readily accessible than heretofore; and as evidence that there is no relaxation in our publishing department, I have to announce that besides the two numbers of our Journal, one in Zoology, and the other in Botany, which have been sent out since our last meeting, two new parts of our Transactions are in the course of delivery, the concluding one of Volume XXVIII., and the second of Col. Grant's Volume XXIX. The first part of Volume XXX. is in the printer's hands.

INAUGURATION OF THE CHEMICAL SOCIETY'S NEW ROOMS

ON Thursday night last the Chemical Society met for the first time in the new apartments assigned to it in the right-hand front wing of Burlington House. The event was a notable one, and it is not often that such an occasion happens to the president of a hard-working body of scientific men as last Thursday fell to the lot of Dr. Odling when he rose to welcome the fellows to their new home, and he might well feel it his duty to break for once the tradition which imposes silence on the president on the first night of the session.

Dr. Odling accordingly rose and proceeded to bid them welcome to the new rooms, and then to give in a few words a general statement of what had been done in relation to the taking possession of them by the society. This it seems had been by no means an easy matter, as but a few days back the society was still in its old quarters without a book of its library moved, and the present apartments were in a damp and generally unfinished state.

Thanks, however, to the exertions of the Council and especially of the Junior Secretary (Dr. Russell), who were most kindly met and aided in their endeavours by Mr. Barry (the architect) and the Clerk of the Works; the new rooms were got into a habitable condition, the books in great part placed in their cases, and the meeting-room provided with seats in time for the first meeting of the session.

The rooms in question at present in use consist of the library, a noble room on the second floor, well capable of holding the books of the society for some time to come. That for meetings, below the library and overlooking Piccadilly, is capable of seating nearly twice the number of listeners that could be provided for in the old quarters. The seats, however, are somewhat crowded, and though the room is provided with double windows there is a considerable noise from the street. The president, however, held out hopes of a wooden or asphalt pavement being before long laid down in front of the building, and we hope a point of such importance will not long be neglected by the authorities. The most noticeable point, however, is a laboratory, placed on the right-hand side of the meeting-room and opening into it with double doors immediately behind the lecture-table. This, though at present not quite ready for use, is supplied with every fitting of a good laboratory, and will shortly be provided with the necessary apparatus and re-agents. According to the president, "whatever may be its subsequent use, it is intended at present to place it at the disposal of those authors who may wish to illustrate their papers with experiments." We do not know whether the words of the president imply an intention on the part of the society to aid research by granting the use of its laboratory in such cases as it may think deserving, but in any case the society deserves the thanks of every scientific man for so admirable an innovation as a room for the preparation of experiments.

Dr. Odling in his speech alluded to the "childish pleasure, childish in its earnestness and simplicity," with which a chemist looks upon a new experiment. We quite agree with him as to the fact of its existence, but we think that this desire to see answers a far higher purpose than that of mere pleasure. The science of the chemist is essentially a science in which, to quote a popular phrase, "seeing is believing," and nothing can be more wearisome than the constant repetition of the description of reactions, or the recounting of qualitative or quantitative results unenlivened by a single experiment. Such descriptions quite fail to lay hold upon the mind, except at the expense of a wearisome strain, and the consequence is that many a valuable paper loses half or all its effect when read (which should be to raise discussion), simply because in an attempt to describe facts the author loses sight of the necessity of succinctly generalising therefrom.

In the meantime what have the other societies affected by the changes in Piccadilly been doing to provide for the experimental illustration of papers? and especially what has the Royal Society done in the direction to which we have alluded? We are informed on the best authority—nothing! The rooms of the latter consist as did the temporary ones, simply of those requisite for the accommodation of the library and for the *reading* of papers. Now is the Chemical Society right? If so the Royal Society is wrong. It has not done all when it has provided comfortable reading-rooms for its members, and a place where its secretaries can read the papers to a few silent Fellows who are sparsely scattered over the benches. The reading and publication of papers is not all that a great and wealthy society can or ought to do for the advancement of science. Why should its laboratories not exist as well as its library?

There is no reason why the meetings of the societies instead of being, as some of them now are, dull reunions only attended by the Fellows as a matter of duty, should not be made more useful to men of science. What could be better than to see them attended by the more advanced of the younger students of science, as the meetings of the Chemical Society now very often are, who might there see how the better known workers demonstrate their discoveries, and how their papers are examined and discussed. Unless some attempt is made to give the other societies a greater grasp over the several classes of workers to which they more directly appeal, they will infallibly lose the guiding power they have hitherto had, and the advantages conferred by their organisation in the propagation of scientific knowledge will be lost. It behoves the Royal Society in particular to show the way to the others in following in the steps taken with

such signal success by the chemists. If it does not do so, but allows itself to be left behind, it must soon see many of the most important papers sent to the Chemical or to such of the other societies as may choose to provide the means of properly illustrating them.

It may be urged that if papers are to be experimentally illustrated, all cannot possibly be read. We can only say so much the better. Why should not a society's council exercise a wise discretion, and relegate some classes of papers at once to the "Journal," the proper place for many a mass of numerical data now perforce read, but of which discussion is impossible?

F. C. S.

NOTES

WE regret to announce the death, on the 10th inst., of Mr. B. F. Duppa, F.R.S., well known for his numerous and important researches in organic chemistry. He was educated at Cambridge, and was afterwards, in the year 1857, a pupil in the Royal College of Chemistry. Within a period of eleven years he published, partly alone and partly in conjunctton with Mr. W. H. Perkin and Dr. Frankland, no less than twenty papers, most of which appeared in the Transactions and Proceedings of the Royal Society. The most important of these researches related to the action of bromine and iodine on acetic acid, the artificial production of tartaric acid, the formation of organic compounds containing mercury, and the synthetical production of numerous acids of the fatty and acrylic series. Mr. Duppa was elected a Fellow of the Royal Society in 1867. Being a man of independent means, he never applied for, nor held, any scientific appointment, but formed one of that small band of enthusiastic and disinterested amateur workers of whom England may justly feel proud, and to whom she is so much indebted for a very large proportion of the contributions which she has made to the progress of science.

MR. MITCHELL, of Old Bond Street, is, we believe, about to publish a portrait of the late Dr. Bence Jones, engraved by Holl from the beautiful drawing by Mr. George Richmond, R.A.

THE following awards have been made by the French Geographical Society:—2,000 francs to M. Dournaux-Dupéré, who has just set out for Timbuctoo; this gentleman has also received a similar sum from the Minister of Public Instruction; 2,000 fr. to M. Francis Garnier, to aid him in his explorations along the Blue River in China, and which have Yun-nan and Tibet for their objects; 1,500 fr. to MM. Marche and Compiègne, who have already proceeded a considerable distance along the course of the Ogowe with the design of penetrating as far as the great African lakes, and joining Livingstone.

THE subject for the Le Bas Prize (Cambridge) for the present year is "The Respective Functions of Science and Literature in Education." Candidates must be graduates of the University of not more than three years' standing from their first degree when the essays are sent in, which date is fixed before the end of the Easter Term, 1874. The essays must each bear some motto, and be accompanied by a sealed paper bearing the same motto, and enclosing the name of the candidate and that of his college. The successful candidate is required to publish the essay at his own expense.

MESSRS. TRÜBNER AND CO. will publish, in about ten days, Mr. George Henry Lewes' new work, entitled "Problems of Life and Mind."

WITH reference to the paragraph in last week's NATURE on the discovery of the conversion of spherical into plane motion, Prof. Sylvester writes: "I feel it an act of simple justice to another to say that I should never have hit upon the instrument which effects this, had it not been for the previous, wholly original and unexpected, discovery made nine years ago, by M. Peaucillier, of the conversion of circular into rectilinear motion, with which I was recently made acquainted by M. Tchebicheff, and which seems to have been little noticed in the discoverer's own country, and to have remained wholly unknown in this. M. Peaucillier has succeeded by the most simple means in solving a kinematical problem which had baffled the attempts of all mechanicians, from our James Watts downwards, to accomplish, and a simple Captain of Engineers in the French army has actually accomplished by a stroke of inspiration the mathematical solution of a question which many of the most profound and sagacious mathematicians of the age have been long labouring, but necessarily (as it is now obvious) in vain, to prove to admit of none. The conversion of circular into rectilinear motion before M. Peaucillier's discovery was gradually growing to be classed in the same category of questions as the quadrature of the circle, and by a great number of mathematicians was actually deemed to be equally impossible in the nature of things. A working model of Peaucillier's machine constructed by my friend M. Garcia, the brother of Malebrau and the inventor of the laryngoscope, is in my possession at the Athenæum Club, and several copies of it have been already made by its admirers, which term comprises all who have seen it. The wonderfully fertile kinematic and mathematical results which I have succeeded in educing from the simple conception involved in this machine may form the subject of another communication to NATURE."

PROF. JELINEK, of Vienna, writes us that the death of Prof. Donati is the only unhappy event connected with the Meteorological Congress of Vienna, which in all other respects has proved successful. The fact of all countries of Europe (France excepted) and the United States of North America being represented at the Congress, and the conciliatory spirit in which all the proceedings were held, the general desire to arrive at an uniform system of observation and publication make us hope, he thinks, that further decisive steps in this direction will be taken. The Congress has expressed the wish, that another Congress of Meteorologists shall meet in three years, and it has appointed a permanent Committee under Prof. Ruys Ballot of Utrecht, as President, and with Prof. Bruhns of Leipzig, Cantoni of Pavia, Jelinek of Vienna, Mohn of Christiania, Director Scott of London, and Director Wild of St. Petersburg, as members to prepare the solution of certain questions especially relative to the best form of publishing meteorological observations and to the extension of the existing system of meteorological observations. The permanent Committee has been also charged with the preparatory steps towards the convocation of a second Maritime Conference (the first having been held at Brussels in 1853). There will be three editions of the proceedings of the Congress. The one German, the other French, the third under the care of Mr. Robert Scott, in English.

RATHER an unusual incident has recently occurred in the Belgian Academy of Sciences, about which, according to the two gentlemen most concerned, erroneous statements have been made in the Belgian papers and *La Revue Scientifique*. The common statement is that at the *séance* of June 7 last M. E. van Beneden, son of the well-known Professor of Zoology at the Catholic University of Louvain, and himself Professor of Zoology at Liége, by appointment of the present Catholic Ministry, read a paper on the results of a voyage which he had recently made to Brazil and La Plata. Speaking of the difficulty of obtaining a dolphin on account of the superstitions of the Brazilian fishermen, he is reported to have referred to the ancient belief in Europe that dolphins were in the habit of bringing dead bodies on shore, and to have said, "The *fable* of Jonah is an embodiment of this belief." Thereupon, it is said, M. Gilbert, Professor

of Mathematics, and M. Henry, Professor of Chemistry at Louvain, in a letter to M. Quetelet, the secretary, protested against the expression being allowed to pass uncensured, as it was a violation of their religious convictions, and an infringement of the traditional law of the Academy, that nothing be said to hurt the religious convictions of any member. At the next meeting of the Academy, October 11, M. Gilbert insisted on this note being read, but by the vote of the Academy the order of the day was at once proceeded with. Thereupon the two aggrieved professors felt called upon to resign their connection with the Academy. The real facts of the case are stated by MM. Gilbert and Henry in a long communication to the last number of the *Revue Scientifique*, from which it appears that the reference to "the fable of Jonah" was not in the paper at all as originally read, but was added in a note to the paper when subsequently printed in the *Bulletin* of the Academy. No doubt the two professors have a greater grievance than the irate Bishop Dupanloup had in the admission to the French Academy of M. Littré; and no doubt it is well in all scientific discussions in a mixed society to steer clear of "the religious difficulty" entirely, but after all it must seem to an outsider as if all this pother about "the fable of Jonah" were a case of "much ado about nothing."

A MEETING of the local executive of the British Association was held on Monday, at Bradford, and the financial account, which was submitted, showed the total expenses of the late meeting in that town to amount to about 3,300*l*. The guarantee fund subscribed amounted to 5,200*l*.

AT a recent meeting of the Manchester Scientific Students' Association at the Royal Institution, Mr. George C. Yates, F.S.A., exhibited a unique specimen of a Neolithic Flint Celt, or axe, which he had obtained at Holyhead a few weeks ago. The specimen, we believe, has been thoroughly authenticated, and Mr. Yates has consented to deposit it in the British Museum.

A SERIES of Birkbeck Scientific Lectures for the People was commenced last week at Leeds, by Mr. J. Norman Lockyer, F.R.S., to be continued by Dr. Carpenter, Mr. Miall, and Prof. Martin Duncan, till Christmas. We believe that the action of the Trustees in thus aiding the spread of scientific knowledge throughout the country will be attended with the best results.

ON Tuesday last a deputation of the Harrow Vestry, representing the residents, tradesmen, and other classes of the parish, had a second interview with the Governors of Harrow School, for the purpose of lodging and explaining thirty-six objections in detail to the proposed statutes for the government of the school. One point most justly insisted on by the deputation is the fact that John Lyon, the founder of the school, intended it mainly for the benefit of the parishioners of Harrow, whereas the Governors, like the Governors of others of our public schools, notoriously throw every possible difficulty in the way of children of common parishioners reaping the benefit of the fund generously left for their education. The Governors try to silence the complainants with a pittance of 250*l*. a year to found a subordinate school. We hope the Harrow Vestry will not cease to agitate the matter, until they obtain all that rightly belongs to them.

WE have received a revised list of those who obtained Queen's Medals at the Science and Art Examinations, May 1873.

A CORRESPONDENT at Cannes, France, informs us that on November 4, about 6 P.M., a beautiful and distinct, though faint, lunar rainbow was seen there, which lasted a quarter of an hour, and then suddenly disappeared just as the first drops of rain were felt.

THE forthcoming number of Petermann's *Mittheilungen* will contain an article by Messrs. E. Behm and F. Hanemann on the most recent discoveries in South-east Australia, accompanied by a map in which these discoveries are embodied.

MESSRS. W. AND A. K. JOHNSTON have published a very useful war-map of the Gold Coast of Ashantee and neighbouring countries, with a sketch-map of Guinea and a small map of the whole of Africa, all carefully disposed on one large sheet.

FOR several winters past courses of lectures, intended mainly for the industrial classes, have been given on scientific subjects in the Edinburgh Museum of Science and Art, by the professors of the University and other gentlemen eminent in their particular departments. The charge for a course of six lectures, the number given on each subject, is only sixpence, and we believe the results have been extremely satisfactory. The following is the programme for the present winter:—"Chemistry of the Common Metals," by Prof. A. Crum Brown, M.D.; "Physiology and Public Health," by Dr. John G. M'Kendrick, F.R.S.E.; "Cosmical Astronomy," by Prof. Tait; "The Carboniferous Formation of Scotland," by Mr. James Geikie, F.R.S.E.; "Weather and Climate," by Mr. Alex. Buchan, F.R.S.E.; "The History of Commerce," by Prof. W. B. Hodgson, LL.D.

THE same journal has the following details concerning the Italian Association of Men of Science:—Inaugurated in 1837 by the Grand Duke of Tuscany (twenty-five years before France had followed the parent movement in England), it fell under the ban of Pope and Bourbon alike, who saw in it the foster-mother of revolution. In spite of police restrictions and other proofs of the dislike with which it was viewed, its meetings gained in attractiveness every year till, in 1846, favoured by the early liberalism of Pio Nono and Charles Albert's ill-will to Austria, it celebrated the centenary of Balilla's throwing off the German yoke in the Ligurian capital. Thanks to Piedmont, it outlived the reaction of 1848; and in 1859-60 it shared in the national jubilee it had assisted in consummating. Rome, proclaimed as the capital in 1861, was to be the scene of its reunion in 1862; but the Vatican, countenanced by Austria and France, frustrated the attempt. The storming of the Porta Pia in 1870 rendered possible the long-cherished design, and, under the appropriate presidency of the venerable Count Mamiani, formerly Prime Minister of Pio Nono during his short constitutional reign, it met on the 20th ult. in the capital. One hundred and fifty was the muster of members—not a numerous one, but counting the most distinguished statesmen and *savans* in the kingdom. Donati had but lately fallen a victim to cholera, but his science was adequately represented by the Padre Secchi, who still clings to the Society of Jesus.

WE have received from Mr. D. Mackintosh a reprint of his article from the *Quarterly Journal of the Geological Society*, "On the more remarkable Boulders of the North-west of England and the Welsh Borders."

THE additions to the Zoological Society's collection during the past week include a Crab-eating Opossum (*Didelphys cancrivora*) from the West Indies, presented by Mr. G. H. Hawtayne; a Common Parodoxure (*Paradoxurus typus*) from India, presented by Mr. C. Maurer; an Indian Jackal (*Canis aureus*) from Penang, presented by Mr. F. H. Fredericks; three Robbin Island Snakes (*Coronella phocarum*) presented by Rev. G. H. R. Fisk; a Little Grebe (*Podiceps minor*), British, presented by Mr. H. P. Hensman; a Black Wallaby (*Halmaturus Ualabatus*) from N. S. Wales, purchased; a Gazelle (*Gazella dorcas*) from Egypt, deposited; an Axis Deer (*Cervus axis*) and a Molucca Deer (*C. moluccensis*), born in the Gardens.

PHYSICAL GEOGRAPHY AND TERRESTRIAL MOLLUSCA OF THE BAHAMA ISLANDS

A PAPER on this subject has recently been communicated to the Lyceum of Natural History, New York, by Mr. Thomas Bland.

The northern end of the Bahama group lies opposite southern Florida, and from this point the islands stretch off in a double series, nearly parallel to the trend of Cuba and San Domingo, and terminate, properly, in the Turk's Island Bank, on which are the last and most easterly of the chain, which extends about 600 miles, from within 70 miles of the coast of Florida to within 100 miles of that of San Domingo.

Several banks are distinguishable, and the islands are generally on the windward sides of these, never exceeding 200ft. in height, and being almost universally environed with reefs or shelves of rock, which extend often to a considerable distance and usually terminate abruptly.

The geological formation appears to resemble that of Bermuda; their form and surface condition being largely due to prevailing winds and currents, but also owing much, probably, to the configuration of the land on which the coral reefs were built up.

Lieutenant Nelson speaks of the Bahamas as the Gulf Stream Delta; thrown down where the stream receives a check from the Atlantic on emerging from the Gulf of Mexico.

In a communication to NATURE, vol. vi. p. 262, Mr. Jones furnished evidence of the subsidence of the Bermudas. In excavations made for the great dock *e.g.*, there was found, at 46 ft. below low-water mark, a layer of red earth, containing remains of cedar trees, and resting on a bed of compact calcareous sandstone.

Mr. Bland examines the evidence afforded (as to subsidence), by the distribution of land shells on the Bahama Islands. The total number of species known is about 80.

Judging from both operculates and inoperculates, the land-shell fauna of the Bahamas is essentially West Indian, and that of the Great Bank (especially), closely allied to the Cuban fauna. Mr. Bland gives a list of inoperculate species common to the Bahamas, the adjacent continent, Bermuda, and certain of the West Indian Islands; which shows in a marked manner the alliance referred to.

The banks and islands of the Bahama chain diminish in size to the south-east, indicating greater subsidence in that direction. Similarly, the submerged Virgin Island bank, Sombrero and the Anguilla bank, terminate the parallel West Indies chain eastward from Cuba; and in Anguilla have been found remains of large extinct mammalia which must have inhabited at one time a much more extensive area.

The author criticises Dr. Cleve's geological grouping of the slands north of Guadeloupe (in two groups, one comprising Bahamas, of post-pliocene date, another of the tertiary Eocene, Miocene, and Pliocene), and points out that the land shell fauna of Saba, St. Eustatius, St. Kitts and Nevis, of Redonda and Montserrat, and of Barbadoes and Antigua, is, in common with most of the islands to the south, to and inclusive of Trinidad, distinct from the fauna of the islands between and inclusive of the Bahamas and Cuba, and the Anguilla bank, on which are Anguilla, St. Martin and St. Bartholomew. This well-defined line of separation must be considered in connection with the past and present geological history of the islands.

Dana traces parallel bands of greater or less subsidence in the Pacific Ocean, and analogous conditions in the Atlantic; the subsidence was probably, he says, "much greater between Florida and Cuba than in the Peninsula of Florida itself, and greater along the Carribbean Sea parallel with Cuba, as well as along the Bahama reefs than in Cuba." Recent soundings, cited by Mr. Bland, confirm this view.

SCIENTIFIC SERIALS

Ocean Highways, November.—In an article on "The Results of the Arctic Campaign, 1873," it is shown that the right direction for Arctic Exploration has been unmistakeably indicated, further proofs have been afforded of the practicability of attaining an advanced position by following that direction, and additional evidence has been accumulated against the route advocated by "unpractised theorists." These conclusions are rightly drawn from the eminently successful results obtained from the *Polaris* expedition and from Captain Markham's fruitful cruise in the *Arctic*, as contrasted with the comparatively unsuccessful attempts made in the Spitzbergen direction by the Swedish Expedition and that of Mr. Leigh Smith. "The learned societies will be able to make their appeal to the Government with even stronger and more cogent arguments than were at their disposal in the end of last year; while in the present Prime Minister and Chancellor of the Exchequer they have an old and staunch supporter of Arctic expeditions, and one who has studied their history and appreciated their uses." There is a carefully constructed map illustrative of Captain Markham's voyage in the *Arctic*. Other articles are, "On the Distribution of Coal in China," by Baron von Richthofen; "South American Progress" (Argentine Republic), by F. J. Rickard; "Highways and Byeways of Naval History," the first of a series of articles by Mr. R. Lendall.

Gazetta Chimica Italiana, Fascicolo V. and VI.—The number commences with a paper on Santonin, by S. Cannizzaro and F. Sestini. Santoninic acid is described; it is derived from santonin by the addition of one molecule of water to one of santonin. The addition is effected by acting on santonin by means of a warm aqueous alkaline solution. The formula of the acid is $C_{15}H_{20}O_4 = C_{15}H_{18}O_3 + H_2O$. The properties of the acids and its salts are described, and the action of nascent hydrogen on santonin is then considered.—New researches on benzylated phenol, by E. Paternò and M. Fileti.—On the chemical analysis of some wines grown in the Veronese province, by Prof. G. Dal Sie. The wines in question seem to be somewhat strong, the percentage (volume) of alcohol ranging from 9·4 to 16·4. Very voluminous tables of analyses are given.—A paper on the dry distillation of calcic formate, by A. Lieben and E. Paternò concludes the original portion of the number, which concludes with 155 pages of abstracts from foreign journals.

Annalen der Chemie und Pharmacie, Band 168, Heft 2 and 3, August 30.—The number commences with two papers from Prof. Beilstein's laboratory. The first by W. Hemelian is on a new method of preparing the sulpho acids; the method in question is a modification of that of Strecker. Dr. E. Wroblevsky communicates a paper on certain haloid derivatives of toluol; he describes a number of the meta-brom-toluol compounds, and also deals with the para-brom-toluols and the tri-brom-toluols.—The other papers are: On selenic acid and its salts, by Dr. v. Gerichten. He finds that the seleniates are all isomorphous with the corresponding sulphates, and the double salts also agree with the double sulphates.—On the action of tri-sulpho-carbonate and sulpho-carbaminate of ammonium on aldehyde and acetone, by E. Mulder. A number of the compounds resulting from these reactions are described.—On a new mode of forming orthotoluilic acid, by R. Fittig and William Ramsay. On metatoluic acid, by C. Boettinger and W. Ramsay.—On ethyl and di-ethyl-allyamine, by A. Rinne. Ethyl-allylamine is isomeric with methyl crotonylamine, the two bodies having the formulæ—

$$N\left\{\begin{array}{l}C_3H_5\\C_2H_5\\H\end{array}\right. \text{and } N\left\{\begin{array}{l}C_4H_7\\CH_3\\H\end{array}\right. \text{respectively.}$$

The author describes several of the salts of the former. Di-ethyl-allylamine $N\left\{\begin{array}{l}C_3H_5\\C_2H_5\\C_2H_5\end{array}\right.$ is produced by the action of ethyl iodide on allylamine. The author describes it and its hydrochlorate and platino-chloride.—Researches on the isomers of cresol with regard to their occurrence in coal tar, by M. S. Southworth.—Researches on sorbic acid by E. Kachel and R. Fittig.—The number concludes with a very lengthy paper on the actions occurring in the inner non-luminous flame of the Bunsen burner, by R. Blochmann. The author has collected and examined the gases from various parts of the flame, and the memoir is illustrated with two plates showing the apparatus used, and the flames given by the burner under various treatments, and a diagram showing the percentages of CO_2 and H_2O, given by flames when burning, at various heights above the burner up to 120 millimetres.

SOCIETIES AND ACADEMIES

LONDON

Zoological Society, Nov. 4.—Prof. Newton, F.R.S., vice-president, in the chair. The Secretary read a report on the additions that had been made to the Society's menagerie during the months of June, July, August, and September. Mr. G. Dawson Rowley exhibited a singular malformed variety of the Domestic Duck, and the Secretary a collection of fishes (containing six examples of *Ceratodus forsteri*) made by Mr.

Ramsay, in Queensland.—A communication was read from Mr. J. B. Perrin, containing an account of the Myology of the Hoatczin (*Opisthocomus cristatus*).—A communication was read from Capt. R. Beavan, Bengal Staff Corps, containing a list of fishes met with in the River Nerbudda, in India.—A second communication from Capt. Beavan contained some remarks on certain difficulties involved in the acceptance of the Darwinian theory of evolution.—A communication was read from Mr. Montague R. Butler, containing descriptions of several new species of Diurnal Lepidoptera.—A communication was read from Mr. R. Swinhoe, H.B.M. Consul at Chefoo, on the Song-Jay of Northern China, with further notes on Chinese ornithology.—Mr. P. L. Sclater, F.R.S., exhibited and pointed out the characters of fourteen new species of birds collected by Signor Luigi Maria D'Albertis during his recent expedition into the interior of New Guinea.—A communication was read from Prof. J. V. Barboza du Bocage, on the Ground Hornbill of Southern Africa—*Buceros caruncnlatus cafer* of Schlegel.—A second communication from Prof. Barboza du Bocage contained a note on the habitat of *Euprepes coctei*, Dum. et Bibr.—A communication was read from Surgeon-Major Francis Day, containing descriptions of new or little known Indian fishes.—Mr. R. B. Sharpe, read a paper describing the contents of a collection of birds recently received from Mombas in Eastern Africa.—A second paper by Mr. R. B. Sharpe contained a list of a collection of birds from the River Congo.—Mr. G. B. Sowerby, jun., communicated the descriptions of eleven new species of shells.—A communication was read from Dr. J. E. Gray, F.R.S., on the skulls and alveolar surfaces of Land Tortoises, *Testudinata*.

Linnean Society, Nov. 6.—Mr. G. Bentham, president, in the chair.—Before the commencement of proceedings, this being the first occasion of the meeting of the society in its new rooms in Burlington House, the president gave an address on the present relation of Government towards the learned societies, which will be found elsewhere.—A resolution was then proposed by Dr. Hooker, seconded by Mr. Gwyn Jeffreys, and carried unanimously, recognising the obligations of the Linnean Society towards the Government for the handsome accommodation now for the first time provided independently for it.—On *Hydnora americana*, by Dr. J. D. Hooker. In his monograph of the Rafflesiaceæ in De Candolle's "Prodromus," Dr. Hooker had thrown some doubt on the correctness of De Bary's description *Hydnora*, and on the close affinity which he traced between it and *Prosobanche*. Further investigation has, however, amply confirmed the accuracy of De Bary's description. A very great difficulty is presented, from the point of view of the theory of evolution, in the occurrence of two species of this genus, one in South Africa and one in South America, so closely resembling one another in every point of their structure, and both root-parasites, that it is impossible to look upon them otherwise than as very nearly related. The only possible connection between them would appear to be through *Cytinus*, another nearly allied genus of root-parasites, species of which are natives both of South Africa and of South and North America.

Chemical Society, Nov. 6.—Dr. Odling, F.R.S., president, in the chair.—The president delivered a short address, to which we refer elsewhere, congratulating the Fellows on taking possession of their new rooms in Burlington House. A paper was then read by Mr. David Howard on the optical properties of some modifications of the cinchona alkaloids, being an elaborate investigation of the variations in the rotatory powers of this class of bodies when examined by the polarimeter. The other communications were—a preliminary notice on the oils of wormwood and citronella, by Dr. C. R. A. Wright; on the estimation of nitrates in potable waters, by Mr. W. F. Donkin; and a note on the action of iodine trichloride upon carbon disulphide, by Mr. J. B. Hannay.

Royal Microscopical Society, Nov. 5.—Chas. Brooke, F.R.S., president, in the chair. A paper by the Rev. W. H. Dallinger was read, describing some further researches made by himself and Dr. Drysdale on the development of certain monads, in the course of which they had been able to trace the life-history of a species, although in their earliest stages these organisms were so minute as to require an objective of $\frac{1}{50}$ in. for their observation. A number of beautifully executed drawings accompanied the paper.—Mr. Alfred Sanders read a paper on the art of photographing microscopic objects, in which he described a simple and successful process of manipulation, and showed how the most satisfactory results might be obtained without the aid of expensive and complicated apparatus.—A paper was also read by Mr. S. J. McIntire, entitled "Some Notes on Acarellus," in which he minutely described a species found parasitic upon Obisium, and which he believed to be identical with Hypopus, described by Dujardin. Specimens both mounted and alive were exhibited under the Society's microscopes.—Some photographs of *Navicula lyra* and *Amphipleura pellucida*, taken by Dr. J. J. Woodward, were also exhibited.

PARIS

Academy of Sciences, November 3.—M. de Quatrefages, president, in the chair.—The following papers were read:—An analysis and criticism of an "Essay on the Constitution and Origin of the Solar System, by M. Roche," by M. Faye.—On the mutual action of voltaic currents by M. Bertrand. On the verification of Baume's hydrometer, by MM. Berthelot, Coulier, and d'Almeida.—On certain calorimetric values and problems, by M. Berthelot.—Observations of the solar protuberances during the last six solar rotations (April 23 to October 2, 1873) with some consequences affecting the theory of the spots, by Father Secchi. In this paper Secchi continued his observations, portions of which appeared in the first half of the year. The author again asserted that the spots are the product of eruptions, and observed that some metals were more opaque than others, *e.g.*, a sodium eruption gave a very black spot. He admitted, however, that some spots existed without eruptions.—Researches on the thermic effects accompanying the compression of liquids, by MM. Favre and Laurent.—MM. Morin and Phillips presented a report on M. Graeff's paper on the *régime* of rivers and the effects of a multiple system of reservoirs.—Memoir on experimental teratology, by M. C. Dareste.—On a map of the world on a gnomonic projection, &c., by M. B. de Chancourtois.—The following papers were presented to the Academy:—Observations on M. Dubois' paper on the influence of refraction at the moment of contact of Venus with the Sun's limb, by M. Oudemans.—On a new volatile saccharine matter extracted from Madagascar rubber, by M. Aimé Girard.—On the cooling effects produced by the joint actions of capillarity and evaporation: Evaporation of carbonic disulphide on porous paper, by M. C. Decharme.—Origin and formation of the dental follicule in the mammiferæ, by MM. Magitot and Legros.—On capillary embolism and hemorrhagic infarctus, by M. Bouchut.—Observations on M. Pellarin's note on choleraic dejections as agents in the propagation of that disease, by M. H. Blanc.—On the different practical problems of aërial navigation, by M. W. de Fonvielle.—On the formation of swellings on the rootlets of the vine, by M. Max. Cornu.—Observations on M. Guérin Méneville's suggestion that the *Phylloxera* is a result of the vine disease.—Note on the best dimensions for electro-magnets, by M. Th. du Moncel.—On a proeess for the preparation of active amylic alcohol, by M. J. A. Le Bel.—On the influence which certain gases exercise on the preservation of eggs, and on the influence of certain substances in the preservation of eggs, by Mr. C. Calvert.—On the metamorphism and physiological changeability of certain microphytes under the influence of media and on the relation of these phenomena to th initial cause of fermentation, &c., by M. J. Duval.—On the action of the respiratory apparatus after the opening of the thoracic cavity, by MM. Carlet and Strauss.—On the different properties and structures of the red and white muscle in rabbits and in rays, by M. Ranvier.—On scurvy and its treatment, by M. Champouillon.—On telluric intoxication, by M. L. Colin.—On the calcareous spar of the green marles of Chennevière, by M. Stan. Meunier.

CONTENTS

THURSDAY, NOVEMBER 20, 1873

THE ARCTIC EXPEDITION OF 1874

THE prospect of the Government being convinced of the propriety of despatching an Arctic Expedition, really seems to be brightening. We expressed some apprehension, when the Royal Geographical Society addressed the late Chancellor of the Exchequer on the subject last year, that sufficient pains were not taken to have all branches of Science represented in the Deputation, and that, consequently, the importance of the results of Arctic Research had not been completely explained. There is no cause for any such doubt on the present occasion. The matter has been most carefully and maturely considered by a joint committee appointed by the Councils of the Royal and the Royal Geographical Societies, and consisting of representatives of various departments of Science as well as of the most eminent Arctic authorities.

A memorandum has been drawn up, and submitted to the Council of the Royal Society, in which the scientific results to be obtained from the examination of the unknown area round the North Pole are set forth; the different sections having been prepared by men who are in the first rank as authorities in their particular departments of study—namely, geography, hydrography, geodesy, physics, meteorology, geology, botany, zoology, and anthropology. The memorandum also includes a carefully prepared statement, drawn up by distinguished Arctic authorities of the practical aspects of the question, the composition of such an expedition, the precautions that should be taken, and the best route.

The Royal Society is a body which, from its high position and from its strong sense of responsibility, never takes action without very careful and mature previous consideration. When this body once adopts a course on any question, the public can always feel satisfied that it has first received the closest attention, in all its bearings, from men of the highest attainments. The memorandum of the Committee has been before the Council, and we are able to announce that the value of the scientific results to be derived from Arctic exploration has been recognised, and that the Royal Society is prepared to represent to the Government the desirability of undertaking the discovery of the unknown region.

With the object of inducing the Government to undertake a North Polar Expedition, the Council of the Royal Society has appointed a deputation to represent their views, consisting of Dr. Hooker, the President-elect, Prof. Huxley, Prof. Allman, Mr. Prestwich, Mr. Busk, Mr. Sclater, and General Strachey.

The British Association has also appointed a Committee with the same object.

The Royal Geographical Society will be represented by its President, Sir Bartle Frere, Sir Henry Rawlinson, the veteran Arctic explorer, Sir George Back, and Admirals Collinson, Ommanney, and Sherard Osborn.

The Dundee Chamber of Commerce is also deeply impressed with the practical importance of discovery in the unknown area, and has drawn up a memorial to be presented to the Prime Minister, through the member, Sir John Ogilvy. Dundee is not only the principal whaling port of Great Britain, but is also the centre of a great and thriving industry, namely, the manufacture of jute, the growth of which employs millions of ryots in Bengal. Now, in the process of preparing the jute fibre, the use of animal oil is essential, so that the business of chasing whales and narwhals in the Arctic seas is of the utmost importance to the cultivators of the Gangetic delta. One industry supports the other, and India, as well as Great Britain, has an interest in Arctic discovery. The Chamber of Commerce, considering the vast interests at stake, holds it to be most important that the unknown polar region should be explored, in order that a more complete knowledge may be acquired of the haunts, migrations, numbers, and habits of the various oil-yielding animals. The Chamber also feels the advantages derived from Arctic expeditions by the best among the experienced mates and harpooners who obtain employment, and indirectly by the whole seafaring population of the west coast of Scotland. Nor are the bold seamen and enterprising manufacturers of the northern ports, any more than the naval officers and men of science, indifferent to the old renown of their country, and to the immense advantages which are derived from voyages of discovery.

The events of the last year have strengthened the arguments in favour of an Arctic Expedition. We believe that the despatch of a naval officer to Baffin's Bay last spring was due to the forethought of Admiral Sherard Osborn. The choice was undoubtedly a fortunate one, for Captain Markham entered heart and soul into the spirit of the service on which he was employed. He studied the new system of ice navigation, and of handling powerful steamers in the ice with minute attention. He had the rescued crew of the *Polaris* on board for several months, and learned from Dr. Bessels and Mr. Chester all the particulars of their extraordinarily successful voyage. Nothing escaped him, and on his return he submitted a full and most valuable report. Thus the fact that a ship can pass up Smith Sound to 82° 16′ N. without check of any description, unknown before, is now established, as well as the constant movement and drift of the ice in the strait leading to the unknown region. The revolution in ice navigation, caused by the use of powerful steamers, is also more fully understood and appreciated through the report of Captain Markham.

The deputation which is about to seek an interview with Mr. Gladstone and Mr. Goschen, is thus strengthened with fresh arguments and with a more exact and complete statement of the objects of Arctic research. It will represent interests which cannot be neglected, and bodies whose individual opinions must needs carry great weight. There will be the Royal Society, the recognised adviser of the Government on all matters relating to Science; the Royal Geographical Society, the British Association, and the Dundee Chamber of Commerce representing the interests of a great industry and of the sea-faring population of Scotland. The navy will also be fully represented, and the leading Arctic authorities will be present, acting in perfect unanimity as regards the route to be taken and the work to be done.

We believe that such a deputation must have considerable influence on the decision of the Government, and that there is every prospect of sanction being given to

the fitting out of a naval Arctic expedition in 1874. Mr. Goschen is, we have reason to think, now conversant with the subject, and, as the Minister whose duty it is to advance and foster the interests of the British navy, it is imposible that he can fail to see the advantages of Arctic service. He is supported, at the Admiralty, by Sir Alexander Milne, who has ever been friendly to such enterprises, and sensible of the excellent school for nnval men afforded by voyages of discovery; and by Admiral Richards, the hydrographer, whose sound judgment and great Arctic experience render his advice most valuable.

The Prime Minister, with whom the decision will rest, is a statesman who well knows the general, as well as the scientific uses of Arctic enterprise. He formed one of that Ministry which despatched the last scientific expedition to the Arctic Regions; and, as a member of the Select Committee of the House of Commons on Sir John Ross's case, he signed a report expressing his approval of Arctic voyages in the strongest terms—"A public service is rendered to a maritime country, especially in times of peace, by deeds of daring, enterprise, and patient endurance of hardship, which excite the public sympathy and enlist the general feeling in favour of maritime adventure." Such were, and we trust still are, the views of Mr. Gladstone with reference to the general uses of Arctic voyages of discovery. When to these general impressions are added a knowledge of the important scientific and practical results to be attained, the assurance that there is no undue risk, that the cost will be comparatively slight, and the good both to the navy and to mercantile interests incalculable, we cannot bring ourselves to believe that the decision of Mr. Gladstone will not be favourable to a renewal of Arctic research.

LOCAL SCIENTIFIC SOCIETIES *

II.

ALTOGETHER, so far as we have been able to ascertain,† the number of existing local societies ‡ which have for their main, or only as a part of their object the culture of Science, that were established in the years between 1781 and 1830, are only 22. We shall see that the increase since 1830 has been enormous, though the large majority of those established during the last forty-three years are of a much more simple kind, so far as organisation is concerned, than those established during the former period, have to a great extent a different object in view or rather accomplish the intellectual improvement of the members after a different fashion, and are, we think, thoroughly characteristic of the scientifically inquisitive and increasingly intelligent period during which they have been established. Not many "Literary and Philosophical Societies" have been established during the latter period, most of them being professedly devoted to study and research in Science, especially in natural history, in all or one of its branches, and a large majority of them being Field Clubs, as those associations are called, the whole or part of whose programme is to investigate the natural history (including botany, zoology, and geology) of particular district s, in combination sometimes with their archæology. Indeed the last forty years might well be designated the era of field clubs.

We have already mentioned the Northumberland, Durham, and Newcastle Natural History Society, established in 1829, which, although it has done some excellent field-club work, was not professedly established for this purpose. There can be no doubt that the first genuine field-club was the Berwickshire Naturalists' Club, founded September 21, 1831, though Sir Walter Elliot traces the true origin of field-clubs to an association of students, formed in 1823 at the University of Edinburgh, under the name of the Plinian Society, for the advancement of the "study of natural history, antiquities, and the physical sciences in general." They met weekly in the evening during the session, from November to July, for reading papers and discussions; and also, as the season advanced, made occasional excursions into the neighbouring country. The chief promoters of the scheme were three brothers named Baird, from Berwickshire; but John, the eldest, must be considered the founder. He drew up an elaborate code of laws in eighteen chapters, and, as the first president, made a statement of the proposed plan and objects of the society at their inaugural meeting on the 14th January 1823. Among the original members occur the names of James Hardie, J. Grant Malcolmson (both Indian geologists), and Dr. John Coldstream; and, at a later period, those of Charles Darwin * (of Shrewsbury, 1826), John Hutton Balfour (1827), and Hugh Falconer (1828), with others who have since become distinguished in the scientific and literary world. The latest notice of the society is the session of 1829-30, up to which time the Bairds, although they had left the University, appear as occasional contributors.

No doubt this Edinburgh Association had considerable influence in originating the Berwickshire Club, for two of the Bairds became parish ministers in Berwickshire, and it was they, along with their brother, the late Dr. William Baird, of the British Museum, Dr. Johnstone, Dr. Embleton, and four or five others, who met at Coldingham on the date above given, and drew up the plan of the Berwickshire Naturalists' Club, "a term," Sir W. Elliot remarks, "now first extended to a scientific body." Its object was declared to be the "investigation of the natural history of Berwickshire and its vicinage;" in reality its field extends over the whole of Berwickshire, Roxburghshire, and the north-east part of Northumberland, to the limits of the Tyneside Club's district. The rules of the club, as all rules should be, are short, providing that the club should hold no property, require no admission fee, and should meet five times in the year at a place and hour to be communicated to each member by the secretary. Thus the Berwickshire Club is a field-club pure and simple, having, unlike many other similar clubs, no winter meetings for the reading of papers, whatever papers are read being read after dinner on the days when excursions are made. At the first anniversary it numbered 27 members, and in 1870, when Sir Walter Elliot gave his address, there were 249 members on the roll, including a few ladies, and "two corresponding members, the last description having been

* Continued from vol. viii. p 524.

† We regret to say that none of the Edinburgh Societies have seen meet to forward us information.

‡ We do not include in this article the great London Societies, as the Royal, the Linnean, the Astronomical, &c.

* The first paper contributed by him, entitled "On the Ova of the *Flustra*," in which he announces that he has discovered organs of motion, and, secondly, that the small black body hitherto mistaken for the young of *Fucus loreus* is in reality the ovum of *Pontobdella muricata*, exhibits his early habits of minute investigation.

added in 1868 to admit intelligent working-men," though why this invidious distinction should be maintained in a body solely devoted to scientific research, we fail to see; surely Science at least is a common ground on which all classes can meet without a shadow of bitter class-feeling to mar the geniality of intercourse. The more that the higher tastes and recreations are common to all classes, the less room will there be for misunderstanding and bitterness. If a working-man can pay the subscription—and the field-club subscription is usually small, and working-men's wages are now unusually high—by all means let them be received on a common footing with the other members. Many of our best field-clubs are composed almost entirely of working-men, and every encouragement should be given to this class to join such clubs, for, morally and intellectually, we think they will reap more benefit from such associations than any other class.

The Berwickshire Club continues to be one of the most efficient and productive in the country, the fruits of its excursions being contained in six goodly volumes, containing many valuable papers on the natural history and archæology of its large district, and extensive and carefully compiled lists of the existing and extinct fauna and flora. As the Berwickshire Club is the model after which, to some extent, all succeeding field-clubs have been formed, we shall here give from Sir Walter Elliot's address, its simple and inexpensive method of conducting its field-days :—" Arrangements are made with the railway companies for the issue of tickets on favourable terms. The members assemble at breakfast at 9.30, after which the programme of the day is explained, and any objects of interest procured since the last meeting are exhibited and described. At 11 the party proceeds on foot or by conveyance to the points indicated, breaking into sections for botanical, geological, or antiquarian research, and either meeting again at some convenient spot, or returning independently to dinner at 4 o'clock. The members present rarely exceed from 30 to 50, often fewer. Of course the hive contains a considerable proportion of drones who rarely appear, ladies never. The distances are so great, the excursions so thoroughly directed to investigation, that few but those intent on work attend. After a frugal repast, the staple of which is a fine salmon invariably sent from Berwick, papers are read and discussed, and the members disperse according to the exigencies of their trains. The whole expenses of the day vary from four to five shillings per head."

In the decade between 1830 and 1840, other sixteen local societies were formed, many of which, though not professedly field-clubs, have done, through individual members, good field-club work, as is testified by their publications, and have otherwise done much to promote the cause of Science in the neighbourhood. It was during this period that the Cornwall Polytechnic Society (already mentioned), the Penzance Natural History and Antiquarian Society, the Royal Institution of South Wales, the Ludlow Natural History Society, and the West Riding Geological and Polytechnic Society, were formed, each of which, in its own particular fashion, does good service to Science, and helps to keep the lamp of culture burning in its neighbourhood.

No other regular field-club was instituted until nearly fifteen years after the foundation of the Berwickshire Club, when a sort of offshoot of that Society was formed in 1846 in Newcastle-on-Tyne, under the title of the Tyneside Naturalists' Field Club, which, "guided by the experience of the parent club, at once assumed a perfect organisation." The constitution was, however, somewhat amplified, a proviso being put in the rules that should assuredly have a place in the rules of every similar society in the kingdom. Its last rule, we think, worthy of all commendation and universal imitation; it is as follows :—

"That the Club shall endeavour to discourage the practice of removing rare plants from the localities of which they are characteristic, and of risking the extermination of rare birds and other animals by wanton persecution; that the members be requested to use their influence with landowners and others, for the protection of the characteristic birds of the country, and to dispel the prejudices which are leading to their destruction; and that consequently the rarer botanical specimens collected at the Field Meetings be chiefly such as can be gathered without disturbing the roots of the plants; and that notes on the habits of birds be accumulated instead of specimens, by which our closet collections would be enriched only at the expense of nature's great museum out of doors. That in like manner the club shall endeavour to cultivate a fuller knowledge of the local antiquities, historical, popular, and idiomatic, and to promote a taste for carefully preserving the monuments of the past from wanton injury."

We have more than once recently in noticing the proceedings of some societies, and it has been animadverted on in other quarters, referred to the pernicious practice of encouraging, by the offer of prizes for rare specimens, especially of plants, the extermination of the rare flora peculiar to certain districts. One of the prime duties of every local club should be the preservation of such rare specimens, the fact of whose existence is often of great value from a scientific point of view, and the destruction of which, by transference to a herbarium, can serve no good purpose whatever. The Tyneside Club is divided into six sections, each charged with a special department for investigation :—1, Mammalia and Ornithology; 2, Amphibia, Ichthyology, Radiata; 3, Mollusca, Crustacea, Zoophytes; 4, Entomology; 5, Botany; 6, Geology. This club holds meetings during the winter in Newcastle. Up to 1864, it had published six volumes of very valuable Transactions. In that year an arrangement was come to whereby the members (numbering 429), became associates of the Northumberland, Durham, and Newcastle Natural History Society, already referred to. Thenceforth, as we have already said, the proceedings of the two bodies have been published conjointly under the title of "Natural History Transactions of Northumberland and Durham," of which three volumes have been published. "The work of the Club," Sir Walter Elliott says, "has been most conspicuous in zoology. It has the merit of publishing its lists and catalogues in a separate form for sale, so as to make them accessible to all inquirers."

We cannot mention in detail the foundation of the swarm of field-clubs which have come into existence in the various parts of the country since 1846; we can only allude very briefly to two of the most important, the Cotteswold and the Woolhope, the former an offshoot of the Berwickshire Club. The originators of the Cotteswold Field Club, which, like the Tyneside Club, was started in 1846, were Sir Thomas Tancred (who had been

a member of the Berwickshire Club), Mr. T. B. Lloyd Baker (the well-known originator of the "Reformatory System"), Dr. Daubeny, of Oxford, Hugh Strickland, and some others, who met "at the Black Bull Inn, in Birdlip, a village on the summit of the Cotteswold range overlooking the vales of Gloucester and Worcester, about six miles south of Cheltenham, and seven south-west of Gloucester." There the club was inaugurated, Mr. Baker being elected the first president. "The labours of the club have been most conspicuous in geological investigation, for which the district offers such a rich field. Many of the members have, by their recorded observations, attained to high distinction. In the words of the president, 'It will suffice to mention the names of Daubeny, Strickland, Woodward, Maskelyne, Wright, Moore, Buckman, Jones, Lycett, Brodie, Symonds, Maw, and Etheridge, all members of the club, to recall at once names of writers well known in the scientific annals of the county, and of whom some have by their works obtained a more than European reputation.'"

The Woolhope Club, in Bedfordshire, whose publications are also well known as among the most valuable of those of provincial societies, was formed in 1851, and derived its name from the mass of Silurian rocks described by Sir Roderick Murchison as the "Woolhope Valley of Elevation." This club and the Cotteswold have occasional joint field days, and their example is followed by several other societies, and might, we think, with advantage be followed much more extensively than it is.

The Worcestershire Naturalists' Club originated in the same year as the Cotteswold, followed the year after by the Huddersfield Naturalists' Society, and in 1849 by the Yorkshire Naturalists' Club. Besides the four field-clubs mentioned, other six societies originated in this decade, most of them distinctly scientific, including the Torquay Natural History Society, the Bristol Microscopic Society, and the Isle of Wight Philosophical and Scientific Society.

In the decade between 1850 and 1860, twenty-two local scientific societies were founded, of which sixteen are field-clubs, including such well-known names as the Woolhope, just mentioned, the London Geologists' Association, the Liverpool Naturalists' Field Society, the Bath Natural History and Antiquarian Field Club, and the Malvern Field Club.

(To be continued.)

HARTWIG'S "SEA AND ITS WONDERS"

The Sea and its living Wonders. A popular account of the Marvels of the Deep, and of the progress of Maritime Discovery from the earliest ages to the present time. By Dr. G. Hartwig. Fourth edition, enlarged and improved, with numerous woodcuts and eight chromoxylographic plates. (London: Longmans, 1873.)

NO other evidence is needed beyond the publication of the fourth edition of this work to prove the demand there is in Great Britain for this kind of literature, The reading public want to know what about the sea, and all that is in it; and, in their eagerness to know, they buy even such books as this. When will scientific men turn their attention towards teaching the public as far as it can be taught, in a correct, yet popular manner, the rudiments of biological science? When they do the time for such books as the one we must now notice will have passed away, and the resources of the great publishing firm who issue it will be engaged on more truly solid and important work. As an indication of what we mean, let us contrast the popular works of Hartwig or Figuier with Quatrefages' "Souvenirs d'une Naturaliste," or Gosse's "Devonshire Rambles;" or let the reader imagine what a delightful work the one before us would have been if written by, say Huxley, Allman, Günther, or Wyville Thomson. But to return to this volume, which consists of three parts; (1) the Physical Geography of the Sea; (2) the Inhabitants of the Sea; (3) the Progress of Maritime Discovery. The latter part commences with the maritime discoveries of the Phœnicians, and ends with a reference of sixteen lines in length to the numerous scientific voyages of circumnavigation of the present century.

Before proceeding to very briefly notice Parts I. and II., we have to object most strongly to the woodcuts not being drawn to any scale; thus, on page 101 the Rorqual is figured as rather smaller than the Herring, while, on the same page, and just above these figures, will be found a Whale Louse, and a Lepas represented as bigger than either. Surely figures like these must terribly mislead the ordinary reader, who, though he may possibly have some notion of the size of a herring, cannot be supposed to be aware of the dimensions of the whale's parasites. Many of the woodcuts are very good, but several of them are bad, and the majority of them are not seen in this volume for the first time; this we would not so much object to if the woodcuts were selected to illustrate the text, and not, as is too often the case in this work, the text written so as to make some forced allusion to the woodcuts.

Though the Dugong is illustrated by copying the woodcut from Tennent's work on Ceylon, yet scarcely a word is to be found about it in the chapter on the Cetacea. The Tailor birds' nest is figured on page 143, but no allusion whatever is made to it in the text. The great Auk is figured, and in the accompanying explanation is said to congregate in vast flocks on the rocky islets and headlands of the Northern Coasts. Surely a little careful supervision would have prevented such mistakes as these occurring. But leaving the subject of the woodcuts, we come to consider the letterpress; and here, too, not only a more careful supervision, but some more acquaintance with the subject would have been desirable. Why, among the Fishes, should the Anchovy have five lines devoted to it, when not one word is to be found about that equally important little fish, the Sardine? and surely half a page would not have been too much to devote to that interesting living wonder of the sea, the Whitebait. It would be an easy, but withal a useless task to point out other errors of omission and commission among the other classes.

Among the Corals and Sponges the author had enough to guide him, for he has borrowed wholesale the really beautiful woodcuts illustrating Prof. Greene's Manuals; if he had borrowed equally largely from their text, he would have made this the most trustworthy portion of his book.

No notice is taken of such important new forms as Rhizocrinus, or Brissinga, nor do we find mention under

the Sponges of such strikingly beautiful ones as belong to the genera Euplectella, Holtenia, &c., though, indeed, some allusion is made to these in the chapter on the geographical distribution of marine life. But perhaps we have said enough to show that while the subject of this work is a good one, it might easily have been treated by a writer more familiar with it in a better, a more original, and a more comprehensive manner. E. P. W.

OUR BOOK SHELF

The Theory of Evolution of Living Things. By Rev. G. Henslow. (Macmillan and Co.)

SCIENTIFIC men cannot but feel how false is the stimulus given to that form of literature of which the above-named work is an example. If considerable pecuniary reward is offered for the production of treatises in favour of any theory, or of the mutual compatibility of any two or more different doctrines, the work will undoubtedly be produced, however inaccurate the theory, or however dissimilar the doctrines. That mistaken enthusiasm which led to the production of the Bridgwater Treatises and the establishment of the Actonian Prize, has resulted in the publication during the last year of two Actonian prize essays, the former of which, by Mr. B. T. Lowne, we noticed on a previous occasion, whilst the latter is the one under consideration. The present author's treatment of his subject is much that which would have been adopted by Paley if he had been living at the present day. Several previously accepted axioms are shown to be incompatible with the existing position of biological science, and their weakness is well brought forward. Other considerations of modern development are introduced, and it is in these that the difficulty of combining the two doctrines appears. For instance, the origin of moral evil is said to be "the conscious abuse of means, instead of using them solely for the ends for which they were designed." But on evolutionary principles, it can hardly be said that there are means for designed ends, because that peculiarity in an organ which is of service is the only one retained, insomuch that if the delicate sensitiveness of the conjunctiva of the eye were to prove of more value to the individual than its sight, the power of vision would most probably become lost at the expense of the developing tactile organ. "The continual effort of beings to arrive at mutual and beneficial adjustments" is said to be a great principle of nature; does not the term "struggle for existence" imply something very different from this? Again, that "animals and plants do not live where circumstances may be best suited to them, but where they *can*, or where other animals and plants will respectively let them live," is quoted by the author as an instance of Nature falling short of that absolute degree of perfection which may be conceived as possible; however, there cannot be many who think a locality a suitable residence, in which they are prevented from taking up their abode, or perhaps entering, by the animals and plants which inhabit it. In other places similar weaknesses may be found in the argument adopted. In one thing Mr. Henslow has done great good: he has shown that it is consistent with a full dogmatic belief, to hold opinions very different from those taught as natural theology some half century and more ago.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Transfer of the South Kensington Museum

I AM glad to see that an effective opposition is likely to be made to the ill-advised proposal of the Government to place the South Kensington Collections under the control of the fifty irresponsible Trustees of the British Museum.

In common with many other naturalists I had always hoped that the national collections of natural history, when removed to the new buildings in South Kensington, would be freed from the rule of the Trustees and placed under a responsible director. The memorial of which I enclose a copy, and the republication of which would, I think, be opportune at the present juncture, will serve to show that I am by no means alone in believing that such a change would be beneficial to Science.

It would seem, however, that the Government, so far from acceding to our views, have resolved to proceed in exactly the contrary direction, and to increase the power of the Trustees. I can only hope that we may succeed in preventing them from carrying this retrograde measure into effect.

P. L. SCLATER

44, Elvaston Place Queen's Gate, Nov. 17

"*Copy of a Memorial presented to the Right Hon. the Chancellor of the Exchequer*

"To the Rt. Hon. the Chancellor of the Exchequer

"Sir,—It having been stated that the scientific men of the metropolis are, as a body, entirely opposed to the removal of the natural history collections from their present situation in the British Museum, we, the undersigned Fellows of the Royal, Linnean, Geological, and Zoological Societies of London, beg leave to offer to you the following expression of our opinion upon the subject.

"We are of opinion that it is of fundamental importance to the progress of the natural sciences in this country, that the administration of the national natural history collections should be separated from that of the library and art collections, and placed under one officer, who should be immediately responsible to one of the Queen's Ministers.

"We regard the exact locality of the National Museum of Natural History as a question of comparatively minor importance, provided that it be conveniently accessible and within the metropolitan district.

GEORGE BENTHAM, F.R.S.
WILLIAM B. CARPENTER, M.D., F.R.S.
W. S. DALLAS, F.L.S.
CHARLES DARWIN, F.R.S.
F. DUCANE GODMAN, F.L.S.
J. H. GURNEY, F.Z.S.
EDWARD HAMILTON, M.D., F.L.S.
JOSEPH D. HOOKER, M.D., F.R.S.
THOMAS H. HUXLEY, F.R.S.
JOHN KIRK, F.L.S.
LILFORD, F.L.S.
ALFRED NEWTON, F.L.S,
W. KITCHEN PARKER, F.R.S.
ANDREW RAMSAY, F.R.S.
ARTHUR RUSSELL, M.P.
OSBERT SALVIN, F.L.S.
P. L. SCLATER, F.R.S.
G. SCLATER-BOOTH, M.P.
S. JAMES A. SALTER, F.R.S.
W. H. SIMPSON, F.Z.S.
J. EMMERSON TENNENT, F.R.S.
THOMAS THOMSON, M.D., F.R.S.
H. B. TRISTRAM, F.L.S.
WALDEN, F.L.S.
ALFRED R. WALLACE, F.Z.S.

"London, May 14, 1866"

Deep-sea Soundings and Deep-sea Thermometers

WILL you allow me to reply to a letter from Messrs. Negretti and Zambra that appeared in vol. viii. p. 529, in reference to my Casella-Miller Deep Sea Thermometer, in which they accuse me and the late respected Dr. Miller of "plagiarism."

I presume, by this remark, that they intend to convey the idea of their own introduction having been imitated, because they state also that "their thermometer is identical in every respect except in size." Without venturing to trespass upon your valuable space by now going into more detail to prove the con-

trary, I will merely remark that if you, or any of your numerous readers who may feel interested in this subject, will favour me with a visit to my establishment, I shall be happy to give the fullest explanation as well as show the great difference existing between the two, will point out the cause of failure in their arrangement, and also the reason of the complete success of my own thermometer.

Though perhaps it is unfortunate for your correspondents that their reference to Dr. Miller was not made during his lifetime, yet, admitting that he said he was not aware of their arrangement, I must ask in all seriousness, What had their thermometer accomplished to make any one acquainted with it?

Facts speak for themselves. Their arrangement still remains without result, whilst my thermometer, which has solved the great problem of the true temperature of the sea even at its greatest depths, has been adopted not only by our own Government, but also by all the principal Governments and scientific authorities throughout the world. LOUIS P. CASELLA

147 Holborn Bars, Nov. 3

Squalus spinosus

ON the 9th inst. the fishermen of Durgan, in Helford Harbour, sent for me to look at a fish new to them, which had been caught (with a ½*d*. hook) on the preceding night near its entrance. Congers had been numerous, but suddenly ceased to bite. The fish (a spinous shark) had been hooked in the corner of its mouth, out of the reach of its sharp teeth, had wound the line many times round its body, which was 7 ft. in length, and 30 in. in girth, being longer and more slender than one of which I sent a notice to the Royal Cornwall Institution 38 years ago. The back, sprinkled over with spines, was of a dark grey colour, the belly nearly white. It was a male fish. The lobes of the liver were 4 ft. in length. In the stomach was a partially digested dogfish, 2 ft. long. The upper lobe of the tail was muscular and long, perhaps to aid its ground feeding, the lower lobe more marked than in Dr. A. Smith's drawing, as given by Yarrel, and entirely unlike that of the Filey Bay specimen. Twelve hours or more after its capture, when all external signs of life had disappeared, I was surprised to observe the regular pulsations of the heart.

Prof. Huxley has not observed a correspondence between the mass and large convolutions of the brain of a porpoise and its intellectual power.

Several years ago a herd of porpoises was scattered by a net, which I had got made, to enclose some of them. It was strong enough to catch tigers if set in the straits of Singapore, across which they sometimes swim. The whole "sculle" was much alarmed, two were secured. I conclude that their companions retained a vivid remembrance of the sea-fight, as these cetacea, although frequent visitants in this harbour previously, and often watched for, were not seen in it again for two years or more.

Trebah, Falmouth, Oct. 27 C. FOX

Zodiacal Light

IT is a matter for regret that with the magnificent opportunities of investigating the character of the Zodiacal Light afforded to Maxwell Hall by his elevated position in Jamaica, he does not seem to have brought the powers of either the spectroscope or polariscope to bear on it.

I think the full importance of the inquiry is hardly appreciated by many. Taking the generally accepted theory of the light—that of a lens-shaped disc of luminous matter, with the sun for its centre and a diameter exceeding that of the earth's orbit—its matter, lying as it does in the plane of the elliptic, actually connects us with the sun, and may be the medium through which the solar magnetic forces act upon our own.

The intimate connection between solar outbursts, auroras, and terrestrial magnetism is an established fact.

To the aurora, the zodiacal light is by many conceived to be nearly allied, and I do not think the evidence hitherto adduced against this theory is at all conclusive. The remarkable wave of light seen by Maxwell Hall is strongly in favour of it; and though spectroscopic observations seem to point the other way, they are as yet so scanty in number that it would be as unfair to argue from them the want of connection between the two phenomena, as it would be to assert that the planets have no volcanic fires of their own because they only give us a reflected solar spectrum.

Assume the zodiacal light to consist of solid particles of matter—planet dust—shining by reflected light, and it is not difficult to imagine the aurora playing amongst these tiny worlds, each of which might have its own small magnetic system, swayed like our own by the master magnet, the sun.

So far as my own experience goes I can see no objections to this assumption. Though I have seen the light very brilliant in both its branches, I have never yet found it to have a decided outline. Nor have I been able to trace it either east or west to 180° from the sun. Granting that this can be done, however, the apparent vanishing point of the earth's shadow lies comparatively near us, and far within this again is the point at which the shadow would subtend only a degree or two of arc, and at which it would be very hard to discern mid the feeble light of this portion of the zodiacal light; so that a slight extension of the diameter of the disc would remove any objection that might be raised under this head.

Imagine one of Saturn's moons revolving in an orbit within his belts, and fairly embedded in the matter, which, for the sake of the argument, we must assume to be illuminated by the planet. To inhabitants of that satellite each night would bring a phenomenon closely resembling our zodiacal light, only far more brilliant. At midnight two cones of light would taper upwards east and west, and meet overhead. The brightest portion of each cone would be that along the axis and nearest the horizon. Towards the summit and on the borders, where the line of sight would lie through less depths of matter, the light would gradually fade away, but from the satellite being embedded in the belt, the entire sky would be more or less luminous.

Has it not been noticed on our earth that when the zodiacal light has been seen unusually bright, a "phosphorescence" of the sky was everywhere visible? May this not arise from our solar belt in a somewhat similar manner?

From my personal observations I see no reason to give a lenticular form to the disc. Parallel faces would afford a perspective such as the zodiacal light appears to me.

I would urge observers who may be fortunately situated, not to neglect opportunities. So far as I am able I shall do my best to aid the work of inquiry, and with the powerful instruments that Browning is forwarding me, placed at an elevation of more than 6,000 ft., under the clear skies of our Indian winter, I trust I shall be able to add something to our knowledge of the zodiacal light.

I should feel much indebted to any of your readers who would inform me which is the best adapted polariscope for such researches, and whose (amongst makers) speciality such instruments are. E. H. PRINGLE

Camp Udapi, South Canara, Oct. 3

Cold Treatment of Gases

ALLOW me to submit to your readers the following sketch o an apparatus for producing extreme cold, by which it might perhaps be practicable to liquefy or even solidify the elementary gases which have hitherto resisted the efforts of chemists.

The gas to be operated on is compressed to any required degree by means of one cylinder, is cooled to the lowest convenient degree in the ordinary way, passes into an expansion cylinder with a properly arranged cut-off, where in expansion its temperature is still further lowered. From the expansion cylinder it returns back to the compression cylinder, extracting the heat from the counter current proceeding from the compression cylinder, so that the latter will be always arriving at the expansion cylinder with a continually decreasing temperature.

As out here I have no possible means of trying whether there is anything in this idea, I offer it to any of your readers who may feel disposed to try it.

Graaff Reinet College, Cape Colony, July 19. T. GUTHRIE

The Relation of Man to the Ice-sheet

MR. TIDDEMAN has shown for Yorkshire what I proved six years ago for the South of England in a paper in the *Geological Magazine* (vol. iv. p. 193), that glacial conditions have obtained in this country since its occupation by Palæolithic man. Unfortunately an attempt which I made to explain this coincidence between his result and mine in a letter to the same periodical in February last was rendered abortive by a clerical (or perhaps printer's) error. I would press upon geologists to consider

whether the point proved is not that a glacial period has intervened since the times of Palæolithic man and the present, rather than that man existed in this country before the glacial epoch, I think Mr. Tiddeman thinks as I do; but I take the liberty ot stating this view more distinctly. O. FISHER

Wave Motion

IN NATURE, vol. viii. p. 506, Mr. Woodward has suggested a simple and ingenious illustration of wave motion. Could he, or any other correspondent, supply, or refer to, a popular explanation of the action of the particles upon each other, to which the propagation of the wave is due?

In the case of sound waves, the propagation is comparatively simple, and is fully and clearly explained in Dr. Tyndall's "Lectures on Sound," and elsewhere. Helmholtz, in his "Popular Lectures," has figured the motion of the individual particles of which a water wave is composed. And in Sir John Herschel's "Familiar Lectures," there is an elaborate and beautiful demonstration of the motion of the particles of ether in plane and circularly polarised light; but neither of these expositions appears to deal with the mode of propagation of the motion by which the wave is formed.

On the other hand, Sir Charles Wheatstone's ingenious model beautifully exemplifies the interaction of *waves* and their results. But here the waves are produced by the wooden wave forms introduced into the machine, the beads representing the particles remaining fixed in relation to each other. Neither, therefore, can this explain the manner and direction of the actual impact of each particle upon the adjacent one (beginning with those in contact with the source of motion itself), to which, combined with the tendency to yield in the direction of least resistance, the water wave must owe its form, and upon which the still more complicated conception of the light wave must ultimately depend.

Could a reference be given to any practical explanation of this point, it would confer a benefit on many who are not competent to follow the subject into the higher mathematics. M. F. E.

Sussex, Nov.

Elementary Biology

I, ALONG with many others, who are desirous of obtaining an insight into Nature, would esteem it a great favour, and it would be of the greatest benefit to us, if any of your scientific readers would undertake to give through your columns a short account of the various low forms of life included under the elementary stage of biology of the Science and Art Department. They might give instruction as to where the various objects could be seen, how inspected, names of the best text-books for the students' guidance, &c.

By so doing, they would secure the praise of many who at present cannot find out the modes of studying such subjects.

Hull, Nov. 8 BIOLOGY

Black Rain and Dew Ponds

CAN any of your readers explain the cause of this phenomenon? On Thursday, the 4th Sept., about 5 P.M., in the village of Marlsford, in the valley of the Thames, near Wallingford, a heavy storm of rain occurred: and the water which fell in several parts of the village was found to be nearly black. It is described as being of such a colour as would be produced by mixing ink with water. Another of these black water showers fell during the night of the following Friday.

Would any reader of NATURE also kindly set forth the theory upon which the utility of the dew ponds, found in many of the highest points of the Berkshire Downs, rests. They are circular ponds made with considerable care, and are supposed to receive so much dew as to supply all the water needed for the sheep in their neighbourhood through the driest summer.

Tiverton E. HIGHTON

ALBANY HANCOCK

THE brief announcement by which some of our readers may have first learnt of the decease of one of our greatest biologists is, in its simplicity, in singular harmony with the life the close of which it commemorates.

The retrospect of so serene a career leaves little to the biographer, for its points seem marked rather by phases of study, as indicated by important scientific memoirs, than by incidents which the world regards as striking or noteworthy.

Albany Hancock was born at Newcastle-on-Tyne on Christmas Eve, 1806. His father, Mr. John Hancock, died some six years later, and of the six little children thus left dependent on their mother, Albany was the third. He received a good education as times then went, and on leaving school was articled to a solicitor of good standing in Newcastle. Uncongenial as was the employment, he served his full term, passed the customary examinations in London, and even took an office in Newcastle with the view of establishing himself in practice. But the occupation was irksome, and he gave it up ere long to join a manufacturing firm, and this in turn circumstances led him soon to abandon. The simple fact probably was that neither occupation permitted him to follow the bent of his inclination, and that the desk and counting-house were alike distasteful to a mind pre-engaged as was his by other currents of thought. His early taste for natural history pursuits was probably in part derived from the collections, chiefly conchological, formed by his father, who was in many ways a man of superior ability, and had been something of a naturalist; and association with the late Mr. Robertson and Mr. Wingate, the one a botanist, the other an ornithologist, of repute; with the well-known Mr. Bewick; and above all with his near neighbour Mr. Alder, confirmed his inclination in this direction. He was, as a boy, clever with his fingers, and that manual dexterity which in later years served him so well when engaged with dissecting needle and pencil, exhibited itself in many of the pursuits of his early life.

The first mention we find of Mr. Hancock's devotion to natural history is in Mr. Alder's "Catalogue of Land and Fresh-water shells," published in 1830, in which the author handsomely acknowledges the obligations he is under to him and to Mr. John Thornhill "for the communication of many habitats observed during their active investigation of this as well as other branches of the natural history of the neighbourhood" of Newcastle. His earliest appearance as an author seems to have been in connection with two short papers in the first volume of "Jardine's Magazine of Zoology and Botany," published in 1836, the one a "Note on the Occurrence of *Raniceps trifurcatus* on the Northumberland Coast," the other a "Note on *Falco rufipes*, *Regulus ignicapillus* and *Larus minutus*." These notices were, comparatively speaking, of trifling significance, but they were the beginning of a long series of contributions to knowledge which only ceased when his last illness deprived him of the power of continuous work. It is unnecessary here to enumerate the successive memoirs that embody the results of his life's labour. A catalogue of the original papers of which he was author, or joint author, would extend to something over seventy titles.

Early association with Mr. Alder in the study of the mollusca led to the production between the years 1845 and 1855 of their magnificent "Monograph of the British Nudibranchiate Mollusca," which may still be taken as a standard of excellence amongst such publications. Many of Mr. Hancock's earlier papers were devoted to the elucidation of the boring apparatus of the mollusca, and these were followed by similar researches respecting the excavating power of a group of sponges (*Cliona* and allied genera) which until that time had been but little known or understood.

As an anatomist—and after all it was his large knowledge of minute anatomy and infinite skill in dissection that gave its especial value to most of his work—he was, perhaps, best known by his elaborate memoir on the Organisation of the Brachiopoda, published in the Philo-

sophical Transactions for 1857; but many other papers of the same thorough and original character proceeded from his pen. Amongst them will be remembered the following:—"On the Olfactory Apparatus in the Bullidæ" (1852); "On the Nervous Systems of *Ommastrephes todarus*" (1852); "On the Anatomy and Physiology of the Dibranchiate Cephalopoda" (1861); "On the Structure and Homologies of the Renal Organ in the Nudibranchiate Mollusca" (1863); "On the Anatomy of Doridopsis" (1865); "On the Anatomy and Physiology of the Tunicata" (1867).

For some years previous to his death Mr. Hancock had devoted much attention to the fish of the Carboniferous period, and in conjunction firstly with Mr. T. Atthey, whose fine collection afforded ample material for the purpose, and subsequently with Mr. Howse, published a series of fifteen papers on these coal-measure fossils.

The promised Monograph of the British Tunicata, preparations for which had made some progress even before the death of Mr. Alder, had occupied much of his time; and though probably still unfinished, it may be hoped that the results of his investigations are so far complete in themselves, that the work, as far as it has gone, may be saved to science. A supplement to the Monograph of Nudibranchiate Mollusca had been a matter long on his mind, but one that he had never been able to devote himself to realising, beyond the collection of materials.

Allusion has been made to Mr. Alder, Mr. Atthey, and Mr. Howse, as having been associated with Mr. Hancock in certain of his papers; to these must be added the names of Dr. Embleton and the Rev. A. M. Norman as occasional colleagues.

On the establishment of the Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne in 1829, Mr. Hancock became an active supporter, and was one of the original staff of honorary curators; and on the formation of the Tyneside Naturalists' Field Club in 1846, he was one of its principal and most influential promoters. When the new College of Physical Science in Newcastle was instituted, his name, almost as a matter of course, was placed on the provisional committee; and it was only when this body had completed its labours and gave place to a permanent board, that he was permitted, on the ground of ill-health, to retire from active service in connection with the institution. He was a Fellow of the Linnean Society, a corresponding-member of the Zoological Society of London, an honorary member of the Imperial Botanico-Zoological Society of Vienna, and perhaps of some other similar bodies; but honours of this sort, though valued in their way, were thrust upon him rather than sought. Though living a retired life, no man more highly prized social intercourse. His kindly helping hand was held out to every young naturalist: Such were always welcome at his house; and when appealed to by them, as was often the case, he made their difficulties his own till he could help to solve them.

It is yet too soon to attempt to shake oneself free from a sense of his presence, or to essay to weigh in judicial balance the value of his contributions to human knowledge: considerations of this sort are overwhelmed in the sense of irreparable loss to science.

H. B. B.

*FERTILISATION OF FLOWERS BY INSECTS**

IV.

On the two forms of flower of Viola tricolor, and on their different mode of fertilisation.

VIOLA tricolor presents a further example of the same kind of dimorphism as that described in the last article in the case of Lysimahcia, Euphrasia, and Rhinanthus. One of its two forms, illustrated by Fig. 15 in natural size, is more conspicuous than the other (Fig. 16), not only by its larger size, but also by the more striking colour of its petals. When the flower has just opened, its two upper petals are light violet, or, in rarer cases, nearly white; but they gradually become a deep violet, or even dark blue. Far more striking is, ordinarily, the change of colour in the two lateral petals and the lower one, which, immediately after the opening of the flower, are nearly white, while in a fully-developed state they are always violet. The petals of the small-flowered form of *Viola tricolor*, illustrated in natural size by Fig. 16, are, on the contrary, uniform in colour and nearly white during the whole time of flowering. The attractiveness for insects of the two kinds must therefore be very different, whereas those particular marks round the opening of the flower which serve as a guide to insects in search of the honey, the "Saftmal" of Sprengel, are nearly the same in the two varieties. That part of the lower petal immediately before the entrance of the flower (*y*, Fig. 21, 22) is in both dark yellow, and the lower petal is also marked by black streaks converging towards the same entrance. There is only this difference between the two forms as to their guide-mark (*Saftmal*), that in the large-flowered form seven black streaks on the lower petal, and three on each of the lateral ones point towards the entrance of the flower; whereas in the small-flowered form there are but five black streaks in the lower petal, and none at all on the lateral ones.*

Although these two forms have been generally known, at least since the time of Linnæus, all botanists who have published observations on the fertilisation of *Viola tricolor* have apparently turned their attention exclusively to the large-flowered form (Fig. 15), whose beautiful adaptations to cross-fertilisation by insects, have been, therefore, very accurately described; while the peculiarities in structure and fertilisation of the small-flowered form have not even been mentioned. If, in this case, we clearly see that even scientific inquirers have been far more attracted by the larger violet flowers than by the smaller whitish ones, we need not wonder that insects are influenced in like manner, and that from this cause smaller and less conspicuous flowers are so frequently quite overlooked by insects, that they would rapidly become extinct, unless slight modifications of structure and development enabled them to produce seeds by self-fertilisation.

Indeed, in *Viola tricolor*, as in those species hitherto considered, regular self-fertilisation in the small-flowèred form is effected by such slight modifications of structure and development, that by far the larger number of the contrivances in the large and small-flowered forms are identical.

In both forms, honey is secreted by two long appendages (*n*) of the lower filaments (*fi*), from which it ascends by adhesion into the uppermost part of the hollow spur (*sp*); the style (*sty*, Fig. 22) is directed downwards on its base, slender and bent like a knee, while above it is straight and gradually thickened, but does not increase at all or only slightly in breadth, ending in a skull-like stigmatic knob (*k*), thick enough to completely stop the entrance of the flower. This knob is provided with a wide open moist stigmatic cavity (*st*,) and is protected from above by two sets of hairs (*pr*, Figs. 21, 22, Sprengel's "Saftdecke") on the two lateral petals, which at the same time defend the entrance of the flower against rain, and prevent insects from entering into the flower in any other way than by the lower side of the skull-like knob. In both forms the five anthers open inwards, are narrowed towards their

* Continued from vol. viii. p. 435.

* My description relates exclusively to those varieties of *Viola tricolor* which grow in the environs of Lippstadt. From Sprengel's, Bennett's, and other descriptions and illustrations, I am aware that in other localities somewhat different varieties are found. But I do not doubt that differences in the manner of fertilisation, identical or closely allied with those here to be described, will be found wherever a large-flowered and a small-flowered form of *Viola tricolor* co-exist.

end, and prolonged above into orange-coloured triangular appendages of their connectives (*c*, Figs. 21, 22), and lie so close together round the style, as to form a hollow cone containing the pollen, and overtopped only by the skull-like crest of the style. This position of the stigmatic knob rising out of the anther-cone but immediately below its summit, is secured by a remarkable contrivance, the skull-like knob being prevented from sliding into the anther-cone by two tufts of hairs, projecting like whiskers from its two cheek-like lateral surfaces. Thus a lifting up of the stigmatic knob, which must always be effected by insects seeking for honey or for pollen, and which is easily accomplished by them in consequence of the base of the style being slender and bent like a knee, will be more likely to tear off the filaments than to push the stigmatic knob into the anther-cone. Indeed, we find that by the swelling of the fertilised ovary the filaments are always torn off, whereas the anthers remain, enclosing like a hollow cone the narrow portion of the style, and the skull-like knob is never drawn between the anthers. If the anther-cone containing the pollen were densely closed all round, the pollen-grains would not fall out unless the anthers were separated from each other by lifting up the stigmatic knob ; but there actually exists an opening on the lower side of the summit of the cone directed downwards, the appendages of the two lower anthers being cut out (*op*, Figs. 21, 22), by which nearly all the pollen may fall out spontaneously. When it has fallen out, a great part of the pollen is collected in the close hairy lining of the fore part of the spur.

Thus far the two forms of *Viola tricolor* are identical in structure ; and the same, or nearly the same, insects may *a priori* be supposed and have really been observed, to visit the two forms. The distance between the closed entrance of the flower and the honey contained in the uppermost part of its spur being in both of the two forms 6-7 mm., an insect must be provided, in order to reach the honey, with a proboscis of at least that length, unless it be enabled by its small size to crawl with its whole body into the flower. A proboscis of 6-7 mm. length or larger is only to be met with among all our insects in Lepidoptera, Apidæ, and some few Diptera ; insects sufficiently minute to be able to crawl into and out of the flowers, are to be found chiefly in the genera Thrips and Meligethes. It may therefore be supposed, *a priori*, that Lepidoptera, Apidæ, and Diptera provided with a proboscis of at least 6 mm. long, and very minute insects of the genera Thrips and Meligethes, will visit the two forms of *Viola tricolor* for honey, and that, besides, some other insects provided with shorter probosces will seek for their pollen. By direct observation this supposition has been thoroughly confirmed, as shown by the following list of visitors actually observed :—

I. As visitors of the large-flowered form, there have been observed :—(*a*) Lepidoptera : (1) *Pieris rapæ* L.* (12).†—(*b*) Apidæ : (2) *Bombus muscorum* L.* (10-15) ; (3) *B. lapidarius* L. ♀‡ (12-14) ; (4) *B. sp.*§ ; (5) *Anthophora pilipes* F.‖ (19-21) ; (6) *Andrena albicans* K. ♂ (2-2½), in vain seeking for honey.‡—(*c*) Diptera : (7) *Rhingia rostrata* L.§ (11-12) ; (8) *Syritta pipiens* L. (2-3), eating pollen.‡—(*d*) Thysanoptera : (9) Thrips.¶

II. As visitors of the small-flowered form, there have been observed :—(*a*) Lepidoptera : (1) *Pieris rapæ* L. ;* (12), repeatedly ; (2) *P. napi* L.* (11), repeatedly ; (3) *Polyommatus Dorilis* Hfn.*—(*b*) Apidæ ; (4) *Apis mellifica* L. (6) ☿ ;† (5) *Bombus hortorum* L. ♀* (18-21), perseveringly visiting the flowers for honey, although every flower is drawn down by the weight of this large humble-bee ; (6) *B. Rajellus* Fll. ♀* (10-13), the same individual visiting sometimes *V. tricolor*, sometimes *Lamium purpureum* ; (7) *B. muscorum* L. (*agrorum* F.) ♀ (10-14), visiting, without distinction, now the flowers of *V. tricolor*, now the nearly equally large and equally coloured flowers of *Lithospermum arvense*, while omitting the smaller ones of *Capsella busra-pastoris*, *Valerianella olitoria*, and *Myosotis versicolor* ; (8) *Osmia rufa* L. ♂ * (7-9), but once hastily visiting a flower for honey.—(*c*) Diptera ; (9) *Rhingia rostrata* L.* (11-12), several specimens, repeatedly visiting flowers for honey.—(*d*) Coleoptera ; (10) *Meligethes** crawling into the flowers.

Direct observation has thus shown that no essential difference exists between the fertilisers of the large and those of the small-flowered form. But it must appear a striking fact that not only an equal number of different species, but even one more species has been observed on the small than on the large-flowered form. All the visitors of the small-flowered form, with the exception of only one, having been observed by myself, I must add, as an explanation of this fact, that I have repeatedly watched at the most favourable weather, for several hours, a neglected field, in which, besides some other weeds, there grew an abundance of vigorous specimens of the small-flowered form of *Viola tricolor ;* whereas I have never had an opportunity of watching the large-flowered form under favourable conditions. Therefore I have no doubt that, in spite of the incomplete observations hitherto made on this subject, the more conspicuous flowers are in this species also really far more frequently visited by insects than the less conspicuous ones. Otherwise the differences in structure and development of the two forms now to be described would be quite inexplicable. These differences are :—1. In the large-flowered form the stigmatic cavity lies somewhat more towards the top of the skull-like end of the style than in the small-flowered one (as shown by the comparison of Fig. 17 with Fig. 18, and of Fig. 19 with Fig. 20.)

(1) When the skull-like knob in the two forms is pressed against the lower petal, in the large-flowered form the opening of the stigmatic cavity is directed outwards, so that pollen-grains which have fallen out of the anther-cone spontaneously can never fall into the stigmatic cavity unless carried by insects ; whereas in the small-flowered form the opening of the stigmatic cavity is directed inwards, so that pollen-grains falling out of the anther-cone spontaneously, fall directly into the stigmatic cavity.

(2) In the large-flowered form the opening of the stigmatic cavity (*st*, Figs. 17, 19, 21) bears on its lower side, as discovered by Hildebrand, a labiate appendage (*l*, Figs. 17, 19, 21) provided with stigmatic papillæ, so that a proboscis inserted into the flower, when charged with pollen of a previously visited flower, rubs off this pollen on to the stigmatic lip (*l*), thus regularly effecting cross-fertilisation ; whereas, when withdrawn out of the flower, charged with its pollen, the proboscis presses the lip (*l*) against the stigmatic opening (*st*), thus preventing self-fertilisation. This nice adaptation to those visitors provided with a long proboscis (Lepidoptera, Apidæ, Rhingia) is completely wanting in the small-flowered form (Figs. 18, 20, 22).

(3) In the large-flowered form there is a black wedge-shaped streak (*w*, Figs. 17, 19) on the front side of the style, to which Mr. A. W. Bennett first called atten-

* By W. E. Hart (NATURE, vol. viii. p. 121).

† The numbers enclosed between parentheses after the names of the insects indicate the length of their probosces in millimetres.

‡ By myself ("Befruchtung der Blumen durch Insecten," p. 145).

§ By Ch. Darwin, who writes me, May 30, 1873 :—"Between twenty and thirty years ago I observed, for two or three years, large beds (of *V. tricolor*) in the flower-garden, and saw several times *Rhingia rostrata*, and a nearly black humble-bee visit and fertilise the flowers. I say fertilise, because I had watched the flowers for a long time previously, and saw no insect visit them ; but two or three days after the above visits a multitude of flowers withered and set capsules."

‖ By Delpino ("Ulteriori osservazioni," p. 62).

¶ By Sprengel ("Das entdeckte Geheimniss," p. 397), and Mr. A. W. Bennett (NATURE, vol. viii. p. 49).

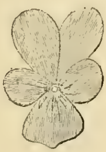
* By myself (June 1873).

† By Sprengel (*loc. cit.*) and by myself (June 1873), perseveringly visiting the flowers for honey.

tion,* and which he has interpreted as a guide-mark for those visitors, which are diminutive enough to crawl entirely into the flower. This streak is also wanting in the small-flowered form (Figs. 18, 20).

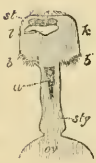
(4) In the large-flowered form pollen-grains do not spontaneously fall out of the anther-cone before the flower has been fully developed for several days; whereas in the small-flowered form, in by far the majority of cases, a great number of pollen-grains fall spontaneously out of the anther-cone into the stigmatic cavity and there develop long pollen-tubes, even before the opening of the flower, in much rarer cases a short time after it has opened.

(5) When the visits of insects are prevented by a fine net, the flowers of the small-flowered form wither two or three

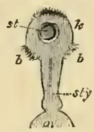


15

16



17



18

19

20

FIG. 15.—Front view of the more conspicuous flower of *Viola tricolor*, natural size. FIG. 16.—Front view of the less conspicuous flower. FIG. 17.—Pistil of Fig. 15, viewed on the under side, 12 times natural size. FIG. 18.—Pistil of Fig. 16. FIG. 19.—Lateral view of the pistil of Fig 15. FIG. 20.—Lateral view of the pistil of Fig. 16.

The following explanation of the lettering applies to all the figures:—
a, anthers; a^1, upper, a^2, lateral, a^3, lower anther; ap^1, appendage of the upper sepal; *b*, beard, *i.e.* tuft of hairs on the lateral surface of the skull-like crest of the style; *c*, appendage of the connective; *fi*, filaments; *k*, knob of the stigma; *l*, lip, labiated appendage of the stigmatic opening; *n*, nectary, *i.e.* honey-secreting appendage of the lower filaments; *op*, opening of the anther-cone; *ov*, ovary; *p*, petals; p^1, lower, p^2, lateral, p^3, upper petal; *po*, pollen-collecting hairs; *pr*, protective hairs (Sprengel's "Saftdecke"); *s*, sepals; s^1, upper sepal (with the appendage ap^1); s^2, lateral sepal; *sp*, the uppermost part of the spur, containing the honey; *st*, stigmatic cavity; *str*, streaks converging towards the opening of the flower; *sty*, style; *w*, wedge-shaped streak of the style; *y*, yellow coloured part of the lower petal.

days after opening, everyone setting a vigorous seed-capsule; those of the large-flowered form remain in full freshness more than two or three weeks, at length withering without having set any seed-capsule; when fertilised they wither also after two or three days.

Summary:—The more conspicuous flowers of *Viola tricolor* are adapted to regular cross-fertilisation by Lepidoptera, Apidæ, and Rhingia; whereas self-fertilisation by these visitors is prevented. Pollen-eating flies and diminutive insects crawling into the flower may effect both self- and cross-fertilisation; fertilisation by insects is possible from the opening of the flower for twenty days or more; spontaneous self-fertilisation never takes place. On the contrary the less conspicuous flowers are

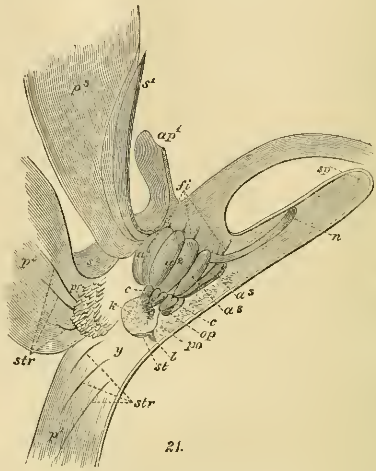


FIG. 21.—Lateral view of Fig. 15 after the half of its sepals and petals having been removed, 7 times natural size.

adapted to regular self-fertilisation; although visited now and then by the same insects as the more conspicuous flowers, cross-fertilisation by these visitors is by no means secured; in most cases it is even prevented by the pollen having previously fallen into the stigmatic cavity; it

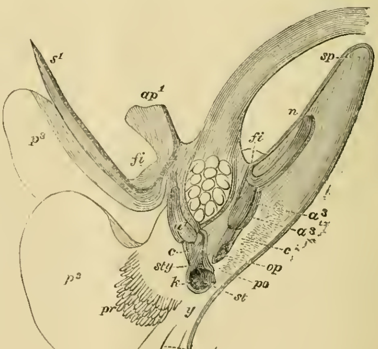


FIG. 22.—Lateral view of Fig. 16, but one lateral anther and the half of one lower anther have been removed and the pistil bisected longitudinally.

is possible only in those cases where the flower has opened before its pollen has filled the stigmatic cavity; and even in these rare instances the possibility of cross-fertilisation lasts but a few hours.

Lippstadt, October 1873 HERMANN MÜLLER

* In his interesting article on the Fertilisation of the Wild Pansy, NATURE, vol. viii. p. 49.

ON THE SCIENCE OF WEIGHING AND MEASURING, AND THE STANDARDS OF WEIGHT AND MEASURE *

VIII.

THE ordinary method of commercial weighing by putting the weights in one scale and the commodity to be weighed in the other, and then observing when a sufficient equilibrium is produced, is inadmissible for scientific weighings, as it is subject to errors arising from defects in the balance itself. To avoid any such errors, and obtain scientific precision in the results, a check is required which is found in a system of double weighing. There are two methods of double weighing for the comparison of two standard weights. One method, known as Borda's, and generally used in France, is that of *substitution*, or weighing first one of the standard weights to be compared, and then the other substituted for it, against a counterpoise placed in the other pan. The difference between the mean resting points of the index needle in these two weighings shows the difference of the two weights in divisions of the scale. The second method, known as Gauss's, but which was first invented by Le Père Amiot, and is now generally used in England and Germany, except for hydrostatic weighings, is that of *alternation*, or first weighing the two standards against each other, and then repeating the weighings, after interchanging the weights in the pans. By this second method no counterpoise weight is required, and *half* the difference between the mean resting points of the index needle shows the difference of the two weights, in divisions of the scale.

In all scientific weighings of standards with balances of precision, it is necessary that the weights to be compared should be so nearly equal that neither pan shall absolutely weigh down the other. The balance must merely oscillate so that the pointer does not exceed the limits of the index scale. In order to obtain an equipoise within this limit, it is requisite to provide small balance weights, most accurately verified, to be added to either pan, as may be found necessary.

The mode of reading adopted by the best authorities in the process of weighing by Gauss's method is as follows:—The comparing standard being in the left-hand pan, and the compared standard in the right-hand pan, and sufficient equipoise being obtained by adding small balance weights, if requisite, the balance is put in action, and the movement of the needle observed through a telescope. The reading at the first turn of the pointer is disregarded. The three next turns are noted, and the reading at the third turn of the pointer, and half the sum of the readings at the second and fourth turns are taken as the highest and lowest readings. Their mean is the resting point of the balance, or the reading of its position of equilibrium. The balance is then stopped, and the weights interchanged, when similar readings are taken and dealt with in the same manner. These two observations constitute one comparison. In cases where great accuracy is required, several successive comparisons are taken, in order to obtain a mean result. Some additional weighings are taken after adding a small balance weight to either pan, in order to ascertain the value of a division of the index scale. And if this balance-weight be added successively to each pan the weighings may be used as additional comparisons.

In using Gauss's method of weighing, it is very desirable to be able to transfer the pans and the weights contained in them from one end of the beam to the other without opening the balance case, and thus to avoid sudden changes of temperature of air within the balance case and consequent production of currents of air. For this purpose, the following plan is adopted. A grooved brass rod is fixed inside the balance case over and a little behind the beam. Upon this rod a brass slider is made to traverse by being attached to a slender brass rod drawn backwards or forwards from the outside of the case. A descending wire with a hook at the end is attached to the slider. For changing the weights, the slider and hook are brought to the right-hand end of the beam, when the pan and weight are lifted from the beam and transferred to the hook by means of a brass rod curved at the end and introduced through a small hole at the side of the balance case. The pan and weight are then slid to the other end of the beam, when the left-hand pan and weight are lifted in a similar manner from the beam and the right-hand pan and weight substituted. It only remains then to transfer the left-hand pan and weight to the right-hand end of the beam.

This method possesses a further advantage. In making a great number of comparisons between two standard weights, they are exposed to some risk of being injured by wear, if they are taken up in the ordinary way with a pair of tongs. This risk is obviated by their being kept in the pans when lifted. Two light pans are used of as nearly as possible equal weight, each of which has a loop of wire forming an arch with the ends attached to the opposite sides of the pan, so that it can be easily lifted with the curved end of a brass rod. The pans are marked X and Y respectively. By interchanging the weights in the pans after a series of comparisons, and making a second series and taking the mean result, it gives the difference between the two weights, unaffected by any possible difference in the weight of the two pans. This contrivance is especially useful, when either of the weights to be compared consists of several separate weights. It was used by Prof. Miller for all his more important weighings during the construction of the imperial standard pound.

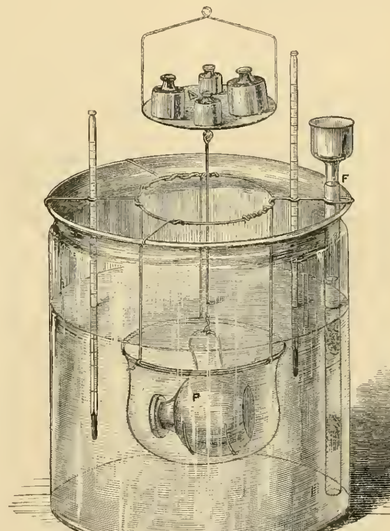


FIG. 18.—Mode of hydrostatic weighing (one-third size).

* Continued from p. 555.

The advantage possessed by Gauss's method of alternation over Borda's method of substitution has been proved by Prof. Miller as follows :—

Let P and Q be two standard weights of the same denomination to be compared, and C the counterpoise of each.

For Borda's method, let the readings of the index be denoted by (C, P), when C is in the left pan and P in the right pan, and by (C, Q), when C is in the left pan, and Q in the right pan.

For Gauss's method, let (Q, P) denote the readings when Q is in the left pan and P in the right, and (P, Q), when P is in the left pan and Q in the right pan.

Let e be the probable difference between the recorded and the true position of equilibrium, that is to say, the probable error of a *single weighing* (not of a comparison, which requires two weighings).

Then by Borda's method, (C, P) has a probable error e, and (C, Q) has a probable error e; and the two weighings give the value of P − Q with a probable error of $\sqrt{(e^2 + e^2)} = e\sqrt{2}$.

By Gauss's method, (Q, P) has a probable error e, and (P, Q) has a probable error e; and the two weighings give the value of P − Q with a probable error of $\frac{e}{2}\sqrt{2}$.

Thus the probable error of the result of two weighings by Borda's method is twice as great as by Gauss's method.

To obtain a value of P − Q by Borda's method with a probable error of $\frac{e}{2}\sqrt{2}$, we must make four comparisons of two weighings each. Therefore one comparison by the method of Gauss gives as good a result as four comparisons by Borda's method.

The result of this weighing of two standard weights against each other gives only their apparent difference when weighed in air. In order to ascertain their true difference, it becomes necessary to determine the weight of air displaced by each, from the data which have been already mentioned, and to allow for any difference of weight of air displaced, according to the following formula :—

If the weights P and Q appear to be equal in air, the weight of P − weight of air displaced by P is equal to the weight of Q − weight of air displaced by Q.

In determining the weight of ordinary atmospheric air in rooms where standard weights are compared, and containing a certain quantity of aqueous vapour and carbonic acid, the practice has been to take, as the unit of weight of air, a litre of dry atmospheric air free from carbonic acid, = 1·2932227 gramme, at 0° C., as determined by Ritter from the observations of M. Regnault in Paris, lat. 48° 50′ 14″, and 60 metres above the level of the sea, under the barometric pressure of 760 millimetres of mercury. Assuming that atmospheric air contains, on an average, carbonic acid equal to 0·0004 of its volume, and the density of carbonic acid gas being 1·529 of that of atmospheric air, the weight of a litre of dry atmospheric air containing its average amount of carbonic acid, under the stated circumstances, is 1·2934963 gramme.

Allowance should be made for the difference of the force of gravity in latitudes other than Paris, as well as for the difference of height of the place of observation above the mean level of the sea. Although the absolute weight varies with the latitude and with the height above or below the mean level of the sea, yet this variation is not felt in the comparison of standard weights in a vacuum, because the weights are equally affected on both sides of the beam. But in all weighings of standards in air requiring special accuracy, such variation must be taken into account in computing the weight of air displaced by each standard weight.

Mr. Baily has shown from his pendulum experiments * that if we take G to denote the force of gravity at the mean level of the sea in lat. 45°, the force of gravity in lat. λ, at the mean level of the sea

$$= G\,(1 - 0·0025659 \cos 2\lambda).$$

And Poisson † has proved that the force of gravity in a given latitude at a place on the surface of the earth at the height z above the mean level of the sea—

$$= \left\{1 - \left(2 - \frac{3\rho'}{2\rho}\right)\frac{z}{r}\right\} \times \text{(force of gravity at the mean level of the sea in the same lat.)}$$

where r is the radius of the earth, ρ its mean density, and ρ' the density of that part of the earth which is above the mean level of the sea. If as is probable,—

$$\rho' : \rho = 5 : 11;\ 2 - \frac{3\rho'}{2\rho} = 1·32 \text{ nearly};\ r = 6366198 \text{ metres},$$

it follows that the weight in grammes of a litre of dry atmospheric air containing the average amount of carbonic acid, at 0°, and under the pressure of 760 millimetres of mercury at 0°, at the height z above the mean level of the sea in lat. λ is—

$$1·2930693\left(1 - 1·32\,\frac{z}{r}\right)(1 - 0·0025659 \cos 2\lambda).$$

At Cambridge, where Prof. Miller's observations for determining the weight of the new standard pound were made, in lat. 52° 12′ 18″, about 8 metres above the mean level of the sea (and for which place his tables were computed,) the weight of a litre of dry air containing the average quantity of carbonic acid was found by him to be 1·293893 gramme. This weight of air is therefore a little greater than at Paris. From similar data, after taking a further correction by Lasch of the weight of a litre of dry air at Paris = 1·293204 gramme, the weight of a litre of dry air at Berlin (lat. 52° 30′, and 40 metres above mean sea level) has been computed to be 1·29388 gramme.

The co-efficient of expansion of air under constant pressure between 0° and 50° C. is taken from Regnault's determination to be 0·003656 for 1° C., in other words between 0° and 50° C., the ratio of the density of air at 0° to its density at $t°$ is 1 + 0·003656 t.

With regard to the barometric pressure of the air and the allowance to be made for the pressure of vapour present in it, the density of the vapour of water is determined to be 0·622 of that of air ; that is to say, the ratio of the density of the vapour of water to that of air is 1 − 0·378.

Hence, if t be the temperature of the air, b the barometric pressure, v the pressure of the vapour present in the air, b and v being expressed in millimetres of mercury at 0° C., the weight of a litre of air at Cambridge becomes

$$\frac{1·293893}{1 + 0·003656\,t}\ \frac{b - 0·378\,v}{760}$$

The ratio of the density of air to the maximum density of water is found by dividing the above expression by 1,000, as a litre of water is the volume of 1,000 grammes of water at its maximum density. Prof. Miller's Table I. gives the logarithms of this ratio at the normal barometric pressure of 760 millimetres, at the several degrees of temperature from 0° to 30°. These logarithms require to be diminished only by 0·000026 for weighings at the Standards Office, Westminster, lat. 51° 30′, and about 5 metres above the mean sea-level ; and when dimi-

* "Memoirs of the Astronomical Society," vol. vii. p. 94.

† "Memoires de l'Institut," tome xxi. pp. 91, 238.

nished by 0·000132, they may be used for the reductions of weighings at Paris.

The values of the pressure of vapour at the same temperatures in millimetres of mercury at 0°, according to Regnault's observations, are stated by Prof. Miller in a separate Table II. These values are given on the assumption that the pressure of vapour in rooms that are not heated artificially is two-thirds of the maximum pressure of vapour due to the temperature, as shown by the results of experiments on the authority of Biot, Regnault, and Bianchi.

The actual mode of ascertaining the weight of air displaced by two standard weights may now be described.

For determining the temperature of the air and of the two standard weights during the weighings, two standard thermometers are placed in the balance case, and their readings noted at the beginning and end of the weighings. The weight of air displaced by each of two standard weights is to be ascertained by the following formula:

Log. weight in grains of air displaced by P = log. h + log. At + log. (1 + ePt) + log. weight of P in grains − log. △P.

Here t denotes the temperature of the air by the Centigrade thermometer;

b the barometric pressure of the air in millimetres of mercury at 0° C.;

v the maximum pressure of aqueous vapour contained in the air, also in millimetres of mercury;

$h = b - 0·378 \times \frac{2}{3} v$;

At the ratio of density of air at $t°$ to the maximum density of water;

ePt the allowance for expansion in volume of P, or the ratio of its density at 0° to its density at t;

△P the ratio of density of P at 0° to the maximum density of water.

By this formula, the required result is to be obtained. The logarithms of the three first terms may be found in Prof. Miller's tables, pp. 785-791 of his account of the construction of the new standard pound, Phil. Trans., part iii. of 1856.

Reference has already been made to the mode of ascertaining the volume or density of a standard weight by determining the difference of its weight in air and in water. The following practice for all such hydrostatic weighings was adopted by Prof. Miller when determining the densities of all the standard weights constructed under the sanction of the Commission for restoring the Imperial Standards, and is also followed in the Standards Department. In this process it is requisite to employ pure distilled water, and with this object the water used in the Standards Department is twice distilled in a still of the best construction, erected in the office, and the best chemical tests are employed for ascertaining that the water is free from any foreign substances.

The vessel for containing the distilled water is a glass jar, rather more than 6 inches in internal height and diameter. A stout copper wire is stretched across the mouth of the jar (see Fig. 18) in such a manner as to leave a circular space in the middle, large enough to admit the passage of the standard weight P, the density of which is to be ascertained. This copper wire supports two thermometers, adjustable as to their height, for determining the temperature of the water at the mean height of B during the weighings. It also serves to sustain a glass tube, open at both ends, and placed close to the side of the jar. A small glass funnel is inserted in the upper part of the tube, and in the lower part are one or two pieces of clean sponge.

The standard weight P is suspended from a hook under the right pan of the balance, specially constructed for hydrostatic weighings. A fine copper wire, the weight of which per inch is known, is attached to the hook by a loop, and has another loop at the other end. To this lower loop is attached a stout wire, bent and terminating in a double hook, which fits round P, and holds it securely. The counterpoise of P is next placed in the left pan of the balance. The glass jar is placed under the right pan of the balance, P being suspended in it, and the water is gently poured into the funnel and the jar filled to the requisite height above P. The bubbles of air are arrested by the pieces of sponge, and, ascending up the glass tube, are thus prevented from entering the jar. It is of importance to ascertain that no bubble of air is attached to P, and if so, it may generally be removed by the feather of a quill. But it sometimes happens that the weight P has an irregular surface, and air attaching to it cannot be thus dislodged. In such cases a small bell-shaped glass jar just large enough to hold P and its supporting wire, is used. This vessel is filled with water sufficient to cover P, and is suspended over the flame of a spirit lamp by a stout wire, bent at its lower end into a ring, into which the jar descends to its rim, and the water is allowed to boil until it is seen that the air has been entirely expelled. When cooled, the small jar containing P is immersed in the water, which nearly fills the large jar, and the small jar, with its wire, is then disengaged and lowered till P hangs clear of it, when it is removed. The transfer of P from the small to the large jar is thus effected without taking it out of the water.

For the actual weighing of P in water, after it has been counterpoised in air, weights equal to the difference of weight of P in water and in air, are placed in the right pan till equilibrium is produced, when the readings of the scale are observed. P is next removed, leaving its hook suspended in the water, and a volume of water equal to the volume of P is added to the water in the jar, so as to leave the same quantity of wire immersed as before. The requisite weights are then added to the right pan, until the equilibrium, which has been disturbed by the removal of P, is again produced, when the reading of the scale is observed and noted. This gives the actual weight in water of P.

The thermometers in the water are so placed as to give the temperature of the water at the centre of gravity of P. Another thermometer is placed in the balance case to give the temperature of the air during the weighings. The reading of the barometer is also noted.

Having determined the weight of P in air of ascertained density, its volume and density are calculated according to the following formula, the unit of volume being the volume of a grain weight of water at its maximum density:—

Let P in water at $t°$ appear to weigh as much as Q in air. Then the weight of water at $t°$ displaced by P = weight of P − weight of Q + weight of air displaced by Q.

Log. volume of P = weight in grains of the water displaced by P + log. W_t − log. (1 + eP_t); where W_t is the ratio of the maximum density of water to its density at t, and ePt is the expansion in volume of P at t. (The logarithms of these values are given in tables.)

Log. density of P = log. weight of P in grains − log. volume of P.

The actual weight of air displaced is to be ascertained by the method already stated.

As the true weight of P in air cannot be ascertained until its volume or density is known, an approximate value of the volume of P may be found by assuming the weight of P to be equal to its apparent weight in air; and this value of the volume of P may be used in reducing the weight of P, and thus a more accurate value of the volume of P obtained, by means of which a closer approximation to the values of the absolute weight of P, and of its density may be found. This process should be repeated when greater exactness is required.

H. W. CHISHOLM

(*To be continued.*)

EARTH-SCULPTURE*

AMONG the questions which may be treated as matters of strict science, and which yet cannot be wholly divested of the strong human, one might almost say personal, interest which belongs to them, is the birth of mountains and valleys. The familiar outlines of his dwelling-place have fixed the attention of man from the infancy of the race up to the present day. Long before science arose to deal with them they had become inwoven with his history, his habits, and his creed. The great mountains had been to him emblems of majesty and eternity, lifting up their fronts to heaven as they had done from the beginning, and would no doubt do to the end. They rose before him as monuments of the power of that great Being who had heaved them out of chaos. It was enough for him in that early time to feel their mighty influences ; he had then no questions or doubts as to how or when they first appeared upon the earth.

Happily, in spite of questioning, exacting Science, these first natural and instinctive feelings are not yet dead within us. A knowledge even of all the laws of mountain-making cannot, if our minds are healthy and our hearts beat true, deprive us wholly of that first genuine child-like awe and wonder in presence of noble mountains,—crag and cliff sweeping in rugged and colossal massiveness above dark waves of pine, far into the keen and clear blue air ;—the vast mantle of snow, so cloud-like in its brightness, yet thrown in many a solid fold over crest and shoulder ; the dark spires and splintered peaks, half snow, half stone, rising into the sky, like very pillars of heaven ; and then the verdure of the valleys below, the dash of waterfalls, the plenteous gush of springs, the laugh and dance of brook and river as they one and all hurry down to the plains—who can see these things for the first time, nay, for the hundredth time, without at least some sparkle of the simple child-like emotion of the olden time, or without appreciating, even if he cannot fully share, the feeling of the poet to whom they bring "dim eyes suffused with tears"?

These great dominant features of the land must indeed ever rivet our imagination, and yet when the questioning spirit of modern science asks to know how they came into being, we are no longer permitted to content ourselves with the early belief that they were but parts of the primæval outlines of the earth. The progress of inquiry and knowledge has destroyed that belief. We find, too, that both labour and patience are needed ere we can understand what has been put in its place. But the task of learning this is well repaid. However grandly the mountains rose when they were gazed at only in awe and wonder, they gain an added sublimity when the eyes which look upon them can trace some of the steps whereby their grim magnificence has been achieved.

We naturally associate the more lofty and rugged parts of the land with the operations of former earthquakes and convulsions by which the solid earth has been broken and ridged into these picturesque forms. This obvious inference was early adopted in geology, and though in many cases a mere belief rather than a legitimate deduction from observation, and springing from a conviction of what ought to be, rather than what has been proved to be the case, it has sturdily maintained its hold alike on the popular mind, and also to a very considerable extent in the orthodox geological creed.

Towards the end of last century, however, Hutton and Playfair, names never to be mentioned in Edinburgh without gratitude and pride, proclaimed views of a very different character. They maintained that the rocks of the land, originally accumulated under the sea, have been upheaved by underground movements, and without pretending to know in what external forms these rocks first appeared above the sea, they contended that the present contours of the land had arisen mainly from a process of sculpture,—the valleys having been carved out by rains, streams, and other superficial agents, while the hills were left standing up as ridges between. So satisfied were these bold and clear-sighted men that their idea was essentially true, that they gave themselves no concern in gathering detailed proofs in its support. They were content with general appeals to the face of nature everywhere as their best and irrefragable witness. But, as events proved, they were in advance of their time. The views which they promulgated on this subject were first opposed, then laid aside and forgotten. In the subsequent literature of the science for fully half a century they almost wholly disappear. An occasional reference to them may be met with, where, however, they are cited only to be dismissed, as if the writer seemed hardly able to restrain some expression of his wonder that men could ever have been found so Quixotic as to vent such notions, or that others could have been so gullible as to believe them.

Apart altogether from the truth or error of the Huttonian teaching regarding the origin of the earth's superficial features, no one who has the progress of geology at heart can regard without regret this almost contemptuous dismissal of the question from the range of scientific inquiry. For together with that teaching went all interest in, and even all intelligent appreciation of, the problem which Hutton had set himself to solve. Men turned back to vague notions about cataclysms, earthquakes, subterranean convulsions and fractures, of which they spoke, and sometimes still speak, with a boldness in inverse proportion to their knowledge of the actual conditions of the problem. They studied with praiseworthy assiduity and success the working of the various natural agents whereby the surface of the land is affected, but it was with the view rather of showing how the materials of new continents are gathered together, than of learning how the outlines of existing continents have been produced. The study of the origin of mountain and valley went out of fashion, and from the time of Playfair's Illustrations, published at the beginning of this century, received in this country but scant and haphazard attention until in recent years the subject has gradually revived, and has become one of the most prominent and interesting subjects of geological research.

It is not my purpose to give any historical sketch of the progress of inquiry on this question, although I ought not even to refer to it without an allusion to the names of Scrope, Ramsay, Jukes, Ruskin, Dana, Topley, Whitaker, Greenwood, the Duke of Argyll, Mackintosh, and others, who, though often differing widely in their views, have done so much to renew an interest in what will probably always prove one of the most alluring aspects of geology. Thoroughly convinced of the essential truth on which the Huttonian doctrines were based I wish, on the present occasion, first to define and illustrate some of the leading features of these doctrines as I hold them myself, and as I believe them to be held by the great body of active field geologists in Britain, and secondly, to review certain objections which have recently been reiterated against them.

At the outset it is necessary to ascertain what relation the internal arrangements of the rocks bear to the external forms of the land, in other words, the influence of what is called Geological Structure. It is obvious, as Hutton showed, that since the rocks have been formed as a whole under the sea, they must have been raised out of that original position into land, so that the first point we settle beyond dispute is that the mass of the land owes its existence to upheaval from below. But though we fix securely enough this starting point in our inquiry, it by no means follows that we thereby settle what was the original outline of the land so upheaved. The non-

* The Opening Address for the Session 1873-4 to the Edinburgh Geological Society, delivered Thursday, Nov. 6, by the President, Prof. Geikie, F.R.S.

recognition of this fact has involved not a few of the writers on this subject in great confusion and error.

Among the geologists of the present day there is a growing conviction that upheaval and subsidence are concomitant phenomena, and that viewed broadly they both arise from the effects of the secular cooling and consequent contraction of the mass of the earth. The contraction has not been uniform, as if the globe had been a cooling ball of solid iron. On the contrary, owing to very great differences in the nature and condition of the various parts of our planet and perhaps to features of the interior with which we are yet but imperfectly acquainted, some portions have sunk much more than others. These, having to accommodate themselves into smaller dimensions would undergo vast compression and exert an enormous pressure on the more stable tracts which bounded them. It could not but happen that after long intervals of strain, some portions of the squeezed crust would at length find relief from this pressure by rising to a greater or less height, according to their extent and the amount of force from which they sought to escape. These upraised areas would no doubt tend to occur in bands or lines across the direction of the pressure, much as the folds we produce in the sheets of an unbound book are more or less nearly parallel with the two sides from which we squeeze the paper. They would sometimes be broad folds—huge wide swellings of the earth's surface. At other times they might be long, lofty, and comparatively sharp ridges. In the one case they would give rise to high plateaux or table-lands, in the other they would be recognised as mountain-chains.

This is a rough-and-ready statement of what seems the probable explanation of the origin of the elevated tracts upon the earth's surface. It is evident that the pressure would be vastly greater a few hundreds or thousands of feet underground than at the surface, and hence that though the rocks deep down might be squeezed and crumpled, as we could crumple brown paper, yet that at the surface they might show little or no contortion. Certainly without further proof we could never affirm that a contorted mass of rock which now forms the surface of the ground rose as part of the surface during the time of upheaval and contortion. Intensely crumpled rocks would rather suggest a deeper position, with the subsequent removal of the rocks under which they originally lay.

As the earth has been cooling and contracting ever since it had a separate existence as a planet, its surface must have been exposed to a long series of such shrinkage movements as those we are considering. Apart, therefore, from local evidence, we should expect that ridges and depressions must have been impressed upon that surface in a long succession from the earliest periods downwards, and hence that the present mountain-chains and basins of the earth must be of many different ages. We cannot tell what the first mountains were made of, nor where they lay, although some of the existing ridges of the earth's surface are undoubtedly, even in a geological sense, very old. In not a few cases the same mountain-chain can be shown from its internal structure to be of many successive dates, as if it lay along a line of weakness which had served again and again as a line of relief from the severe earth-pressure.

These questions have been treated with much ability by Constant Prevost, Dana, Mallet, and others, to whose writings I refer for details. In stating them in this general way my object is to show that those geologists who, like myself, believe in the truth of the Huttonian doctrines of denudation, are most unfairly represented when they are said to ignore the influence of subterranean forces upon the exterior of the earth. None can recognise more clearly than they do how entirely have the great surface outlines of the globe been dependent upon the action of these forces, that is, upon the results which flow from the contraction of the planet and from the reaction of the heated interior upon the surface.

But a block of marble is not a statue, nor would a part of the earth's crust heaved up into land form at once such a surface of ridge, and valley, and nicely adjusted water system as any country of which we know anything on the face of the globe. In each case it is a process of sculpture, and the result varies not only with the tools but with the materials on which they are used. You would not expect the same kind of carving upon granite as upon marble. And so, too, in the great process of earth-sculpture, each chief class of rock has its own characteristic style. The tools by which this great work has been done are of the simplest and most everyday order—the air, rain, frost, springs, brooks, rivers, glaciers, icebergs, and the sea. These tools have been at work from the earliest times of which any geological record has been preserved. Indeed, it is out of the accumulated chips and dust which they have made, afterwards hardened into solid rock and upheaved, that the very framework of our continents has been formed. The thickness of these consolidated materials is to be measured, not by feet merely, but by miles. If the removed materials are so thick, they show what a vast mass of rock must have been carved away. And even before knowing anything of the way in which the various tools are used, we should be justified in holding it to be, at the least, extremely improbable that any land surface would long retain its original contour or even any trace of it.

But when we come to watch with attention how the tools really do their work, this improbability increases enormously. Adopting a method of inquiry suggested by Mr. Croll, I have elsewhere shown that even at their present state of progress the amount of geological change which they would accomplish in a comparatively small number of ages is almost incredible. On a moderate computation they would reduce the general mass of the British Islands down to the level of the sea in five or six millions of years, and might carve out valleys a thousand feet deep in a fourth part of that time. It is evident that though the upheaval of some parts of the continents may go back into the remotest geological antiquity, the forms of the present surface must be, comparatively speaking, modern.

There is reason to believe that many, if not most, of the great mountain chains of the globe are, in a geological sense, of recent origin. The Alps, for example, though they may have undergone many earlier movements, were ridged up into their existing mass long after the soft clays were laid down which cover so large an area of the low lands in the south of England, and on which London is built. It would require far more detailed work than has ever been bestowed upon these mountains to enable us even to approximate to what was the original form of the surface just after the upheaval, and before the array of sculpture-tools began their busy and ceaseless task upon these great masses of rock. We may believe that a series of huge parallel folds of curved and broken rock rose for thousands of feet into the air, that when, after the earth-throes had ceased, rain and snow and frost first laid their fingers on the new-born summits, these agents of destruction would have a most uneven surface to work upon, and would necessarily be guided by it in their working; and hence that some, at least, of the dominant earliest ridges and hollows would be perpetuated. Such a belief would cany probability in its favour, but it would certainly not amount to a proof of the supposed perpetuation. That would require to be corroborated by the internal and external evidence of the mountains themselves. In some tracts, as, for instance, among the singularly symmetrical ridges and furrows of the Jura, it would not be difficult to restore the original outline, and to fix exactly how far the subterranean movements had determined the present external forms of the ground,

though even there, where this connection is so clear, we should see at the same time how greatly the tops and sides of the long saddle-shaped arches of rock have suffered from subsequent waste. But among the contorted, inverted, and broken rocks of the Central Alps the task would be infinitely more difficult.

We could not advance far, however, in such a quest before observing that one feature stands out conspicuously enough among the mountains, viz., that whatever might have been their original outlines, these were most certainly not the same as those which we see to-day. No part of the history of the ground can be made more self-evident than that, since the birth of these mountains, millions upon millions of cubic yards of rock have been worn off their crests and ridges, and carved out of their sides. There is not a cliff, crag, or valley along the whole chain of the Alps which does not bear witness to this great truth.

If then, even when dealing with the young Alps, we cannot be quite sure what were their first or infant features, how impossible must it be to decide as to the early outlines of such immensely more ancient uplands as those which date from palæozoic times! For, evidently, the higher their antiquity, and the longer, therefore, their exposure to ceaseless waste, the more must these outlines be changed. The general mass of land might still remain land, but trenched and furrowed and worn down, as the Alps are now suffering, until not a single vestige or indication of its first contour survived, the remaining portions being, as it were, merely the stump or base of what once was.

Now this is the position in which the question presents itself in Britain. The hills of the Highlands and Southern Uplands of Scotland, of the Lake district, and of Wales, are not mountains in the same sense as the Alps or Pyrenees, or other great continental mountain-chains. However much these long lines of elevated ground may have had their outlines modified by the universal waste of the earth's surface, their linear character, the general parallelism of their component ridges, the undulations of the strata along their flanks, as well as their internal geological structure, bear witness to the fact that they are but huge wrinkles upon the shrivelled globe—tracts which have been thrust up while the neighbouring regions have sunk down. But in Britain these characteristic features are wanting. In all probability there never was any true mountain-chain in our region. There is good reason to believe that in very ancient times, that is to say, previous to the Old Red sandstone, a wide plateau-like mass of land was upraised on the north coast of Europe, surviving portions of it being represented by the detached hilly regions of Britain and the great table-land of Scandinavia. The rocks underlying this upheaved tract underwent, at the time of elevation, enormous compression and consequent contortion. This could not happen without an infinite amount of resistance. The heat thus evolved among the grinding masses may have been amply sufficient even to melt them in part. And no doubt it was during this process that they became crystalline over such wide areas, and were injected with granite and other melted products. But all this had been wholly, or almost wholly, completed before the time of the Old Red sandstone, for the deposits of that geological system are formed out of the older altered rocks, and lie undisturbed upon them. Even now, in spite of all the subsequent denudation, the patches of old red conglomerate which remain show to what an extent the older rocks had been buried under it, for they are found rising here and there to a height of 2,000 or 3,000 ft. above the sea. But they prove further, not only that the contortion of the underlying rocks preceded the Old Red sandstone, but that these rocks had suffered a vast extent of waste at the surface, before even the oldest visible parts of the conglomerate were deposited upon them. This waste has been in progress ever since. We need not, therefore, hope to discover any vestige of the aboriginal surface. A geological section drawn across any part of the hills proves beyond question that the general surface of the country has had hundreds or even thousands of feet of solid rock worn away from it. Such a section shows moreover that our present valleys are not mere folds due to underground movements, but are really trenches out of which the solid rock has been carried away.

So far, this is a question of simple fact, and not merely of opinion. The language of Hutton may be literally true of Britain :—"The mountains have been formed by the hollowing out of the valleys, and the valleys have been hollowed out by the attrition of hard materials coming from the mountains." Our British hills, unlike the chains of the Jura and the Alps, are simply irregular ridges depending for their shape and trend upon the directions taken by the separating valleys. The varying textures of the rocks, their arrangements with relation to each other, their foldings and fractures, and the other phenomena comprised under what is termed "geological structure," have greatly modified this result, but the process has nevertheless, as I believe, been one of superficial sculpturing, and not of subterranean commotion and upheaval. On the details of this process it is not needful to dwell.

From these cursory statements, which express, I believe, the general concurrent opinions of the modern Huttonian school, it should be clear how far that school must be from ignoring the influence of subterranean forces. Hutton himself never did so, and his followers now know far more of these forces than he did. But on the other hand, they claim for the surface-agents in geology a potency great enough to cut down table-lands into mountain ridges and glens, to carve out the surface of the land into systems of valleys, and in the end to waste a continent down to the level of the sea.

(*To be continued.*)

ASTRONOMY AT OXFORD

DR. DE LA RUE having, in the course of last summer, made a munificent offer of several astronomical instruments and apparatus, including a large reflecting telescope, to the University, the subject was brought under the consideration of the delegates of the Museum, who, at their first meeting in this term, appointed a committee to "report on the desirability of accepting the munificent offer of Dr. De La Rue to present to the University his celebrated reflecting telescope, on the probable cost of a building to receive the instrument, and on the precise purposes for which this instrument may be usefully employed, in distinction to the refracting telescope now being set up."

The committee, after full and careful examination of the whole subject, have sent in a report, to which they have unanimously agreed, and which the delegates recommended, with entire confidence, to the favourable consideration of the council. In consequence of this report, the following forms of decree will be submitted to a convocation to be held on Thursday, Nov. 27 :—

1. That the reflecting telescope and other apparatus offered to the University by Dr. De La Rue be accepted ; and that the Vice-Chancellor be requested to return the thanks of the University to Dr. De La Rue for his munificent gift. And that the curators of the University chest be authorised to pay to the delegates of the University Museum a sum not exceeding 1,500*l.*, to be expended by them on the erection of buildings in the park suitable for the reception and use of the telescope and other apparatus presented by Dr. De La Rue, as also of the instruments at present in the small observatory on the east side of the museum, according to plans and specifications prepared by Mr. Charles Barry, architect, and adjoining the observatory now nearly completed.

2. That the curators of the University chest be authorised to pay annually to the Savilian Professor of Astronomy during five years, or until provision is made from some other source, the sum of 200*l.* for providing an assistant and defraying the expenses incurred in the maintenance and use of the instruments in the observatory, an account of the expenditure of such sum to be annually submitted to the auditors of accounts.

We cannot doubt that Convocation will sanction a decree which promises to make Oxford first in the field in this country in the power of aiding the new astronomy which is dawning upon us—thanks to the spectroscope and the application of photography.

Such a position may not be thought much of now, but in the coming time Oxford men will refer to it as one of the things of which Oxford has the greatest reason to be proud.

NOTES

The Copley Medal and the two Royal Medals in the gift of the Royal Society, have this year been awarded as follows:—The Copley Medal to Prof. Helmholtz, the distinguished physiologist, physicist and mathematician, of Berlin; a Royal Medal to H. E. Roscoe, F.R.S., Professor of Chemistry in Owens College, Manchester; and a Royal Medal to Dr. Allman, Professor of Biology in the University of Edinburgh.

The Annual Meeting of the Royal Society will be held on December 1, when, after dining together, the Fellows will adjourn to their new apartments.

A deputation from the Council of the Society of Arts had an interview on Friday last with the Royal Commissioners of Scientific Instruction with reference to museums and galleries of science and art. The deputation consisted of Major-General F. Eardley-Wilmot, R.A., F.R.S. (Chairman of the Council), Mr. E. Chadwick, C.B., Colonel Croll, Mr. Hyde Clarke, the Rev. Septimus Hansard, Admiral Ommanney, C.B., F.R.S., Colonel Strange, F.R.S., Mr. Seymour Tewlon, with Mr. Le Neve Foster, Secretary. The Chairman of the Council stated that the object the Council had in view was to bring before, and ask the support of, the Commissioners to the action the society was now taking in reference to museums, and pointed out that this had special regard to the State giving increasing aid to existing museums, to aid in the multiplication of such museums, and rendering them available for educational purposes. He further pointed out the necessity for all such museums being placed under the control of a Cabinet Minister responsible to Parliament. He handed to the Commissioners a copy of resolutions embodying the views of the Council, stating at the same time that a large and influential committee was in the course of formation, and that a considerable number of members of both Houses of Parliament had already given in their names.

The first award of the Grand Walker prize of 1,000 dols. was voted by the Council of the Boston Society of Natural History on October 1, to Alexander Agassiz, of Cambridge, U.S.A., for investigations on the embryology, structure, and geographical distribution of the Radiata, and especially of the Echinoderms, and the publication of the results as embodied in his recent work. The Annual Walker Prize of 60 dols. for 1873 was at the same meeting awarded to A. S. Packard for his essay on the development of the common house-fly. For the Annual Prize of 1874, the subject is "The Comparative Structure of the Limbs of Birds and Reptiles." Memoirs offered for competition must be forwarded on or before April 1, addressed to the Boston Society of Natural History, for the Committee of the Walker prizes, Boston, Mass., U.S.A., and each memoir must be accompanied by a sealed envelope enclosing the author's name, and superscribed by a motto corresponding to one borne on the M.S.

In the examination for Foundation Scholarships at Trinity College, Cambridge, to be held at Easter, 1874, one or more Scholarships will be obtainable by proficiency in the Natural Sciences. The Examination in Natural Science will commence on Friday, April 10, and will include the subjects set forth in the regulations for the Natural Sciences Tripos. It will be open to all undergraduates of Cambridge or Oxford, and to persons not members of the Universities, provided that these last are under twenty years of age. Candidates who are not members of Trinity College must send their names to the Master, together with a certificate of age and good character, on or before Saturday, March 21.

We congratulate the University of Edinburgh on being the first in the United Kingdom to recognise the duty of universities so to frame their regulations for degrees in science as to encourage original work in opposition to mere book-knowledge. The University of Edinburgh has just issued a regulation that every candidate for the degree of Doctor of Science shall in future be required to submit a Thesis containing some original research on the subject of his intended examination, and that such thesis shall be approved before the candidate is allowed to proceed to examination.

Prof. Chevallier, for many years Professor of Mathematics and Astronomy in the University of Durham, died on the 4th inst., at the age of 80 years.

We learn from *Ocean Highways* that Prof. Mohn, of the Meteorological Institute at Christiania, and Mr. O. Sars are preparing a plan for the investigation of the sea between Norway, the Farö Islands, Iceland, and Spitzbergen, the expense of which will, it is expected, be defrayed by a grant of the Norwegian Storthing.

Dr. Rudolphe Wolf has recently published in the *Vierteljahrschrift* of the Zurich Society of Natural Science, the thirty-third number of his *Astronomische Mittheilungen*. The paper is important in reference to sun-spots chiefly, and as bringing out with great clearness the connection of these with variations in declination of the magnetic needle. The author gives a series of daily observations of sun-spots, during 1872, made at Zurich, Peckeloh, Münster, Palermo, and Athens. The mean relative number obtained is 101·7; and for the years 1866–72 inclusive, the series runs thus:—16·3, 7·3 (min. 1867), 37·3, 73·9, 139·1 (max. 1870), 111·2, 101·7. Dr. Wolf has constructed a formula by which the average yearly variations of magnetic declination, in a particular place, may be calculated from the relative sun-spot number (two constants for the place being given). In this way, for example, he obtains for Munich the quantity 10′·80 as representing the magnetic variation for 1872; the number got from observation is 10′·75, showing a close agreement. In the second portion of his paper Dr. Wolf discusses several points connected with the history of the telescope, the vernier, the pendulum clock, &c.; among other things, attributing to Bürgi (who lived in the early part of the sixteenth century), a share in the discovery of the isochronism of the pendulum. The last portion of the paper reproduces some of the earlier sun-spot literature. The same number of *Astronomische Nachrichten* contains a note by M. von Asten, furnishing evidence against the supposed identity of a cometary object observed by Goldschmidt on May 16, 1855, with Tempel's comet. (1867, II.)

The recent meeting of the American Association for the Advancement of Science held at Portland, Maine, was considered on the whole a successful one. 157 papers were entered, and

abstracts were received of all but nine; most of the remainder were passed by the sectional committees for reading, but a number of those that were read were not approved by the committees for publication, an example that might be very usefully followed in the case of our British Association. The general character of the meeting was stated to be decidedly scientific, and the discussions to have been carried on with good feeling, and free from personalities; though complaint was made that less sympathy was exhibited on the part of the citizens with the objects of the Association than at any previous meeting. The next meeting will be held at Hartford, Connecticut, on the second Wednesday in August 1874, when a report will be received from a special committee appointed to revise the constitution of the Association with a view to a better carrying out of its objects. The general officers for the meeting will be Dr. J. L. LeConte, president; Prof. C. S. Lyman, vice-president; Dr. A. C. Hamlin, general secretary; and Mr. J. W. Putnam, permanent secretary.

DR. BEKE writes to the *Times* as follows with respect to Dr. Livingstone:—"If the intelligence from the West Coast of Africa is to be depended on, we may very shortly expect the return of our great traveller, Dr. Livingstone, to his native country On the 1st and 4th inst. you inserted communications from me, to the effect that our countryman was detained a prisoner at a place about 300 miles from Embomma, on the Congo. According to the news brought by the last African Royal mail steamer, it was reported at St. Salvador that Livingstone was then in the interior, about 30 or 40 miles from that place. Now, as St. Salvador is only 80 miles from Embomma, the distance to the latter town from the spot at which, according to the later intelligence, our adventurous countryman was, is not more than 120 miles; and, Embomma being 70 miles from the mouth of the Congo, he would have been within 200 miles of the coast. As the hardy and energetic traveller is not in the habit of letting the grass grow under his feet, he may well be supposed to have come on nearly, if not quite, as quickly as the natives who brought the news of his whereabouts. Consequently, on the assumption that the intelligence received is founded on truth, we may not unreasonably look for the veteran traveller's arrival in England by the next mail steamer from the West Coast of Africa."

WE learn from the Journal of the Society of Arts, that one of the first results in the rise of the price of coal has been the formation of a company in France, whose object is to utilise the power of the ocean tides on the French coast by proper machinery. The first experiment is to be made at St. Malo, where the tide rises nearly 80 ft., and overflows many square miles of flats.

DR. GEORGE BURROWS, F.R.S., has been appointed one of the Physicians-in-Ordinary to Her Majesty, in the room of the late Sir Henry Holland.

AT a meeting of the Trustees of the Hunterian Collection of the College of Surgeons, held on Saturday, 8th inst., George Busk, F.R.S., was elected a member of the board, to fill the vacancy occasioned by the death of the Bishop of Winchester.

DR. LYON PLAYFAIR, C.B., F.R.S., M.P. for the Universities of St. Andrews and Edinburgh, has been appointed Postmaster-General in succession to Mr. Monsell. Dr. Playfair was a pupil of Liebig, was formerly Professor of Chemistry in the University of Edinburgh, and was at one time Government Inspector-General of Schools and Museums of Science and Art. We hope the new Postmaster-General will endeavour to introduce something like scientific method into the postal department.

THE promoters of the railway tunnel which is intended to cross the Mersey, the shafts for which have already been sunk, have always believed that they would have only a continuous mass of solid sandstone rock to penetrate. A paper has just been published in the transactions of the Liverpool Geological Society for 1872, by Mr. T. Mellard Reade, C.E., of Liverpool, in which he contends that in all probability a deep gorge, filled up with clay or sand, will be met with, being the site of an ancient river or torrent formed in or before the times when England was covered with ice, and when its valleys were filled with glaciers. Mr. Reade believes that the ascertained data warrant the hypothesis, that before the boulder clays and other recent strata were laid down, a river draining the land now drained by the Mersey flowed past Runcorn Gap, between land of some considerable elevation, to the sea.

WE have received, in the form of a neat little pamphlet of 20 pp., price only one penny, an exceedingly interesting lecture on "How Flowers are Fertilised," delivered by Mr. A. W. Bennett, F.L.S., at Manchester, on the 5th inst. It is one of a series of Science-Lectures for the People, published after delivery by Mr. Heywood of Manchester; they are carefully and neatly printed, and judging from the one before us, purchasers have a very good pennyworth indeed. The enterprise is very creditable to the publisher.

AMONG the papers presented to Parliament, says the *Times*, relating to the South Sea Islanders, is a report by Captain C. H. Simpson, of Her Majesty's ship *Blanche*, giving an account of his visit last year to the Solomons and other groups of islands in the Pacific Ocean. While at Isabel Island, Captain Simpson, with a party of officers, went a short distance inland to visit one of the remarkable tree villages peculiar, he believes, to this island. He found the village built on the summit of a rocky mountain rising almost perpendicular to a height of 800 ft. The party ascended by a native path from the interior, and found the extreme summit a mass of enormous rocks standing up like a castle, among which grow the gigantic trees, in the branches of which the houses of the natives are built. The stems of these trees lie perfectly straight and smooth, without a branch, to a height varying from 50 ft. to 150 ft. In the one Captain Simpson ascended the house was just 80 ft. from the ground; one close to it was about 120 ft. The only means of approach to these houses is by a ladder made of a creeper, suspended from a post within the house, and which, of course, can be hauled up at will. The houses are most ingeniously built, and are very firm and strong. Each house will contain from ten to twelve natives, and an ample store of stones is kept, which they throw both with slings and with the hand with great force and precision. At the foot of each of these trees is another hut, in which the family usually reside, the tree-house being only resorted to at night and during times of expected danger. In fact, however, they are never safe from surprise, notwithstanding all their precautions, as the great object in life among the people is to get each other's heads.

THE additions to the Zoological Society's collection during the past week include an Alligator Terrapin (*Chelydra serpentina*) from North America, presented by the Smithsonian Institution of Washington; a large Hill Mynah (*Gracula intermedia*) from North India, presented by Rev. T. Main; twelve Gray's Terrapins (*Clemmys grayi*) from Bussorah, presented by Captain Phillips; a Changeable Tree Frog (*Hyla versicolor*) from North America, presented by Prof. Rolleston; a Ground Rat (*Aulacodus swinderianus*) from West Africa; a Sharp-nosed Badger (*Meles leptorhynchus*) from China; a Telerang Squirrel (*Sciurus bicolor*) from the East Indies; two Mantchurian Crossaptilons (*Crossaptilon mantchuricum*) from North China, and two Blue-rowned Hanging Parrakeets (*Loriculus galgulus*) from Malacca, purchased; an Agile Gibbon (*Hylobates agilis*) from Sumatra, deposited.

SCIENTIFIC SERIALS

THE November number of the *Monthly Microscopical Journal* commences with a paper by Dr. R. L. Maddox on an organism found in Fresh-pond Water, which he thinks to be new. The accompanying illustration, as well as the description, shows that the monads under consideration are of the simplest structure, and amœboid in character, of a violet tint, and highly refracting. They vary in size, and contain great numbers of little granular bodies embedded in the gelatinous matrix. The name *Pseudo-amœba violacea* is proposed for the new form.—Mr. F. Kitton describes some new species of Diatomaceæ, including *Aulacodiscus superbus* from Barbadoes, and others of the genera *Stictodiscus*, *Isthmia*, *Nitzschia*, and *Tryblionella*.—Mr. Carruthers answers Dr. Dawson's comments on his interpretation of the microscopic appearances of *Nematophycus* (Carruthers) or *Protolaxites* (Dawson). As he remarks, the question whether the plant under consideration is a sea-weed or a conifer, is entirely an histological one. Dr. Dawson, in his sections of the fossil found "wood cells, showing spiral fibres and obscure pores;" Mr. Carruthers finds "elongated cylindrical cells of two sizes, interwoven irregularly into a felted mass," and the latter observer substantiates the correctness of his observations and his drawings, which prove the accuracy of his views as to the affinities of the plant.—Mr. J. J. Woodward explains the optical principles involved in the construction of Mr. Tolles' new immersion objective that has caused the contest between him and Mr. Wenham.—Dr. Braithwaite continues his description of bog mosses, treating of figuring *Sphagnum rigidum* and *S. molle*.—This paper is followed by one on the investigation of Microscopic Forms by means of the images which they furnish of external objects, by Prof. O. N. Rood, of Troy, N.Y., which gives an extremely ingenious and simple method of testing with certainty, when the refractive indices of the body examined and the fluid in which it is immersed, are known, of determining whether markings, as of *Coscinodiscus triceratium*, are depressions or elevations; by regarding the object as part of the optical system, and thence finding whether its influence is that of a convex or concave lense.

SOCIETIES AND ACADEMIES

LONDON

Geological Society, Nov. 5.—Prof. Ramsay, F.R.S., vice-president, in the chair.—The following communications were read:—"On the Skull of a species of *Halitherium* from the Red Crag of Suffolk," by Prof. W. H. Flower, F.R.S. A description of this has been already given in NATURE, at p. 13 of the present volume.—"New Facts bearing on the Inquiry concerning Forms intermediate between Birds and Reptiles," by Henry Woodward, F.R.S. The author, after giving a brief sketch of the Sauropsida, and referring especially to those points in which the Pterosaurians approach and differ from birds, spoke of the fossil birds and land reptiles which he considered to link together more closely the Sauropsida as a class. The most remarkable recent discoveries of fossil birds are:—(I.) *Archæopteryx macrura* (Owen), (II.) *Ichthyornis dispar* (Marsh), (III.) *Odontopteryx toliapica* (Owen). The author then referred to the Dinosauria, some of which he considered to present points of structure tending towards the so-called wingless birds. (I.) *Compsognathus longipes* (A. Wagner), from the Oolite of Solenhofen. (II.) The huge carnivorous *Megalosaurus*, ranging from the Lias to the Wealden. The author next drew attention to the Frilled Lizard of Australia, *Chlamydosaurus Kingii* (Gray), which has its fore limbs very much smaller than the hind limbs, and has been observed not only to sit up occasionally, but to run habitually upon the ground on its hind legs, its fore paws not touching the earth, which upright carriage necessitates special modifications of the sacrum and pelvis bones. The Solenhofen Limestone, in which Pterosauria are frequent, and which has yielded the remains of *Archæopteryx* and of *Compsognathus*, has also furnished a slab bearing a bipedal track, resembling what might be produced by *Chlamydosaurus* or *Compsognathus*. It shows a median track formed by the tail in being drawn along the ground; on each side of this the hind feet with outspread toes leave their mark, while the fore feet just touch the ground, leaving dot-like impressions nearer the median line. Hence the author thought that while some of the bipedal tracks which are met with from the Trias upwards may be the "spoor" of struthious birds, most of them are due to the bipedal progression of the Secondary Reptiles.—"Note on the Astragalus of *Iguanodon Mantelli*," by J. W. Hulke, F.R.S. The author exhibited and described an astragalus of *Iguanodon* from the collection of E. P. Wilkins. The bone was believed to be previously unknown. The upper surface presents a form exactly adapted to that of the distal end of the tibia, so that the applied surfaces of the astragalus and tibia must have interlocked in such a manner as to have precluded all motion between them. The author remarked upon the interest attaching to this fact in connection with the question of the relationship between the Dinosauria and Birds.—"Note on a very large Saurian Limb-bone, adapted for progression upon land, from the Kimmeridge Clay of Weymouth, Dorset," by J. W. Hulke, F.R.S. The bone described by the author presents a closer resemblance to the Crocodilian type of humerus than to any other bone, and he regarded it as the left humerus of the animal to which it belonged. The author refers it provisionally to a species of *Ceteosaurus*, which he proposes to name *C. humero-cristatus*.—A despatch from Mr. Alfred Biliotti, British Vice-Consul at Rhodes (dated June 16, 1873), communicated by H.M. Secretary of State for Foreign Affairs, and relating to a volcanic outburst in the island of Nissiros, one of the Sporades, in which there existed a volcano supposed to be extinct. Shortly before June 10 new craters opened in this volcano, and from them ashes, stones, and lava were ejected; many fissures, from which hot water flowed, were produced in the mountain, and the island was daily shaken by violent earthquakes.

Royal Astronomical Society, Nov. 14.—Prof. Cayley, president, in the chair. Sir Geo. B. Airy, the Astronomer-Royal, explained the general state of the preparations for the transit of Venus. First, as to the selection of stations. He had originally selected five observing-stations, and in making his choice he had endeavoured to keep in mind what other Governments were likely to do. He had been induced to recommend another station in Northern India for the purpose of taking a series of photographic observations to be used in conjunction with the photographic records to be obtained at the southern stations. As the French would not support the station which he had selected in the Sandwich Islands, by an expedition to the Marquesas Islands, he had found it necessary to recommend to our own Government that there should be two subsidiary observing stations in the Sandwich Islands. The station which had originally been chosen was Honolooloo, at about the middle of the islands; the new stations were to be Ha-wai-i to the east and an island at the western extremity of the group. The three stations would thus be distributed over a distance of some 300 miles—a fact which would greatly add to their chances of fine weather. He had also been considering the propriety of establishing stations at Christmas Island, at Hurd Island, and in Whisky Bay, but at present they knew little of the chances of anchorage or fine weather at these places. The *Challenger* was, however, about to visit and survey them. It would then proceed to Australia, whence the results of their investigations would no doubt be telegraphed to England. As to the selection of stations in the extreme south, the Admiralty would have nothing to do with any station where there was no anchorage, and where there were no human beings. Any station which laboured under both disqualifications must undoubtedly be rejected as unsuitable. He felt himself borne out in this determination by the fact that other nations had adopted the same practical view in their selection of stations. The Astronomer Royal then enumerated and pointed out upon a globe the stations which had been selected: 8 American, 5 French, 4 German, 19 Russian, and 8 English, besides the private enterprise of Lord Lindsay. He then proceeded to give a description of the now well-known "black drop," which was sometimes described as being so large as to make Venus appear "pear-shaped," at other times the illegitimate connection between Venus and the limb consisted only of a narrow black strap or band. The Astronomer-Royal had had a working model prepared at Greenwich with a black disc moved by clock-work. The black ligament, or drop, came out as a very marked feature of the contact with the artificial limb. And he hoped that Capt. Tupman would be able, from a discussion of the observations of different observers with different telescopes, to determine in what proportion the phenomenon was due to the aperture of the telescope used, and to what he might call the personal equation of the observer. He then proceeded to explain how when Venus was upon the sun's limb measures are to be made of the

common chord of Venus and the limb, and how these measures are affected by the formation of a "black drop" between the two images.—Lord Lindsay then showed some photographs of a model of Venus upon the limb, in which the "black drop" was photographed as a remarkable feature. He pointed out that when the exposure was longest the "black drop" was most marked; and he showed that its size might be greatly reduced by using a stop which only permitted the rays from the central parts of the lenses to reach the plate. Dr. De La Rue said it was quite wonderful to see the amount of preparations which were going forward at Greenwich. It was not right to throw out such insinuations as Mr. Proctor had done about "official obstructiveness." Mr. Proctor's last paper in the *Monthly Notices* was a disgrace to the Society. In former days such papers never appeared.—A paper was read by Mr. Lassell on the finding of longitude with small instruments.—Mr. Ranyard then read a note upon a remarkable spot observed by Pastorff upon the sun's disc of May 26, 1828. In June 1819 Pastorff observed a nebulous spot with a bright nucleus upon the sun, which has since been recognised as being the comet of 1819 projected upon the bright background of the photosphere. The drawing referred to by Mr. Ranyard contained a similar though smaller nebulous marking, with a bright centre. His object in bringing the drawing to the notice of the society was to inquire whether any small comet or known meteoric stream was between the earth and the sun on May 26, 1828.

Anthropological Institute, Nov. 11.—Prof. Busk, F.R.S., president, in the chair.—Mr. T. J. Hutchinson, F.R.G.S., H.M.'s consul at Callao, read a paper on "Explorations amongst ancient burial grounds, chiefly on the sea-coast valleys, of Peru," Part I. The object of the paper was to describe the "huacas" or burial-grounds, especially those lying beweent Arica and the Huatica Valley, and to expose some popular errors respecting them. Every bit of old wall, every heap of gravel, mound of earth, large or small cluster of ancient ruins of any kind is there called a "huaca." The term huaca (Quichua) is synonymous with Quilpa (Aymara) and means "sacred;" the title may therefore be considered as much applicable to the burying-grounds of Ancon, Pasamayo, and other places where there is no elevation above the country, as to those of Pando and Ocharán, large burial mounds in the valley of Huatica The author proceeded to describe in detail the mode of interment and the various articles discovered. The celebrated Pacha-Cámac was described. Along the whole course of the Huatica Valley—from Callao to Chorillos—a distance of ten miles direct or sixteen miles round by Lima, there is no natural elevation that could be made available as a sub-structure for those colossal burial mounds. He gave at considerable length his reasons for concluding that there was no "Temple of the Sun" and no "House of the Virgins" of the Inca religion, and that every huaca was not a "Huaca de los Incas."—Dr. Simms, of New York, gave a most interesting and instructive communication on a flattened skull from Mameluke Island, Columbia River, and described minutely the practice of flattening the head in infancy. In reply to questions put to him, he said that the flattening does not seem to cause pain; that males and females are treated alike, although it had been supposed only males were so treated; that flattening is not apparently transmitted from parents to children; and that, judging from the general intelligence of the native Indians, the practice does not seem in any way to affect the brain or injure the health of the people.

Manchester

Literary and Philosophical Society, October 7.—Edward Schunck, F.R.S., vice-president, in the chair. W. Boyd Dawkins, F.R.S., exhibited a fragment of a post struck by lightning on June 2, 1873. It was completely shattered, fragments being driven as far as the walls of the house, twenty-five yards off, and the downward direction of the loose splinters implied that the explosive force was exerted from below upwards, instead of from above downwards. Mr. Baxendell thought it was most probably due to the sudden conversion of a portion of the moisture in the post into steam of high tension by the heating action of the electrical discharge, and mentioned instances in which condensed vapour was said to have been seen rising from trees immediately after they had been struck by lightning.—"On the Relative Work spent in Friction in giving Rotation to shot from Guns rifled with an increasing, and a uniform twist," by Osborne Reynolds, M.A., Professor of Engineering, Owens College, Manchester, and Fellow of Queen's College, Cambridge. The object of this paper was to show that the friction between the studs and the grooves necessary to give rotation to the shot consumes more work with an increasing than with a uniform twist; and that in the case of grooves which develop into parabolas, such as those used in the Woolwich guns, the waste from this cause is double what it would be if the twist was uniform. The following conclusions were arrived at by Prof. Reynolds:—

1. That when the pressure of the powder is constant,

$$\frac{\text{Work spent in friction with parabolic grooves}}{\text{Work spent in friction with plane grooves} \ldots} = \frac{3}{2}$$

2. That when the pressure diminishes rapidly the above ratio = 2.

3. That this ratio may have any values between these two, but that it cannot go beyond these limits.

Paris

Academy of Sciences, November 10.—M. de Quatrefages, president, in the chair.—The following papers were read:—An examination of the law proposed by Herr Helmholtz for the representation of the action of two elements in a current, by M. J. Bertrand.—Remarks on an historical point in relation to animal heat, by M. Berthelot.—On the foundation of a meteorological observatory at the foot of the peak Du Midi by the Ramond Society, by M. Ch. Sainte-Claire Deville.—An extract from a letter from M. de Lesseps to Lord Granville on the projected Central Asian Railway. In the letter M. de Lesseps argued against the supposed danger of a Russian invasion of India, and expressed a hope that the Viceroy would permit his son and Mr. Stuart to commence their surveys.—On the structure of the teeth of the *Helodermata* and *Ophidians*, by M. P. Gervais.—Memoir on the problem of three bodies, by M. E. Mathieu.—Note on magnetism, by M. J. M. Gaugain. This formed the fifth of the author's notes on this subject.—Researches on the absorption of ammonia by saline solutions, by M. Raoult. The author stated that the difference between the coefficient of solubility of this gas in pure water and in saline solutions of the same salt is proportional to the weight of the salt dissolved in a given volume.—On the transpiration of water by plants in air and in carbonic anhydride, by M. A. Barthelémy.—New researches on the upward transport of nourishment by the bark of plants, by M. Faivre.—On the development of swellings on the rootlets of the vine, by M. Max. Cornu.—On certain cases of intermittence of the electric current, by M. A. Cazin.—On a process for finding the nodes of a sonorous tube, by M. Bourbouze.—On the presence and estimation of titanium and vanadium in the basalts of Clermont-Ferraud, by M. G. Roussel.—A method of estimating sugar by means of iron, by M. E. Riffard.—Certain facts relating to the development of bony tissue, by M. Ranvier.—On the *Pemphigus* of *Pistacia terebinthus* compared with the *Phylloxera quercûs*, by M. Derbès.—On a new kind of fossil Lemur recently found in the Quercy deposits of tricalcic phosphate, by M. Filhol.—On the influence of the moon on meteorological phenomena, by M. E. Marchand.—On a method for the determination of the direction and force of the wind; abolition of weathercocks, by M. H. Tarry.

CONTENTS

THURSDAY, NOVEMBER 27, 1873

THE SOUTHERN UPLANDS OF SCOTLAND *

II.

THE next member of the series of rocks making up the upper Llandeilo series in the Southern Uplands has received from the officers of the Scotch Geological Survey the name of the Lowther group. In its typical area, which is in the N.W. of Dumfriesshire, this group is composed of "fine grey shales and finely laminated felspathic greywackes with occasional grit beds." The estimated thickness of this group amounts to 5,000 feet. It is seen overlying the Haggis rock group in the streams which drain the upper portion of the Lowther hills; with the underlying Haggis Rock group it forms a synclinal trough in which the Lowther hills are contained.

In Wigtonshire the Lowther group rests upon the Dalveen group. The strata here generally correspond with those of Dumfriesshire, but shales are less abundant, and flagstones and grit with shale bands become more developed. In this county, however, the proportion of the fine and coarse rocks of this group varies in different localities. The rocks of the Lowther group in Wigtonshire are best exposed on the shores of the Irish Channel. Here between Morroch Bay and Knockienausk Head, cliffs are seen from 100 to 300 feet high composed of strata often very twisted and broken, belonging to the Lowther group; and in the higher portion of this group, where the flags are well developed, they have been worked for roofing and flooring purposes.

Above the Lowther group, and forming the highest member of the Upper Llandeilo series, as these occur in the Southern Uplands, are strata composed of grey shales with bands of fine-grained blue greywacke and flinty mudstones. Numerous bands of dark anthracitic shales with graptolites interstratify these rocks. These strata, with their associated anthracitic beds, have received the name of the "Upper Black Shale Group." Their estimated thickness is about 3,400 feet. This Upper Black Shale group occurs near the northern limits of the Upper Llandeilo rocks, and is more abundantly developed in Lanarkshire than in Dumfriesshire.

The Upper Black Shale group, in its typical area, has yielded the officers of the Geological Survey a rich graptolitic fauna, no less than 27 species having been obtained from this series of rocks. These species bear a very close resemblance to such as occur in the Moffat Shales, a horizon much below the Upper Black Shale group in position. Two Brachiopods have also been found in connection with these Upper Black Shales, viz., *Siphonotreta micula*, a form also occurring in the Moffat Shales, and likewise in the Upper Llandeilo rocks of Wales, especially in the neighbourhood of Builth; and a *Discina* which has not yet been specially recognised.

The Upper Black Shales group, following the persistent strike of the Upper Llandeilo rocks of the Southern Uplands of Scotland, makes its appearance in Wigtonshire. Two bands of this group lying in a synclinal trough traverse the portion of Wigtonshire contained in Sheet 3. One of these bands is well seen in Morroch Bay, about a mile and a half south-east of Port Patrick. The other appears south-west of Stranraer, and crossing the moors to the north-east, is seen in the bed of the Luce below Cairnarzean. In Morroch Bay the Upper Black Shale group exhibits a threefold petrological nature. The higher beds consist of thin black shales, having in them lenticular masses and seams of coarse clay, ironstone, and nodular layers of greywacke and pyritous kernals. The strata here are much crumpled, and intrusive masses and veins of felstone have invaded them. It is in this upper portion of the group that graptolites occur, but the number of species obtained from these strata is considerably under what have been found in the Upper Black Shale group of Lanarkshire.

The representatives of the Upper Llandeilo rocks in the Southern Uplands of Scotland attain to a very great thickness. Of the lower portion of the series, the Ardwell group, the Lower or Moffat Black shale group, the Queenberry grit group, the Hartfell group, and the Daer group, the officers of the Geological Survey have not given their thickness in Dumfriesshire. Of the other four groups, the Dalveen, the Haggis Rock, the Lowther and the Upper Black Shales, these have an estimated thickness of 13,000 ft. If to this amount be added the five groups below, we have a development of Upper Llandeilo strata in the south of Scotland which must amount to nearly 20,000 ft. This great thickness of strata much exceeds the same series of rocks developed elsewhere in the British Isles.

The Upper Llandeilo rocks of the Southern Uplands of Scotland have a greater uniformity in their mineral nature than is usually common to the series. Greywacke in the form of shales, sandstones, grit, and conglomerates, having in some of their sub-divisions black shales containing graptolites, constitute this great thickness of sedimentary rocks. There is an absence of limestone strata, only nodules occurring occasionally, and the calcareous flags which are so characteristic of this portion of the Lower Silurian in its typical area Llandeilo, have no representatives in the South of Scotland. The rocks in this district have been originally greyish and reddish muds, grey and purple sands, and pebble-beds, with occasionally dark carbonaceous muds, which may have derived their black colour either from decaying sea-weeds or decomposing Hydrozoa. The presence of carbonate of lime seems to have been very rare in the Upper Llandeilo seas of the areas which are now recognised as the Southern Uplands, during the deposition of their strata, and to this great absence of carbonate of lime we may probably attribute the absence of some of the fossils which are so abundant in Wales in this series of rocks. Graptolites are essentially the characteristic fossils of the Upper Llandeilo of the Southern Uplands. The same species seem to run through whole strata from the Moffat Shales to the highest member of the series, having a range of probably 18,000 ft.; and many of these forms of graptolites are common alike to the Upper Llandeilo rocks of Wales and Scotland.

The case is, however, very different when we come to compare the crustacea of the two regions. In Scotland the Upper Llandeilo crustaceans are very few, and almost confined to Phyllopods, being *Peltocaris Harknessi*, *P. aptychoides*, and *Disinocaris Brownii*, while in Wales we have a considerable development of trilobitic life. Of the

* Continued from p. 24.

latter only one specimen, in the form of a tail, has yet been obtained from the Upper Llandeilo strata of the South of Scotland; and this specimen is too imperfect to admit of its being specifically determined. With reference to molluscs, these are nearly equally rare in the Southern Uplands. Only two Brachiopods have hitherto been recognised, while many forms appertaining to several genera have been obtained from the Welsh Upper Llandeilo strata. Notwithstanding the paucity of varied forms of organic remains in the Upper Llandeilo rocks of the Southern Uplands, their rich graptolitic fauna is at once indicative of their age, and the absence of other forms is most probably referable to want of calcareous strata in connection with these deposits.

The labours of the officers of the Geological Survey among the highly contorted and crumpled rocks of the Southern Uplands have afforded further information, were such required, of the causes from whence *cleavage* results. In a country so subject to flexures and contortions, where anticlinal axes and synclinal folds have been inverted, we should naturally look for abundant evidence of the superinduced structures from which true slates have derived their origin. The great mass of the Upper Llandeilo rocks of the South of Scotland rarely furnishes anything in the form of slates proper; and when we consider the nature of these rocks, which consist for the most part of greywacke sandstones and grits, we cannot fail to discover that the cause of the general absence of cleavage from these rocks has arisen from their petrological nature. The officers of the Survey have, however, in several instances, pointed out the recurrence of cleavage among the finer shales; and this occurrence usually accompanies violent contortions of the strata.

Although rocks of an Upper Llandeilo age enter so largely into the composition of the Southern Uplands, they are not the exclusive representatives of the Lower Silurian rocks in this area; above the Upper Llandeilo strata rocks referable to the Bala or Caradoc age occur. These Caradoc rocks, which occupy a very small area when contrasted with the Upper Llandeilo strata, are marked in the Southern Uplands by a feature which is unknown to their occurrence elsewhere. They are *unconformable* to the underlying Upper Llandeilo beds, a circumstance which Prof. Geikie well describes as "a new feature in the geology of Britain." The Caradoc rocks have not been recognised in Wigtonshire. They are described in connection with Sheet 15. They occur in a trough extending from Wedder Dod N.E. at least as far as the hills on the right bank of the Clyde, below Abington in Lanarkshire.

Here they are seen as greywackes, "passing on the one hand into a crumbling sandstone, and on the other into pebbly grits, with shale partings and with beds of conglomerate found chiefly at their base." In one spot a little concretionary limestone is seen, "the only example of limestone met with in the Lower Silurian rocks in Sheet 15." This limestone has afforded no fossils, but the conglomerates and the pebbly and gritty beds higher up in the series are abundantly fossiliferous. Denudation has probably removed some higher beds from this group. Its total thickness amounts to about 1,700 feet.

From the Caradoc rocks of the Lead Hills the geological surveyors have obtained a good series of fossils. We miss from their list the whole of the graptolites so abundant in and so characteristic of the Upper Llandeilo strata. In their place we have corals, trilobites, many forms of brachiopods, two lamellibranchiates, several gasteropods, and an arthorceras. Most of the species are characteristic Caradoc forms; but they have associated with them some which occur also in the Llandovery series.

The Southern Uplands of Scotland have other members of the great Silurian series besides those which have been referred to. These occur along a portion of the south-east flanks of the range, and consist of rocks having a general resemblance to the greywacke strata which form so large a part of the Upper Llandeilo rocks in the South of Scotland. The newer Silurian strata occurring on the south-east margin have, however, a very distinct series of fossils; and associated with their shales are found calcareous concretions frequently affording organic remains; the greywackes flaggy beds also in this higher group often contain fossils, especially graptolites. These graptolites belong to species occupying a much higher horizon than the forms which make their appearance in the Upper Llandeilo rocks; and the organic remains derived from the calcareous nodules also indicate strata higher in position than the Caradoc series. The rocks of an Upper Silurian age are well developed on the shores of the Stewarty of Kirkcudbright, especially on the eastern side of the mouth of the Dee. They occur also in Dumfriesshire, being seen near the southern margin of the Silurians at Dalton Mill, in the parish of Dalton, where the flaggy strata yield the same forms of graptolites which occur near the mouth of the Dee; and they have been extensively recognised in Roxburghshire.

As contrasted with the nearest area where Silurian rocks occur in England, the strata and the organic remains of the Southern Uplands of Scotland show great dissimilarity.

The distance of the nearest portion of the area where Silurian rocks are seen in England from the south-east side of the South of Scotland strata of the same series does not exceed 30 miles; for the northern flank of the Caldbeck range in Cumberland is not greater than this, in distance from the axis of the Lower Silurian rocks in Dumfriesshire where the Ardwell group occurs.

The Lake district of the north of England, occupied principally by Silurian rocks, exhibits strata of a lower position than any of the Silurian deposits of the Southern Uplands. These lower rocks of the Lake district are the Skiddaw slates of Prof. Sedgwick, which in many localities contain graptolites.

The facies of this graptolitic fauna is, however, widely different from that of the graptolitic fauna of the Upper Llandeilo rocks of the south of Scotland. In the Lake district there are no strata which can be paralleled with the Upper Llandeilo rocks. Above the Skiddaw slates of the north-west of England there occur great accumulations of igneous rocks in the form of traps, ashes, traptuffs and similar volcanic products. And it is only when the highest of these rocks is reached, which appear to have resulted from sub-aërial volcanic action, that strata occur in which organic remains are met with.

These strata, the Coniston limestones and their associated shales, are prolific in fossils of a nature indicative of the Caradoc age.

It is difficult to conceive how all traces of the vast igneous action which occurred within the distance of 30 miles from the Scottish Silurian area should be absent from the rocks of the Southern Uplands. The unconformability of the Caradoc deposits on the Upper Llandeilo strata in the Southern Uplands may perhaps afford some clue to this difficulty. The Skiddaw slates were probably ancient land in the area now occupied by the Lake district during the period of the deposition of the Upper Llandeilo rocks of the south of Scotland. This ancient land seems to have been subject to violent sub-aërial volcanic action, being the earlier epoch of the Caradoc series. During the later portion of the same epoch this violent volcanic action ceased, the area covered with igneous products again subsided beneath the sea, and allowed of the accumulation of the materials of the Coniston limestone and the succeeding groups.

In the Southern Uplands of Scotland the well-marked break recognised by the officers of the Survey points to a lapse of time between the deposition of the highest of the Upper Llandeilo groups and the conglomerates at the base of the Caradoc rocks. It is probably during this lapse of time that volcanic action was so rife on the other side of what is now the Solway Firth. This lapse of time is still further indicated by the comparative small development of the Caradoc rocks of the South of Scotland, as contrasted with those of the typical Caradoc areas of Shropshire and Wales, and also by their fossil contents, which indicate that only a portion of the group is represented in this area, and that this portion appertains to the upper part of the series.

From what has been said it will be apparent that the labours of the officers of the Geological Survey of Scotland have put us in possession of most important information concerning the very difficult series of rocks making up the strata of the bulk of the Southern Uplands. There are other matters amply detailed in the "Explanatory Memoirs" such as the metamorphism which the Silurian rocks have in some places undergone, and the intrusive rocks which are associated with them. The Old Red Sandstones as laid down in Sheet 15 are fully described. The important carboniferous areas of New Cumnock and Guelt, of Lugar and Muirkirk, and of Glespin or Douglas Water, with their thin limestone and low coal, are largely detailed. In relation to Dumfriesshire, the Sanquhar coal-field, made up of strata belonging to the true coal measures, and the carboniferous rocks which underlie it are also fully described. The Permian rocks of a portion of the Nith basin, having porphyries in different beds at their base, and brick-red sandstones with trapean detritus forming their upper portion, and also rocks of the same age occurring on the shore near Corsewall House, Wightonshire, are subjects treated of in the Memoirs. Igneous rocks of an age posterior to the Permian are also referred to. Superficial deposits in the condition of drift sands, and gravels, brick clays, and erratic blocks, also still more recent products in the form of raised sea beaches, blown sands, peat and alluvium are fully alluded to. Finally the explanations afford information concerning the economic minerals of the several districts, the whole containing a record of an amount of careful observations and inferences such as could only have been arrived at by the labour and experience of such a staff of officers as that which constitutes the Geological Survey.

ROBERT HARKNESS

LEYBOLD'S EXCURSION TO THE ARGENTINE PAMPAS

Escursion a las Pampas Arjentinas: hojas de mi diario: Febrero de 1871*: Seguido de tablas de observaciones barométricas, un boceto de la ruta tornada.* Por Federico Leybold. 8vo, pp. 108. (Santiago, 1873.)

THE publication of a book relating to Natural History in Chili is a rare event, and therefore well worthy of record. Except Philippi and Landbeck's "Catalago de las Aves Chilenas," and some few papers by the same authors in the "Anales" of the University of Santiago, the present is almost the first that has come before our notice. And these, it must be recollected, are not the productions of native Chilians, but of members of the all-pervading Teutonic race, who have brought their science with them from their distant fatherland.

Herr Leybold, or Don Federico Leybold, as we suppose we must call him, for he writes in Spanish, has been long resident in Santiago, and active in investigating every branch of Natural History in his adopted country. During the last few years, as he tells us in the introductory chapter of the present work, he has sent six expeditions over the Andes to explore the natural riches of the "Argentine Tempe," and finally in the month of February of 1871 was able to make arrangements to proceed himself upon a collecting tour into the same district. The route taken from Santiago was up the valley of the Maipo, to the junction with it of the "Valle del Yeso," and thence up this northern branch to the foot of the "Portillo de los Piuquenes," where the watershed was crossed. But a second and more elevated pass—the "Portillo Mendocino"—succeeds on this route over the main chain, which is, we believe, that usually taken to Mendoza. From the summit the descent was made over the elevated eastern slopes of the Mendozan Andes to an estancia called Vistaflores, situated at the foot of the range, which was made the headquarters of the party while they explored the surrounding country. Rainy weather and drunken servants much hindered operations during the stay at this place, which appears only to have lasted about a week, when it was determined to return to Santiago by the more southern "Paso del Diamante." This pass leads under the volcano of Maipo into the main valley of the Maipo, and thus enabled the travellers to join their former route after about a week's difficult and occasionally dangerous travel amid the snows and storms of the higher Andes.

Herr Leybold's diary of this interesting month's excursion is replete with notes and observations in every branch of Natural History—Zoology, Botany, and Geology. Birds, beetles, and plants appear to have engaged his chief attention—but other objects are not passed unnoticed. Not only are frequent references given to known species observed in the Andes and on the adjacent districts of the Argentine Republic, but descriptions are introduced of species believed to be new to science, and discovered on this occasion. Thus we have characterised

(p. 29) a new Crustacean—*Æglea audina* (pp. 36, 37), two new Violets, *Viola acanthophylla*, and *V. portulacea* (p. 38), a new Pigeon, *Columbina aurisquamata* (p. 45), *Oreosphacus*, a new genus of Menthoideæ; and subsequently two new Snakes, *Bothrops ammodytoides* and *Pelias trigonatus*.

As regards these and other supposed novelties, it may be remarked that it is not very convenient to scatter such descriptions through the pages of a book of travels, where they are liable to escape notice. Moreover, an isolated worker in a remote part of the earth's surface is in great danger of not knowing what is already known to others, and should take the precaution of consulting some correspondent in the great European centres of scientific activity before publishing what is new to him as new to every one else. Dr. Finsch has already shown that Leybold's *Conurus glaucifrons* is a well-known species of Parrot; and we do not doubt that most of the other supposed novelties will be found to have been previously described elsewhere. P. L. S.

A HEALTHY HOUSE

What a House should be, versus Death in the House. By William Bardwell, Architect and Sanitary Engineer. (London: Dean and Son.)

THE author of this work is evidently an enthusiast in sanitary matters, but there is much in it worth the attention of the professional architect and builder, as also of the house-owner and occupier. It will be some time before the precepts of hygienic architecture can be expected to pervade all classes of the community; but reforms in this direction must commence from above, and will gradually be accepted by the poorer classes: this work will assist the dissemination of wholesome rules.

The subject of drainage, which necessarily occupies much of the work, has been forced into prominence by the dangerous illness of the Prince of Wales, in the Autumn of 1871; and this work meets to some extent the demand for further and better information on the subject. Our author is not new to the task, having so long ago as 1828 turned his attention to the sanitary conditions of buildings, and has published several treatises on cognate subjects. The work before us, however, is suggestive rather than profound, and we find a tendency in it to describe very prosaic details in stilted language. There is also a general want of references, so that many of the statements cannot be easily verified—such, for instance, as this, p. 6, art. 10:—"We have progressed some little since 1828, when my first essays on health were published, and public attention has been directed to the subject; but still, one half of the children born in London and other large towns, die before they are three years old; while at a parish in Norfolk, where the principles here set forth are rigidly enforced by the excellent rector, a child is never known to die." After making, however, every abatement—as we are bound to do—the work will not fail to prove very useful, and will assist in leading people to better sanatory arrangements.

In p. 8 he justly animadverts on many modern cottages, which "from admiration of mediæval architecture are irregular in plan, and irregular in outline from an idea of being picturesque; and hence the chimneys are outside, involving loss of heat, the roof all hips and valleys, and dormer windows requiring constant repairs, and exhibiting an utter ignorance of the very first principles of a healthy home." Some fallacy seems, however, involved in the passage which follows, and which describes the effect of asphalted ground floors in some Essex cottages. The inhabitants suffered from rheumatism until the asphalte was covered with boards—"because the boards were conductors of damp, whilst the asphalte was a non-conductor of moisture." It must have been the conduction of temperature, and not of moisture, that led to the inconvenience.

Chapter ii. is on bad drainage, and opens sensibly thus:—"The use of water in cabinets in disobedience to God's command to the Israelites to bury excreta in the earth is unquestionably the cause of those alarming modern diseases—the something in the air—with which the whole country is affected." It may be impossible to return to the more primitive practice, but the fact remains that even the old cesspool system was less unhealthy than the modern more artificial one. Some valuable hints are given in pages 12—13, for discovering the inlets of sewer gases into houses. The closet soil-pipe is often the origin of these irruptions; for the inclosed gases decompose the soldered joints of the lead pipe in a few years' time, if the pipe is not ventilated, as indeed it seldom is, and the junction of the lead-pipe with the drain is often defective. Every sink, too, which modern luxury has introduced to save the old-fashioned labour of throwing slops away out of doors, opens a pathway for the poisonous gases, of which one part in 260 mixed with common air is fatal to life, and of which no sensible proportion can long be breathed with impunity.

There is also a moral aspect to the question. The following passage is introduced as a quotation, but it does not appear from what author, p. 19:—

"A clean, fresh, and well-ordered house exercises over its inmates a moral no less than a physical influence, and has a direct tendency to make the members of the family sober, peaceable, and considerate of the feelings and happiness of each other."

In chap. iii. are some valuable remarks about drains stink-traps, and rain-water pipes. Water-closets, it is said in p. 29, should never be in a basement—for if so, the house is liable to draw its supply of air through them—but always in a back-yard. Those that are wanted to be in immediate connection with the house should be in the upper floors only, and, whenever practicable, approached through a greenhouse.

At p. 33 are some remarks on the necessity of pure, untainted water; and, in p. 34, on the danger of lead-poisoning. The pipes made by Messrs. Walker, Campbell & Co., of Liverpool—lead-cased block-tin pipes—are recommended in those cases where the water acts upon lead. A caution as to the use of these pipes should, however, have been added, as very great care and peculiar arrangements are required in jointing them; otherwise, the combination of the two metals becomes exposed to the action of the water at the joints, when decomposition will take place, and the water will still be affected with lead.

In p. 41 the importance of a dry basement is inculcated, and with a well-merited encomium on Mr. John Taylor's clever contrivance of the damp-proof

course which both keeps down the damp and ventilates the ground-floor. Proceeding to fire-proofing methods, Mr. David Hartley's simple but little known contrivance for protecting dwelling-houses from fire by interposing sheet-iron or copper between the floor boards and the joists is mentioned. The plan described a little farther on, p. 46-47, would probably not be so effective as Hartley's.

In pp. 48-58 fire-grates are mentioned, and with a decided preference (perfectly justified in the experience of the writer of these remarks) for Mr. John Taylor's smoke-consuming grate; but the author should hardly have left Dr. Arnott's smoke-consuming contrivances unnoticed; and when at pp. 61-66 he speaks of ventilation, he should have mentioned at greater length Dr. Arnott's ventilating valve. Boyle's ingenious ventilators, however, quite deserve the praise given them in p. 63.

It would be interesting to have had some references given to sanction our author in claiming the authority of the Duke of Wellington, together with that of Aaron and the High Priests, his successors, for the practice of placing their beds nearly north and south so as to be in the line of the magnetic current. The theory no doubt has its advocates, but can hardly be of universal application, as there are many sound sleepers at all degrees of orientation.

Chapter iv. contains some good suggestions respecting London street improvements and the Sanitary Recipes at the end will be found deserving attention.

OUR BOOK SHELF

Natural Philosophy. Part I. Mechanics. By J. Alfred Skertchley. Pp. 168. (London: Thomas Murby, 1873.)

THIS work belongs to a series of small manuals which the publisher calls the "Science and Art Department Series of Text Books." It is designed for students who possess but little mathematical knowledge, and each of the theorems discussed is explained in very simple language. In some respects the work keeps pace with modern text-books, in others it lags behind them. Thus while we have chapters on Kinetics and Kinematics, and on Actual and Potential Energy, we find some of the units as primitive as possible, and the Metric system is ignored. The unit of length is given as the yard, and the unit of weight as the grain. The definitions leave much to be desired: thus Mechanics is defined as "the Science which treats of the laws of motion and force, especially as applied to the construction of Machines;" Hydrostatics "the science treating of the pressure of water." Again we find the following very loose definition of the force of gravity: "Every particle of matter has a tendency to draw to itself every other particle, and this tendency is called the force of gravity." The other attractive forces are here ignored, the student is left quite in ignorance as to whether the force acts through a sensible or insensible space, whether it acts between particles or masses, whether such particles or masses are necessarily of similar or dissimilar substances. A screw is defined as "an inclined plane *revolving* round a centre." "Any body capable of moving freely about a fixed axis is a pendulum." The chapter relating to Energy requires to be carefully revised, as, indeed, does much of the work so far as accurate and logical definition is concerned. The examples are useful, and the questions at the end of the book will be found of service in teaching elementary Science, but the book can scarcely be recommended until the definitions are more precise and absolute.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

The Dutch Photographs of the Eclipse of 1871

IN the account of the proceedings of the meeting of June 13 last of the Royal Astronomical Society, as published in Vol. viii. p. 175, of NATURE, I read the following:—

"Mr. Ranyard remarked that the paper copies of the Dutch photographs which he had seen had been printed from enlargements on glass, in which the moon had been stopped out with black paper or some other material. On measuring he had found that the body of the moon, as given in the photographs was by no means circular, and Mr. Davis had pointed out to him that the irradiation under the prominences was perfectly sharp at the edges, as it would be when printed through paper: It was therefore unfair to institute any comparisons as to the amount of the irradiation in these and in the other photographs."

I beg leave to state, in opposition to Mr. Ranyard's and Mr. Davis's remarks, that no stopping out with black or any other paper has taken place. I enclose hereby copies on paper of the originals and of one of the enlargements. In the first-mentioned everyone may see that the moon is sufficiently dark to render unnecessary every artifice before making a good enlargement. In fact I have seen the enlargements myself, and in them, too, the moon was as dark as the surrounding sky.

I think Mr. Dietrich's merit to be especially this, that he has directed the attention of astronomers again to a method, as it seems already wholly abandoned, if ever earnestly tried, viz. that of taking an image with a photographic lens of short focus but great force, so that a very short exposure might be sufficient. As to the profit his photographs brought to our knowledge of the sun, Col. Tennant says, almost every depression of outline of the Indian photographs could be recognised in the Java ones, and thereby it is proved that in the interval of time needed by the moon's shadow to make the traject from India to Java, say 50 minutes, almost no change whatever took place in the solar corona.

Of course the method could be improved by moving the camera by clockwork. Then the exposure could last a little longer, *e.g.*, one second, and the exterior outline would reach farther; a larger camera, with photographic lens of the same force would without doubt give more details.

As to the not-circular (in fact elliptical) form of the moon in the photographs, I think it pleads more against than in favour of Mr. Ranyard's remark, for if a disc of paper were to be used to stop out the moon, of course a circular one would have been made, and not an elliptical one. The fact is that the copies of the original *cliché* present the same peculiarity, the difference between the longest and shortest diameter being about $\frac{1}{20}$th of a millimeter, as is easily recognised with a lens and a measure of half-millimeters. In the accompanying diapositive the differenc- $=\frac{1}{4}$ mm. As in other photographs of total eclipses, the diameter corresponding to the poles of the sun is the longer. This phenomenon is in our case only partially explained by the moon's motion during the time of exposure; perhaps a stronger impression at the equatorial regions of the sun, or a trembling of the camera-stand has done the remainder.

In the glass photographs, of which I have sent a pair to Lord Lindsay and to Messrs. Lockyer, Huggins, Warren De La Rue, and Main, the details are finer and sharper than in the paper ones. J. A. C. OUDEMANS

Batavia, Sept. 10

[We have no doubt from an inspection of the photographs sent, that no stop was used.—ED.]

Elevation of Mountains and Volcanic Theories

THE accompanying letter from Captain Hutton is in acknowledgment of my paper on "The Elevation of Mountains by Lateral Pressure," which I read at Cambridge in 1869. I sent it to him in consequence of seeing his lecture on Mountains, in the *Geological Magazine*. He could not have received my critique on that lecture at the time of his writing this letter. In accordance with his suggestion I forward it for publication in NATURE without comment. OSMOND FISHER

Harlton Rectory, Cambridge

I have to thank you for sending me your paper on the Elevation of Mountains, which I have read with great interest. You and Mr. Mallet have done great service to geology by exploding the old-fashioned idea of cavities existing in the interior of the earth. I quite agree with you that a cooling earth must give rise to great pressure in the outer consolidated layers, and that this pressure must crush the rocks composing it; but I cannot think that this crushing is the cause of the elevation of mountains. My reasons for disagreeing with you are the following:—

1. The pressure from a shrinking globe must be uniform, and the lines of least resistance, once chosen, should remain always the same, and the elevation should be continuous. All minor differences would be insignificant in comparison with the flatter arch at the poles. These areas, therefore, would subside, and mountain chains should have had from the first an east and west direction. I see no provision for changing the localities of movement.

2. Where deposition was going on the rocks would be heating and no contraction could occur below them. But mountain chains have been always formed where the deposits were the heaviest, and where, therefore, uplifting would not be likely to occur.

3. All mountain chains are not formed on the same system, but can be divided into two groups, as I have pointed out in my lecture on this subject.

4. Whether a glacial epoch has ever extended over the whole earth or not, it is certain that the northern parts of America and Europe are much warmer now than they were in the Pleistocene period, consequently the rocks under them could not have contracted, and yet we know that extensive movements are even now going on in this area.

5. In order to produce a strain on the surface, the lower contracting rocks must be solid, consequently there would be nothing to support a large anticlinal, and no rocks to pass into the liquid state; the result would be a general small crumpling all along the surface. The relief also to the compression of the upper rocks could not be obtained by a single rising at a point, or along a line, without a horizontal movement of one bed over another, which appears to me to be impossible. Consequently I do not think that the shrinking could produce the observed effects, more especially as the Himalayas, &c. are of tertiary age, and the contraction of the globe, since the cretaceous period, cannot have been very great. These remarks apply also to Prof. Shaler's theory (Proc. Bost. Soc. Nat. Hist. 1866). Mr. Medlicott's section of the Himalayas is, to my mind, physically impossible. It is inconceivable that the beds could be engineered into the positions in which he has placed them.

6. The theory does not account for the numerous minor oscillations of level that coal measures often prove to have taken place.

7. The theory makes no provision for tension in the rocks. But it is a fact not sufficiently dwelt upon by geologists, that faults just as surely prove tension in rocks as contortions prove compression.

I have also a few objections to your theory of Volcanoes, and also to that of Mr. Mallet. They are as follows:—

1. The density of the crust has been shown by General Sabine to increase in volcanic regions, while, by your theory, it should decrease. Mr. Mallet's theory would account for this, as also would the one proposed in my lecture.

2. To cause a volcano the heat must go to the water, for the water cannot go to the heated rock, as your theory would require.

3. Volcanoes are not found in contorted countries, or where great lateral pressure has existed. In the older volcanic districts (*e.g.* North Wales) the eruptions occurred before the folding of the strata. This is also a strong point against Mr. Mallet's theory.

4. By Mr. Mallet's theory the crushing must be very sudden, or the heat would be conducted away, and as each eruption would require a fresh accession of heat, it ought to be preceded by elevation or subsidence on a large scale. The earthquakes that precede eruptions are just as likely to be effects as causes.

5. Faults show no heating where considerable crushing has taken place.

Such are the objections that occur to me, but, after all, we cannot well burke the question as to the state of the interior of the earth, and I must confess that the "Viscidists" appear to me to have a better position than the "Rigidists."

Mr. Hopkins' argument, drawn from precession and nutation, has proved untenable, and the only stronghold that the "Rigidists" now retain is the absence-of-internal-tide argument of Sir W. Thomson. This has not yet been assaulted, but it probably has a weak point somewhere, for its author has allowed that the interior of the earth is probably "at, or very nearly at, the proper melting temperature for the pressure at each depth," which seems hardly consistent with its being "more rigid than glass." On the other hand, the "Viscidists" have a very strong point in the fact that faults are known with throws of several thousand feet (which apparently must penetrate into some yielding material), as well as some minor positions, such as the supposed effect of the moon on causing earthquakes, the composition of volcanic rocks (which contain more alkali than could be obtained by merely melting sedimentary rocks), and the mode of occurrence of granitic rocks, none of which have been seriously attacked by the "Rigidists."

At this distance I cannot take part in a discussion, as I must always be five months behind hand, but if you think that a preliminary skirmish in the pages of NATURE would do good, although it did not bring on a decisive battle, you are quite welcome to publish this letter. F. W. HUTTON

Wellington, N. Z., July 21

P.S.—At the time of writing my paper on Elevation and Subsidence (*Phil. Mag.* Dec. '72), I was not aware that Mr. Scrope had been the first to suggest* the theory there developed, or I should certainly have mentioned his name, and not proposed to call the theory after Herschel and Babbage. I feel that I owe Mr. Scrope some apology for my inadvertence.

* "Volcanoes," 1st ed. 1826, p. 30.

Deep-Sea Sounding and Deep-Sea Thermometers

WE have again to claim your indulgence for occupying space for a few comments on Mr. Casella's reply to our letter.

It is not true that we abstained from drawing attention during the lifetime of Dr. Miller to the fact that he had plagiarised our invention; on the contrary, we wrote to Dr. Miller as soon as we were told that he had read a paper before the Royal Society on his supposed invention, and we have before us Dr. Miller's answer, dated Nov. 23, 1869, wherein he writes:

"I am sorry if I have inadvertently done anything which may fairly be considered an injustice to you in respect to the deep-sea thermometer," &c.

We believe Dr. Miller did not know of our thermometer, but Mr. Casella did, having had one or more in his possession years previously, and as a fact our thermometer was well known in the trade; therefore he as the workman employed by Dr. Miller ought to have acquainted that gentleman with the fact. It is most likely that we should not have taken any further notice had the thermometer retained the modest title given to it by Dr. Miller, viz. the "Miller-pattern." This, however, did not suit Mr. Casella. Mr. Miller died—"mors tua vita mea,"—and forthwith the thermometer is styled the Miller-Casella, then by a little "progressive development," the instrument is brought out at the British Association as the Casella-Miller, and to day we have it in Mr. Casella's letter as "*my thermometer*."

On reference to the Royal Society's Proceedings, vol. xvii. p. 482, we find no mention of Mr. Casella's name except as the workman who took Dr. Miller's instructions, and we have yet to learn what right a workman has to appropriate to himself an instrument made for Dr. Miller, or any other customer, supposing, even for argument's sake, that we had no priority in its invention.

Mr. Casella asks "What has Negretti and Zambra's thermometer done that it should be known?"

In the first place it served him as a pattern, it showed him how the best deep-sea thermometer was constructed, and how to make others on the same principle; and we contend that had our instruments been placed in the hands of skilful, careful, and trained observers, such as are now engaged in the *Challenger* Expedition, they would have given results equal to those now obtained with the instruments supplied by Mr. Casella, and obviously so, their principle being precisely the same.

Mr. Casella talks about our thermometers having failed. Can Mr. Casella point out where are recorded any of the failures? Was Mr. Casella able to make them fail when he tried by placing one of them in his hydraulic press in the presence of gentlemen connected with the Meteorological Office? But this is not the point at issue, the sole question is, are the thermometers supplied to the expedition the same in principle as ours, or are they not?

Doubtless it would be much more agreeable to Mr. Casella that these questions should be decided by himself in private, hence his invitation to your readers "to go to his establishment

and hear his explanation." Surely no such arrangement will satisfy "all the scientific men in the world." We contend that as Mr. Casella has publicly claimed the invention as his own, it ought to be decided with equal publicity whether he has done anything more than copy our instrument.

We again give the description of our thermometer (not in our own words, for we might be accused of shaping them to suit our purpose) but in the words of the late Admiral Fitzroy as they appear in the first number of Meteorological Papers, page 55, published July 5, 1857, in referring to the erroneous readings of all thermometers consequent on their delicate bulbs being compressed by the great pressure of the ocean, Admiral Fitzroy says :—

"With a view to obviate this failing, Messrs. Negretti and Zambra undertook to make a case for the weak bulbs which should transmit temperature but resist pressure. Accordingly, a tube of thick glass is sealed outside the delicate bulb between which and the casing is a space all round which is nearly filled with mercury. The small space not so filled is a vacuum into which the mercury can be expanded, or forced by heat or mechanical compression, without doing injury to, or even compressing the inner or much more delicate bulb," &c. &c.

Mr. Casella "did not wish to take up your valuable space to describe his thermometer." Well, it matters not; the late Admiral Fitzroy has done it for him. He described it sixteen years ago; and if the reader will take every syllable of the extract above quoted, and substitute the word "alcohol" for "mercury" (which colourable change was effected by Mr. Casella, to the detriment of the instrument), they will have a correct description of Mr. Casella's thermometer in the most minute details.

HY. NEGRETTI AND ZAMBRA

Rain-gauge at Sea

I BEG to send you a copy of a letter I received lately from Capt. Goodenough, of the Royal Navy, respecting the use of my rain-gauge at sea. (See NATURE, vol. vii. p. 202.)

Nov. 8 W. J. BLACK

"H.M.S. *Pearl*, lat. 6° S., long. 22 W.

"Dear Sir,—I should have taken an earlier opportunity of writing to you about the instrument which you were so good as to design for use on board ship, but have not had the good fortune to fall in with any rain up to the present time with which I could at all events in some measure test and chronicle the rain-gauge. It is odd that in a journey of twenty days I have had only ·07 in. of rain, and that although I am at this moment in a district in which an average of seven hours' rain usually falls at this time of the year. On that one occasion ·07 in. did fall and was duly caught in your instrument as well as in another mounted on gimbals, the measurements being exactly alike in each. I much prefer the mounting of your instrument, and will report to you as to the amount of weight it requires after some experimenting with it. The usually most steady instrument is one which is heavy, and whose centre of gravity is very near its centre of oscillation. I do not think it would be well to increase the size of the instrument, as it would become inconvenient to place, except for the use of a man who wishes to devote himself very much to that order of observation. Our poop is so high here that I do not anticipate any mixture of sea-spray in the gauge, but if it were so your table would be sufficient to clear it, supposing we had Carpenter's Hydrometer to test with, as we might not expect enough water to float an ordinary one.

"I remain, yours very truly,

"JAMES E. GOODENOUGH

"Captain R.N. Command H.M.S. *Pearl*, proceeding *viâ* the Cape to Australasia."

Glaciers

IN a letter printed in your number for Oct. 16 (vol. viii. p. 506), Mr. J. H. Röhrs states that he believes that glaciers existed at or near the sea-level in central Hindustan in the glacial period. Glaciers undoubtedly existed in the Himalayas at a much lower elevation than at present; there are traces of their action in Sikkim in valleys, the bottoms of which are now only 4,000 ft. above the sea, and in the north-western Himalayas, Mr. Medlicott, I think, considers that in some valleys, glaciers descended to within 1,000 ft. of the sea-level, but I have never heard of any marks of old glacial action in the Indian peninsula south of the Himalayas. There are no mountains in central Hindostan exceeding about 4,000 ft. in height, and a careful examination of the portions of the Nilgiri mountains in Southern India, which rise above 8,000 ft., has not afforded any proof of the former presence of ice. It is very probable that Mr. Röhrs possesses information upon this subject with which I am unacquainted, and it is without the least wish to express a doubt of the accuracy of his information, that I ask for any evidence he can produce in favour of his assertion, as the subject is one in which I am greatly interested.

W. T. BLANFORD

JOHANN NEPOMUK CZERMAK

JOHANN NEPOMUK CZERMAK was born June 17, 1828, in Prague. His father, Johann Conrad Czermak, was a medical practitioner of high repute in that city, and his uncle, Joseph Julius Czermak, enjoyed a considerable reputation as Professor of Medicine and Physiology, first at Gratz and afterwards at Vienna. Educated at the high school of his native town, Johann Czermak entered upon the study of medicine at the University of Vienna in 1845. In 1847 he moved to Breslau, where he had the great advantage of living with the distinguished physiologist Purkinje. From Breslau he passed on in 1849 to Würzburg, where in 1850 he received the degree of M.D., publishing on that occasion an inaugural dissertation on "The Microscopical Anatomy of the Teeth," in which he called attention to the larger "interglobular" spaces so often found in the upper part of the dentine. After a visit to England he settled at Prague, where he became assistant to Purkinje, who then held the chair of Physiology in that place. In 1855 he left Prague to take the chair of Zoology at Gratz; but zoology was not his proper province, and he gladly accepted in 1856 the offer of the Professorship of Physiology at Krakau, which however he left in the following year for the like chair in Pesth. In both these universities he established physiological laboratories and gave a decided impulse to physiological research; but the political agitations then rife made life distasteful to him there, and in 1860 he resigned his chair and returned to Prague. Such frequent changes must have interfered greatly with sustained research, but by this time Czermak had made his name known as well by several investigations in experimental physiology and in subjective vision, as especially by his researches on the laryngoscope, his treatise on which ("Der Kehlkopfspiegel und seine Verwerthung") embodying the results made known in various papers in 1858 and 1859, he published shortly before his return to Prague.

Here he resided some years, visiting at times England, Holland, and France, in order to make the value of the laryngoscope better known to his fellow-workers in science and medicine. There are many in England who retain pleasant memories of these visits.

The ample means brought to him by the gifted lady whom he had the happiness to marry, enabled him to build in Prague and furnish at his own expense a private laboratory for research, in which he not only worked himself, but which he also placed at the disposal of others. Many would have envied, and few would willingly have let slip, such an opportunity for quiet labour; but Czermak, conscious of the power he possessed of lucid exposition, delighted in teaching, and felt perhaps the want of the stimulus which pupils afford. Accordingly, when in 1865 he was offered the chair of Physiology in Jena, vacated by the removal of von Bezold to Würzburg, he at once accepted it. Here he continued until, in 1869, finding the disease to which he eventually succumbed (and the beginning of which he himself attributed to the irritation caused by the

controversies which arose out of his laryngoscopic work), was rendering him unfitted for the energetic performance of his professorial duties, he withdrew to Leipzig, where he was made Honorary Professor at the University, and where he continued to reside until his death, on Sept. 16 in the present year.

Carried off while yet in the prime of his life, and the energies of his last few years impaired by an insidious disease, Czermak has perhaps left a mark on the scientific progress of his time incommensurate with his talents or his promise. He will doubtless be best remembered through his laryngoscopic labours. We owe to him the real introduction into medical practice of this valuable instrument. But his other researches, such as those on the action of the vagus, the pulse, the sense of touch, the manége movements resulting from injuries to the brain, those on dyspnœa, and others, show remarkable acuteness and clearness of insight.

Two talents he possessed deserve special notice. He had remarkable aptitude in devising apparatus for observing or for demonstrating physiological phenomena. It was this faculty which made him successful where others had failed in the use of the laryngeal mirror; and would be difficult to exaggerate the immense help to experimental physiology which has been afforded by the ingenious "holder" which bears his name.

The other faculty, that of popular exposition, less common in his country than in ours, he possessed to a very high degree. And his popular lectures, which were originally delivered at Jena, and which were reviewed in an early number of NATURE, achieved and deserved great popularity.

Perhaps had his love of teaching been less strong, his work as an investigator would have been more sustained and weighty. But while in this country we might with profit often lose a lecturer and gain an investigator, Germany could well afford that one whose powers of rigorous and yet clear and popular demonstration were so exceptionally great, should somewhat slacken in his work as an inquirer. Or perhaps we should not so much say that Czermak slackened in inquiry, as that the consciousness of his power as an expositor, and the delight he consequently took in exposition, drew much of his energy in that direction. In the grounds of his residence at Leipzig he had built and fitted, at his own expense, a large hall, or "spectatorium," as he called it, in which he proposed to deliver lectures on physiology, richly illustrated with experiments. In connection with the hall, the construction of which was admirably adapted in every way for its purpose, he had also erected a private laboratory for research; and on both he had spent much time and labour. They were intended to be a supplement—not a rival—to the more technical institute of Prof. Ludwig in the same city. The writer will never forget the delight with which Czermak showed this "Erklärungs-Tempel,"—as he was fond of calling it—to Dr. Sharpey and himself in the summer of 1871, and pointed out all its ingenious contrivances, and the enthusiasm with which he looked forward to the lectures which would be delivered, and the work which would be carried on in it. He lived to open it by an inaugural lecture in December 1872; but the effects of his fatal disease were already painfully evident; and after a vain struggle during the following summer, Czermak—just as the British Association was gathering for its meeting at Bradford—was taken away from his unfinished work. He was a man of broad culture, outside his professional attainments. In philosophy especially he was well versed; and his last contribution to scientific literature—a pap r in "Pflüger's Archiv," on the mesmerism of animals—was doubtless prompted by his interest in psychological questions. His straightforward, generous, and unostentatious manner formed a fitting frame for his intellectual attainments.

A widow and children mourn his death. He is also mourned for by many friends in many lands, both by those who had known him long and by those who knew him for a short while only.

M. FOSTER

THE ATMOSPHERIC TELEGRAPH

THE *Times* of the 15th inst. contained an article on the Pneumatic Despatch, which has never been used to any extent in this country. From that article we learn the following particulars as to the working of this method of conveyance in London:—

The pneumatic tube extends from the London and North-Western Railway Station at Euston Square to the General Post Office in St. Martin's-le-Grand. The central station is in Holborn, where is also the machinery for effecting the transit of the trains. Here the tube is divided, so that in effect there are two tubes opening into the station, one from Euston to Holborn, and the other from the Post Office. The length of the tube between Holborn and Euston is 3,080 yards, or exactly a mile and three-quarters, a greater length than was originally contemplated, but which was rendered necessary by the avoidance of certain property on the route. The tube is of a flattened horse-shoe section 5 ft. wide and 4 ft. 6 in. high at the centre, having a sectional area of 17 square feet. The straight portions of the line are formed of a continuous cast-iron tube, the curved lengths being constructed in brickwork, with a facing of cement. The gradients are easy; the two chief are 1 in 45 and 1 in 60, some portions of the line being on the level; the sharpest curve is that near the Holborn station, which is 70 ft. radius. The tube between Holborn and the Post Office is 1,658 yards in length, or 102 yards less than a mile, and is of the same section, and similarly constructed to the first length. Two gradients of 1 in 15 occur on the Post Office section, but this steep inclination is in no way inimical to the working of the system. The Holborn station is situated at right angles to the line of the tubes, which are therefore turned towards the station into which each opens. All through trains, therefore, have to reverse there, and this is effected in a very simple manner by a self-acting arrangement. A train upon its arrival runs by virtue of its acquired momentum up a short incline, at the summit of which it momentarily stops, and then quickly descends by gravity. In its descent it is turned on to a pair of rails leading to the other tube, into which it enters and through which it continues its journey, the whole process of reversing occupying barely 30 seconds. Trains containing goods for the Holborn station are simply run down from the top of the incline on to a siding.

The waggons, or carriers, as they are termed, weigh 22 cwt., are 10 ft. 4 in. in length, and have a transverse contour conforming to that of the tube. They are, however, of a slightly smaller area than the tube itself, the difference—about an inch all round—being occupied by a flange of indiarubber, which causes the carrier to fit the tube exactly, and so to form a piston upon which the air acts. The machinery for propelling the carriers consists of a steam engine having a pair of 24-in cylinders with 20 in. stroke. This engine drives a fan 22 ft. 6 in. in diameter, and the two are geared together in such a manner that one revolution of the former gives two of the latter, or, in technical terms, the engine is geared at 2 to 1 with the fan. The trains are drawn from Euston and the Post Office by exhaustion, and are propelled to those points by pressure The working of the fan, however, is not reversed to suit these constantly varying conditions; it works continuously, the alternate action of pressure and exhaustion being governed by valves. The engine takes steam from three Cornish boilers, each 30 ft. long and 6 ft. 6 in. in diameter. Telegraphic signalling is carried on between the three stations by means of needle instruments.

The system of Pneumatic Despatch, or "Atmospheric Telegraph," as the French call it, is utilised to a much greater extent in Paris than in London, though with some important differences in construction and object. We have thought that some details concerning the working of this system in Paris might be useful and interesting at the present time, and we therefore give an abstract of some articles on the subject which have recently appeared in *La Nature*.

The question of the distribution of messages in the interior of towns has revived the systems of pneumatic transport, which, after having had their day of celebrity, seemed for twenty years doomed to oblivion.

In following the aspects of this question, we shall show in what way the atmospheric telegraph is a result of the electric telegraph; we shall afterwards consider the former more specially, and after having shown its present condition, shall inquire what future is in store for it.

The telegraphic despatch has become an article of everyday use; as the age is a fast one, it is natural that it should utilise with eagerness so handy a means of transmitting almost instantaneously its impressions or its wishes to all distances. It is necessary to remember that a city like London or Paris sends out and receives every day an immense number of telegrams. The wires which serve as conductors of electricity are multiplied in all directions for the purpose of meeting the demands of this traffic. They meet in the interior at the central office. This central station speaks *urbi et orbi;* in other words, it receives the messages of the city for the purpose of spreading them over the entire world, and it accomplishes also an inverse movement. The aspect with which we are here concerned is the distribution throughout the city itself; let us see what has been done in Paris to accomplish this purpose.

As each house cannot be put in immediate communication with the telegraphic network, it became necessary to adopt some other convenient plan. In the case of Paris, the city is divided into districts of a mean radius of 500 metres in order to limit the journeys of the foot-messengers. The application of this rule gave fifty points, distant one kilometre from each other, where are established so many branches of the chief office.

This system was found, however, not to work well, and was moreover very expensive, for reasons which we need not detail here; and after *voitures* were tried for some time as a means of sending despatches from the head office to the more important branches, it was resolved to have recourse to the pneumatic tube. We have just referred to the extent to which it has been carried in London. Paris and Berlin followed the example of London in 1865: we shall speak here of the system of Paris.

In Paris there are fifty stations, distant from each other about a kilometre, connected by an iron tube, which is interrupted at each station. The central station, by which the transit of messages is effected with the interior, is in the Rue de Grenelle; there are seventeen district stations, in the Rue Boissy-d'Anglas, Grand-Hôtel, Bourse, &c.

How is this network managed? Like a diminutive subterranean railway, in which the waggons are cylindrical boxes and the motive power compressed air prepared in the stations. At the central bureau the trains are formed, composed of as many boxes as there are branch offices to supply. The trains are *omnibus* when they stop at the intermediate stations, *express* when they shoot past them.

Every quarter of an hour an omnibus train leaves the Rue de Grenelle, and accomplishes the distance which separates it from the Rue Boissy-d'Anglas (1,500 metres) in a minute and a half. There it is received in a vertical column, and the box which carries the messages to be distributed in the district having been taken out, the others are put into the section of the line which runs towards the Grand Hotel, a new box having been added containing messages to be transmitted, which have been deposited since the last train. The train again takes its departure, composed of as many boxes as before; it goes through the same operations at the Grand Hotel, the Bourse, the Thèâtre Français, and at the Rue des Saints-Pères. It re-enters the Rue de Grenelle twelve minutes after its departure, having changed all its boxes and carried back messages for distribution.

Besides this there is a secondary network, the details of which, however, we need not now enter upon. There is a direct line which goes from the Rue de Grenelle to the Bourse, and to branches in the Champs-Elysées, the Place du Havre, and the Rue des Halles. On the first run the express trains going and returning, the departures of which are intercalated between those of the omnibus trains, for the purpose of supplying those stations which are busiest, twice every quarter of an hour. The departure is accomplished by pressure, the return by aspiration. The same method of working is applied to the branches, which correspond with the omnibus trains of the principal network.

The tubes which compose the lines are of iron, the interior diameter being 0·065 metre. They are connected by bridle joints (*à brides*), and admit of curves having a radius of from 5 to 20 metres.

Various systems for the production of compressed or rarified air are employed. The first in date is an application of the principles of the apparatus known as Hiero's Fountain. Atmospheric air is decanted from a first receiver B (Fig. 1) into a second receiver communicating with the first by means of the tube *b b*, by the introduction of water into the receiver B. The air thus forced is drawn into the receiver for the purpose of being dispersed in the tubes. Where the machines are not allowed to be used, the employment of steam is much more economical for the compression of air. Recourse is then had to ordinary pumps, which insure an active service and are subject to fewer causes of irregularity. The latter method has been preferred in recent establishments.

Trains composed of ten boxes weigh about four kilograms, they are either pushed or sucked along by a difference of pressure of three-fourths of an atmosphere, which gives a mean speed of a kilometre per minute.

The travellers which take their places on the Lilliputian carriages already described are closed envelopes containing messages; they are piled in groups of thirty or forty in a *curseur*, or box. This box is formed of two cylinders, the interior one of sheet-iron, the outer one, enveloping the former, of leather. To make up a train, a piston must be affixed after the last box, for the purpose of enabling the compressed air to take effect. The piston is a piece of wood provided with a leather collarette, which assumes the shape of the interior of the tube, and forms an almost hermetical joint, without much friction.

The apparatus at first adopted for receiving and despatching the boxes having been found neither sufficiently rapid nor convenient, a much more complete system, shown in Fig. 2, is now employed. The figure explains itself: two lines enter the office, each attached to separate apparatus. In the first place, for the purpose of despatching messages, a man opens the door A by means of the lever *d*; the boxes and the piston are thrown into the tube, and await at the bottom the current of air which will propel them. This current is produced as soon as the cock *c* is opened, which commands the head of the apparatus opposite to the tube. The cock *c'* distributes the air upon the second line. In the second place, the receiving door B is opened by a second attendant, who finds the train at the station, and takes out the boxes in order to bring the telegrams to light. The entire apparatus has somewhat the form of a cannon, only the effect is more blessed, the artillerymen are not exposed to death;

the worst accident they have to fear is the bursting of the tube. To this drawback, which happens very rarely, we shall refer by-and-by.

The messages are divided into two classes,—questions and answers, orders and the execution of orders, which can at once be exchanged between any point of the city and any point of the interior, in the provinces, or abroad, —or inversely. All that is necessary in this case is a centre, as the Hôtel des Télégraphes in the Rue de Grenelle is called. Connected in the one part with the exterior by the network of electric wires, and with the interior by the network of pneumatic tubes.

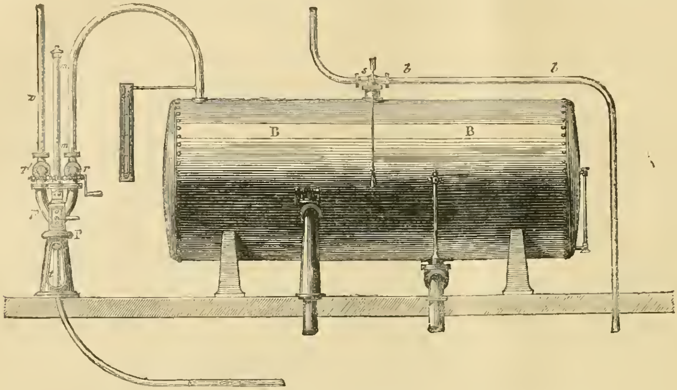


FIG. 1.—Apparatus for the production of compressed air.

These tubes are, moreover, well adapted for the service of the local post, *i.e.* for the exchange of messages within the city. The great advantage in this case is that the despatch can be sent. On the plan adopted, when the network is complete, a letter may always be sent from one quarter to another at any distance within Paris in less than an hour. Every year the development of the lines increases, and the number of Paris telegrams meant for the city, and of which the originals themselves can be transmitted, is getting greater and greater.

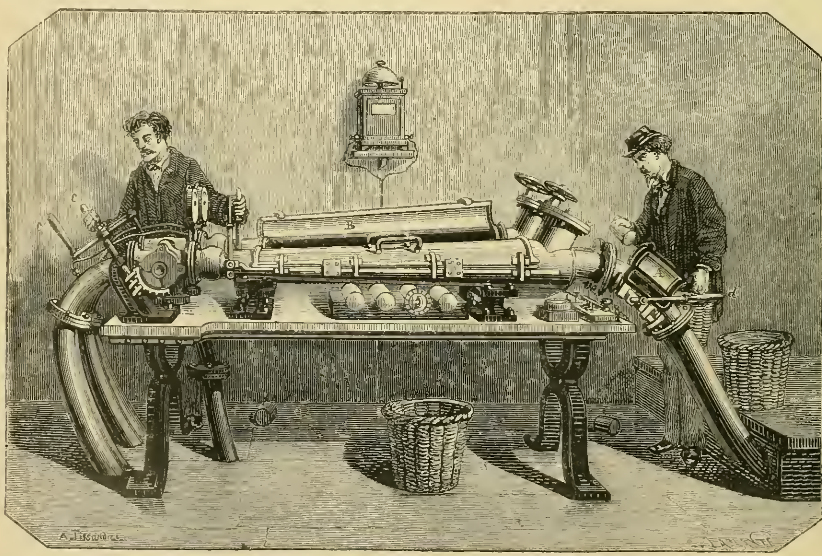


FIG. 2.—Apparatus for reception and despatch.

THE COMMON FROG*

V.

THE third order of the class *Batrachia* is made up of a few creatures the distribution of which is limited to the warmer regions of the earth, where one of the genera (*Cæcilia*) comprising the group is distributed over both hemispheres, being found in India, Africa, and South America. Two other genera (*Siphonops* and *Rhinatrema*) are exclusively American, while a fourth genus (*Epicrium*) is only found in Asia. The order is called *Ophiomorpha*. These creatures are singularly unlike the frog in external appearance, as they are entirely destitute of limbs and have quite the appearance of earthworms, because they are not only very long and slender, but have also a skin which is soft and naked. By earlier naturalists, and even by Cuvier, they were classed with snakes.

In spite of this striking dissimilarity between the *Ophiomorpha* and *Anoura*, the former are really more like frogs than they are like efts in one important respect.

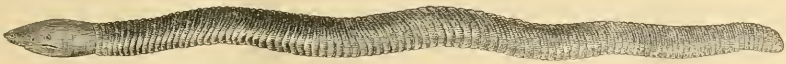


FIG. 22.—*Cæcilia.*

This is because, for all their elongated figure, the tail in them is quite rudimentary or altogether absent.

The *Ophiomorpha* would by many be supposed to present an analogy with serpents, from their long and elongated bodies, and from the utter absence of limbs.

There are, however, but very few snakes (the "roughtails" *Uropeltidæ* and the *Tortricidæ*) which have long bodies and very short tails.

It is rather the singular family of lizards, *Amphisbenidæ* (with one exception completely limbless) that the Ophiomorpha resemble.

FIG. 23.—Skeleton of the Icthyosaurus

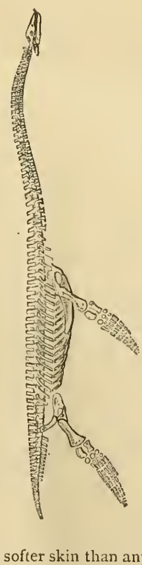


FIG. 24.—Skeleton of the Plesiosaurus.

These Amphisbenians have a softer skin than any other Saurians except chameleons. It is also marked in grooves which are arranged in transverse rings. They have an exceedingly short tail which is blunt, so that, the head being small, one end of the body is as large as the other.

The *Ophiomorpha* also have the body marked with numerous transverse grooves or rings; they are utterly devoid of limbs, and the head is scarcely, if at all, larger than the hinder end of the body.

These creatures burrow beneath the soil (which habit increases their resemblance to earth-worms) and feed on worms and other small animals and mould.

To turn now to another aspect of our subject, let us consider the relations of the Frog to past time. If, extending our survey over the records of past epochs, we search the tertiary and all other rocks above the Lias for fossil allies of our Frog, we shall (judging by what we yet know) fail to find any not at once referable to one or other of the three ordinal groups above enumerated.

Fossil frogs and toads have as yet only been found down to the miocene, the oldest being some found in the so-called "brown coal" which is not a carboniferous deposit

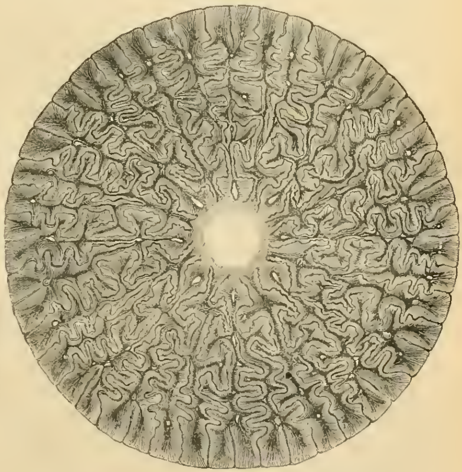


FIG. 25.—Much enlarged horizonta section of the tooth of a Labyrinthodon

at all. The remarkable thing, however, is that the difference between these oldest known Frogs and the existing forms is so very trifling. They are as complete and thorough frogs as any that live now.

Again, the fossil Urodeles similarly resemble their existing representatives, and no one extinct species exhibits characters in any way tending to bridge over the chasm which separates the Urodela from the *Anoura*.

When, however, we descend to the Lias, Trias, and Carboniferous rocks, we come upon a rich variety of extinct species of animals evidently allied to those forming the three Batrachian classes already described. They form, however, an order by themselves, to which the term *Labyrinthodonta* has been applied, and thus our search into the past has brought us a rich and important harvest,

* Continued from p. 30.

and has introduced us to the fourth and last Order belonging to the frog's class of vertebrate animals. The Labyrinthodonts were creatures with long tails and mostly two pairs of limbs, but these members were always relatively small with slender toes. Some species attained a greater size by far than does any existing Urodele, even the gigantic Salamander.

To what existing animals can these huge monsters be considered to have affinity? It is impossible to say that they in any way bridge over the chasm separating the Frogs from the Efts. They appear indeed to have been almost equally removed from both—for the possession of short limbs and a long tail (characters common to so many widely different animals) cannot be regarded as any good evidence of affinity.

It is not improbable that they find their nearest allies in the existing insignificant *Ophiomorpha*. The latter, though apparently naked, have minute scales imbedded in the skin and arranged in rings at intervals, and the skull is provided with certain extra ossifications. The Labyrinthodonts have similar extra cranial ossifications, and though they have not rings of scales, the ventral region was protected by minute plates arranged in linear series converging inwards and forwards towards the middle line. Moreover, some forms appear to have been entirely devoid of limbs; at least no remnant of such parts has yet been discovered. Nevertheless the degree of development of the tail constitutes a marked distinction between the *Labyrinthodonta* and the *Ophiomorpha*.

Certain Labyrinthodonts had great formidable teeth in elongated jaws like those of crocodiles. Altogether these singular remains tempt us to speculate as to the succession of life upon this planet's surface. We know that as to the later secondary period that part in the life of the globe which is now played by beasts was then played by reptiles. Instead of the existing bats, Pterodactyles of all sizes flitted through the air. The ocean was peopled not by whales and dolphins, these had not yet appeared, but by huge Ichthyosauri and Plesiosauri. Reptiles of huge bulk (Iguanodons, Megalosauri, Notosauri, &c. &c.) fulfilled the parts of herbivorous and carnivorous beasts, and altogether the Mammalian fauna of to-day was represented by analogous reptilian precursors.

May it not have been similar in yet older periods with regard to animals of the Frog class? We have seen the possibility of aërial locomotion in even the existing *Rhacophorus*. It is true that all existing Urodeles are freshwater forms, but it may well be that marine creatures once bore the same relation to them as the great marine *Ganoid* fish fauna bears to the few existing Ganoids* which now constitute a fresh-water group.

The great crocodile-like Labyrinthodonts must have been no ignoble predecessors of the rapacious reptiles which were to succeed them, and the fossil form *Ophiderpeton* suggests that the existing *Ophiomorpha* may be the last remnants of a race which preceded and represented the subsequently developed serpents.

This, however, is but a conjecture which future discoverers will probably ere long establish or refute.

The name *Labyrinthodonta* was bestowed upon the great fossil group on account of the beautiful and singularly complex structure of the teeth of some members of the order. These teeth are conical, and exhibit slight vertical grooves on their surface. A horizontal section shows that these surface-grooves are the external indications of deep indentations of the substance of the tooth. All these indentations converge towards the centre of the tooth, but not in straight lines, each indentation being elaborately inflected. Radiating from the centre of the tooth are a corresponding number of processes of the central pulp cavity—the radiating processes undulating like the converging folds.

* Existing Ganoids are the sturgeon, bony pike (Lepidosteus), mud-fish (Lepidosiren), and others as noticed earlier.

A similar structure of tooth is found in some Ganoid fishes, and an incipient stage (as it were) of the same condition existed in the Ichthyosaurus.

We have now reviewed the closest as well as the more remote allies of our Frog, and have seen how the Frog is a species of a group (*Anoura*) which is one of three existing and widely divergent orders, supplemented by an extinct ordinal group of the carboniferous period—the four orders (1. *Anoura*, 2. *Urodela*, 3. *Ophiomorpha*, and 4. *Labyrinthodonta*) being embraced in a higher unity termed a "Class," which is the Frog's *class*, as "Anoura" is his *order*. This class is with propriety spoken of as the *Frog's class*, since the Frog is the species from which its scientific derivation BATRACHIA is derived. This class may now be considered as a whole.

The Batrachians (of all three existing orders) are in the main aquatic animals, inasmuch as the greater number, even when adult, frequent, at least at intervals, ponds and streams, or delight in humid localities. Water also is necessary for the larval stages of almost all; and absolutely all, at one period of life, possess gills, while some (as we have seen) retain gills during their whole existence, and are permanently and constantly inhabitants of water.

The extinct forms (*Labyrinthodonta*) were, no doubt, also aquatic, as, besides their general relation to other Batrachians, traces or indications of the hard parts which supported the branchiæ of some Labyrinthodonts appear to have been actually found.

It is somewhat singular that in spite of this predominating aquatic habit, all Batrachians, both living and fossil, appear to inhabit, and to have inhabited, fresh water only. No Batrachian of any period is yet known to have been marine. This is the more remarkable since the most nearly allied class, that of fishes, is much more rich in salt-water than in fresh-water forms; while even existing *Reptilia* have (in the true sea-snakes and in chelonians) representatives which inhabit the open ocean, while in the secondary geological period marine reptiles (*Ichthyosauri* and *Plesiosauri*) abounded.

Indeed, of all classes of vertebrate animals, this aquatic class (*Batrachia*) has the least to do with the ocean, for many birds, and a still greater number of Mammals (*e.g.* the whales and porpoises), are constant inhabitants of salt water. All the adult Batrachians feed on animal substances, generally small worms, insects, or slugs, and animals allied to slugs. The larger Frogs and Toads will, however, as has been said, devour vertebrate animals, such as mice and small reptiles and birds. The existing large, tailed Batrachians devour fishes. The extinct tailed Batrachians, in their adult condition, were also undoubtedly animal feeders, but they may, in their young state, have been vegetarians. At any rate the tadpoles of the existing *Urodela* will eat vegetable matter, and indeed probably sustain themselves mainly upon it.

In cold latitudes the Batrachia, like the Reptilia, go into the winter sleep called *hibernation*, as also do the hedgehogs and bats amongst Mammals.

The Frogs and Toads sometimes hide and shelter themselves by creeping into out-of-the-way holes and corners, but more generally they (as also the Newts) bury themselves in mud at the bottom of ponds and streams. In hot latitudes, some forms pass the dry season in a similar state of lethargic inactivity.

Many beasts, birds, and fishes, range in flocks. The Batrachians, however, usually wander about in a solitary manner, and only congregate in the breeding season. It is then that their vocal powers find utterance, though only in the Anourous order; the tailed Batrachians never make more than a very feeble sound.

As regards the geographical distribution of the whole class, the northern hemisphere, and especially the American portion of it, is the more richly furnished. Africa, India, and Australia, are the most poorly supplied on the whole, because, though possessing very many kinds of

frogs and toads, the whole Eft order is unknown in those regions.

Our question "What is a Frog?" has now been somewhat further answered; but it cannot be completely so until the organisation of the animal has been more fully surveyed, and not only the relation of the frog to other Batrachians thus more clearly seen, but also the relations and affinities borne by the several orders of Batrachians and by the whole class to the other orders and other classes of the Vertebrate sub-kingdom.

Accordingly, we have now to make an acquaintance with more than those obvious and external characters which are found in the Frog, and to penetrate into its inner anatomy, surveying successively its bony framework and the various parts and organs which subserve the several actions necessary to its continued existence.

At the same time the more noteworthy resemblances presented by the Frog to other creatures will be pointed out. Thus we shall become acquainted with the relations existing first between the Frog and other members of its order; secondly, between the members of its order (*Anoura*) and its class fellows—*i.e.* other Batrachians; thirdly, we shall comprehend the degree of relationship existing between the Batrachia and the other classes of the Vertebrate sub-kingdom; and fourthly, we shall come to recognise certain singular resemblances which exist between the various groups of Batrachians (the Frog's order of course forming one), and some of the orders into which other vertebrate classes—especially the class of Reptiles—have been divided.

The skeleton of the Frog, both external and internal, naturally comes first as the support and foundation of the other structures. The internal skeleton (or *endo-skeleton*) will include the bones of the head, *i.e.* the skull, backbone (already referred to), and the bones of the limbs. The external skeleton (*exo-skeleton*) will consist of the skin only.

St. George Mivart

(*To be continued.*)

*ASTRONOMICAL ALMANACS**

V.—*The "Connaissance des Temps" under the continued direction of the old Academy*

LET us return to the *Connaissance des Temps* of the old Academy.

Jeaurat, who succeeded Lalande in 1775, adopted exactly the same principles as the latter; he, however, extended considerably the ephemerides of the moon, giving its declination for every six hours, to facilitate the calculation of the altitude, when at the same time only the distance could be observed. Méchain succeeded Jeaurat in 1788; he followed the example of his two predecessors, and like them, continued to take from the "Nautical Almanac" the distances of the moon, which Maskelyne had the kindness to send him even in manuscript.

Moreover, besides the ephemerides and the lunar distances, the *Connaissance des Temps* still contained observations, memoirs on various astronomical topics, an abridged notice of new books likely to be of interest to astronomers and navigators, and a brief history of astronomy during the past year, due to the skilful and well-informed pen of Lalande. This state of things continued until 1794, the year when Méchain left Paris, to take part in the meridian work. Soon after, the suppression of the academies having dispersed the astronomers, the *Connaissance des Temps* for 1795 was compiled and published by the temporary Commission of Weights and Measures. Finally, on June 25 of the same year, 1795, the publication of this work was placed under the eminent direction of the Bureau des Longitudes. Here we may conclude the first part of our account of the *Connaissance des Temps*—a work at first completely independent, then published with the approbation of the Academy, which included at the time nearly all those who were occupied with astronomy; and afterwards entrusted to the care of the Bureau des Longitudes, a commission which still continues to be charged with its publication.

* Continued from vol. viii. p. 531.

VI. *The "Connaissance des Temps" under the Bureau des Longitudes*

The first care of the Bureau was to entrust one of its members with the publication and direction of the *Connaissance des Temps*, thus showing, from the first, the true course which ought to have been adopted from the beginning, that a work of this kind demands strictly personal superintendence. Its choice fell upon Lalande, then Astronomer of the Observatory of *l'Ecole Militaire.* As to the calculations, however, the superintendence of this astronomer was more nominal than real; he was occupied mainly with the *Additions* which he had commenced in 1760, and towards which the bent of his mind,—"more of a collector than an inventor"—carried him. Thanks to the great quantity of material which he had acquired, he made of these additions a work really useful, for at this time periodic scientific publications were very rare. His *Journal d'Astronomie* (history of astronomy during the preceding year), contains a mass of information of great value, even at the present day, to all who take an interest in the history of the science of astronomy.

As to the calculations, they were made partly by Bouvard, whom Laplace had appointed adjoint to the Bureau des Longitudes, and partly in the bureau of the *Cadastre*, under the direction of Prony, its chief. It was in the office of this celebrated engineer that the distances of the moon from the sun and from the principal stars were calculated, distances which ceased from that time to be taken from the *Nautical Almanac.* Let us, however, add, that up to the year 1806 the greater part of the other calculations of the *Connaissance des Temps* were drawn from the *Nautical Almanac*, "with the view," according to the preamble, "of accelerating the publication." Despite this assistance, nevertheless, this work appeared only about a year and a half or two years in advance; it was then, at that time, completely useless to navigators who had to make a long round. The attention of the Bureau des Longitudes was not however turned in this direction. Its president was then the illustrious Laplace, one of the glories of the mathematical sciences, and who first knew how to deduce from the great discovery of Newton, all the consequences which it was calculated to yield.

Pierre Simon Laplace was born March 23, 1749, of a family of poor farmers of Beaumont-en-Auge (Normandy, Calvados). It is not known where he got the elements of his education, for when later he was raised to the highest honours, he had the weakness to wish to conceal his humble origin. Appointed in 1770, on the recommendation of d'Alembert, Professor of Mathematics at *l'École militaire* of Paris, he became in 1772 adjoint member of the Academy of Sciences, next succeeded Bezout as examiner of the pupils of the royal corps of artillery, and in 1785 was made titular Academician. During this time, his beautiful memoirs on which he founded his *Mécanique céleste*, succeeded each other almost without interruption. Finally, in 1795, he was nominated president of the Bureau des Longitudes, a position which he held till his death, March 5, 1827.

Under his leadership the Bureau was occupied mainly in perfecting and re-constructing the tables, by means of which are calculated in advance the positions of the different stars. The tables of Delambre (the sun, Jupiter, Saturn, Uranus and the satellites of Jupiter, 1792), of Mayer (corrected by Mason, 1787), for the moon, of

Lalande for Venus and Mercury, showed with the observations very great errors which the theory of Laplace promised to eliminate, or at the very least to diminish. It was to the solution of these questions that Laplace directed the forces of the Bureau, and it was to their practical execution that he applied the resources which the budget granted him.

"To accelerate the work, the different parts were distributed to various members of the Bureau. The tables of the moon, on account of the constant use made of them in astronomy and navigation, were those which it was of special importance should be completed promptly; but the length of the researches, the magnitude of the calculations, which so complicated a theory required, only permitted the hope to be cherished that in the distant future errors might be made to disappear which had gone on increasing from day to day. This was the occasion of making an appeal to all astronomers, national and foreign, who might have sufficiently advanced works upon the lunar tables. With this object the Bureau des Longitudes was authorised to offer a prize." *

This prize of 8,000 francs was awarded by the Bureau to an astronomer of Vienna, Bürg, whose tables, based upon 2,500 observations, made at Greenwich from 1765 to 1795, were deemed the most accurate and convenient. At the same time, Delambre published new tables of the sun; Bouvard, pupil of Laplace, whom he had assisted in the publication of the *Mécanique céleste* (Laplace resigned to him entirely the detailed investigations and astronomical calculations), published *Nouvelles Tables des planètes Jupiter et Saturne* (1808), a new edition of which he brought out in 1824, to which were added tables of Herschel's planet, Uranus; Delambre published his *Tables écliptiques des satellites de Jupiter* (according to the theory of Laplace and the totality of the observations made from 1662 to 1802); Burckhardt, a German astronomer, whom the conquests of Napoleon had given to France, published new *Tables de la lune* (1812), which, in the estimation of some astronomers, took the place of those of Bürg.

However, the impulse given by the splendid works of Laplace was not confined within the French frontiers. In Italy, a celebrated astronomer, Francisco Carline, published, in 1810, new tables of the sun, which were soon employed everywhere except in France.† In Germany, a man of Science, who was at one and the same time an eminent lawyer, a distinguished captain, and an excellent astronomer, Bernhard von Lindenau, published, according to Laplace's theory, tables of Venus, Mars, and Mercury. ‡

Unfortunately these excellent works, due to the powerful initiative of Laplace, were not made use of in the publication of the *Connaissance des Temps.*

In 1808, Delambre, one of the most eminent French astronomers, undertook the direction of the *Connaissance des Temps.* No essential change was made in the work till 1817; at that time the right ascension of the moon, which had until then been calculated only to a minute, was given to a second for noon and midnight. Sailors could thus determine the longitude of their ships with more exactness; and astronomers, instead of finding in the *Connaissance des Temps* only the indication of the time at which they ought to observe our satellite, could thus compare the results of their observations with those which the tables gave, and prepare the material for their improvement. Finally, in 1820, were introduced the differences in right ascension and in declination of the sun, differences useful in calculating the preceding co-ordinates at an hour other than that of noon. This was still another advantage to sailors.

But these improvements were of very little consequence in comparison with those which astronomy, geography, and navigation demanded. Germany was the first to set an example in this direction, and the Royal Astronomical Society of London, after a long and learned discussion, came to the conclusion that they were necessary. Moreover, besides being incomplete, the *Connaissance des Temps* was full of errors from beginning to end, errata being found even among the errata themselves. Radical reforms were indispensable; but to make this clearly evident, we must return to the history of the "Nautical Almanac" and the Berlin "Jahrbuch."

(*To be continued.*)

* Report of the Bureau des Longitudes, 1800.

† "Esposizione di un nuovo methodo di construire le Tavole Astromische applicato alle Tavole del Sole" (Milan, 1810).

‡ "Tabulæ Veneris novæ et correctæ ex theoria gravitatis, *clarissimi de Laplace*, et ex observationibus recentissimis in specula astronomica Seebergensi habitis erectæ" (Gotha, 1810). "Tabulæ Martis novæ et correctæ ex theoria gravitatis, *clarissimi de Laplace*, et ex observationibus recentissimis erectæ" (Essenberg, 1811). "Investigatio nova orbitæ a mercurio circa soli descriptæ, accedunt Tabulæ Planetæ ex Elementis recens repertis et theoria gravitatis, *illustrissimi de Laplace* constructæ" (Gotha, 1813).

MAN IN THE SETTLE CAVE

UNTIL the appearance of Mr. Tiddeman's paper in NATURE, vol. ix. p. 14, I had not fully realised the important issues which, according to him, depend upon the proper identification of the fragment of bone from the Victoria Cave to which he refers; nor was I aware that he was about to commit me in such very absolute terms to the opinion that it was human, but of this, as it turns out, I have no reason to complain.

Looking, however, at the apparent gravity of the statement, and knowing, also, that opinions might, and as I believe did, differ as to the origin of the bone, I have been induced to go into the matter again, and am now in a position to affirm that there is no room for the slightest doubt on the subject.

Mr. James Flower, the excellent and estimable articulator to the College of Surgeons, to whom I am under many obligations for assistance in such questions, and who at one time suggested, and had almost convinced me, that the bone was elephantine, has, after much search, found amongst the Museum stores of human osteology, a *fibula* which places the question beyond all doubt, and fully confirms the opinion I had come to, especially after seeing the Mentone skeleton, that the Victoria relic, pre- or post-glacial as it may be, is human. It is further important as showing that bones of the same conformation may occasionally be met with at the present day.

GEO. BUSK

Harley Street, Nov. 14

NOTES

DR. A. DEW-SMITH and Francis M. Balfour of Trinity College, Cambridge, have been nominated by the Board of Natural Science Studies, in accordance with the grace of the Senate (May 1, 1873), to study at the Zoological Station at Naples under Dr. Dohrn, until the end of July 1874.

AT the General Monthly Meeting of the Royal Institution to be held on Monday first, a President will be elected in the room of the late Sir Henry Holland, Bart.

PROFESSOR TRAQUAIR, of the Royal College of Science in Dublin, has been appointed to the Keepership of the Natural History Museum in the Edinburgh Museum of Science and Art. This gentleman was formerly one of the Demonstrators to the Professor of Biology in the University of Edinburgh, and is the author of several important contributions to Science.

MR. W. F. BARRETT, F.C.S., has been appointed Professor of Physics to the Royal College of Science, Dublin, in succession to the late Professor W. Barker. We feel sure that this appoint-

ment will give great satisfaction. Sir Robert Kane, F.R.S., having resigned the post of Dean of Faculty to the College, for the purpose of spending his winters in the south of Europe, Professor Galloway has been selected to fill this post. It is said that there either are, or will very shortly be, a vacancy in the Professorship of Chemistry owing to Professor Sullivan's appointment to the Presidentship of the Queen's College, Cork.

Dr. E. H. Bennett has been elected Professor of Surgery in the University of Dublin, in succession to the late Dr. R. W. Smith; and Dr. Thos. E. Little has been elected to fill the post of University Anatomist. In connection with news from the Dublin University, we may mention that it is understood that the authorities have determined to build a new museum for their anatomical and zoological collections. At present, in connection with the Medical School, there is a small collection of human and comparative anatomy, and, in the Arts' School a very good collection of zoology. It is intended to combine these two in a new building. The College authorities would confer a great boon on natural science in Dublin if they would venture to go a step further and make their new museum contain all their biological collections. The advantages would be great of having the distribution of animals in space and time shown in connection the one with the other; and there is something incongruous in separating the specimens illustrating the past and present races of mankind from the zoological collection, and combining the specimens illustrating the anatomy and physiology of the human species with those illustrative of the other animals. For the convenience of the students, we trust that the extensive herbarium of the College may also be lodged under the roof of the new building, which, to be useful, need contain no lofty halls or grand corridors, but should consist of a series of well-lit rooms, after the fashion of, we would suggest, that nicest of museums, the one for Economic Botany at Kew.

The following memorandum on the Whitworth Scholarships, prepared by Sir Joseph Whitworth, has been approved by the Lords of the Committee of the Council on Education:—"I wish that candidates for my Scholarships in 1874, who, owing to the shortness of the notice, may not have been able to be in a mechanical shop for six months before the competition takes place, should be allowed to compete, but that if successful, their scholarship should not begin until they have worked six months in a mechanical shop. I think the same privilege should be accorded to candidates in 1875, who have not served eighteen months in a mechanical shop, the scholarship not beginning until this period is completed."

The 120th session of the Society of Arts was opened on the 19th inst. with an address by the Chairman of the Council, Major-General F. Eardley-Wilmot, F.R.S.

The *magnum opus* of three generations of botanists, De Candolle's "Prodromus Systematis naturalis vegetabilium," containing a diagnosis of every known species of flowering plant, has now been completed as far as Dicotyledons are concerned, and it is not intended to continue the work into the Monocotyledons. In commemoration of the completion of the work, the Horticultural Society of Belgium has awarded M. de Candolle a special medal. The publication of the work was commenced in 1818.

The trustees of the Gilchrist Educational Fund offer a scholarship of the value of 50*l.* per annum, tenable for three years at Girton College, Cambridge, to be competed for at the General Examination for Women, conducted by the University of London in May, 1874.

From the commencement of next year, *The Gardeners' Chronicle and Agricultural Gazette* will be divided into two papers, each weekly, to be devoted to the interests of the two sister sciences.

Dr. William Wallace, in opening recently the session of the Chemical Section of the Philosophical Society of Glasgow, spoke, among other things, of the endowment of research. From what he said on this subject, we think the following pointed remarks worthy of attention:—With regard to students who attended evening lectures and classes, a very great deal had been done for them by the Society of Arts, and by the examiners of the Science and Art Department, both of which had given great encouragement to the class of students whom they were intended to benefit. What was lacked most was a stimulus to men of the highest educational class. In this country, apart from professorships, there were no means of assisting that class except, perhaps, a few sinecures and the conferring of empty titles. In France, at least under the Imperial *régime*, when a man acquired renown in a particular line of investigation, a laboratory with all the best and most suitable appliances was immediately fitted up for him. Hence Paris was provided with a series of the most complete laboratories for metallurgy, for agriculture, for the sugar manufacture, and for many other branches of the science; and students might go to study a particular subject with the certainty that they would have a most efficient teacher and the advantages of a laboratory fitted up specially, and, as one might say, regardless of expense, with the apparatus and requirements necessary for the teaching and study of the subject. It appeared to him (Dr. Wallace) that the endowment of research would form a desirable stimulus for chemists, many of whom had the necessary education and talent, but could not afford the time nor the expense, often considerable, of obtaining the apparatus and materials required.

A Society of Physical and Natural Science was founded four years ago at Caracas, Venezuela; but the political agitations of the country have, until recently, hindered its development. Meanwhile it has commenced the publication of a Bulletin under the title of *Vargasia*, so named in honour of the American botanist Vargas. *L'Institut* learns, by a letter from Dr. Ernst, who is at once president, secretary, and treasurer of the society, that the present Government of Venezuela intends to promote, as much as it can, the growth of scientific studies, mainly by the establishment of various institutions for public instruction. Dr. Ernst, appointed Professor of Botany in the University of Caracas, where hitherto there has been no such chair, has been charged with the direction or rather the creation of a botanic garden and a museum of natural history. In the museum Prof. Ernst intends to collect—1st, a herbarium of Venezuela; 2nd, a general herbarium; 3rd, a collection relating to economic botany. He intends to publish in a few years a Flora of Caracas. Dr. Ernst appeals to European botanists and collectors for exchanges to assist him in the formation of these herbaria.

It is not often that Mr. Disraeli says anything which calls for particular notice in a journal of this kind, therefore it is with peculiar pleasure that we quote the opinion he uttered last week at the Glasgow banquet as to the share which Science has had during the present century in moulding the world. Coming from a man of his shrewdness and sentimentality withal, the words have a striking force. Speaking of the last fifty years, he said:—"How much has happened in these fifty years—a period more remarkable than any, I will venture to say, in the annals of mankind. I am not thinking of the rise and fall of empires, the change of dynasties, the establishment of Governments. I am thinking of those revolutions of science which have had much more effect than any political causes, which have changed the position and prospects of mankind more than all the conquests and all the codes and all the legislators that ever lived."

At the first meeting of the Edinburgh Botanical Society for

the winter, Mr. James McNab, curator of the Royal Botanical Gardens, delivered an address on the change of climate in Scotland, which, during the last fifty years has undergone a considerable lessening of the summer heat. From this cause peaches and nectarines cannot be ripened to the same perfection in the open air as formerly, while asparagus, mushrooms, and tomatoes are gradually disappearing. The larch, in spite of the enormous quantities of seed annually imported, if declining in vigour, and there is a talk of substituting for is the Wellingtonia as a nurse-tree. Mr. McNab proposes that a central committee should be appointed to investigate the whole subject of the change of climate in Scotland.

THE following is an ephemeris (for 0^h Berlin time) of the comet discovered by M. Coggia at Marseilles, on the evening of the 10th inst:—November 22, $14^h\ 51^m\ 25^s$—$6^\circ\ 8'\cdot2$; November 30, $14^h\ 14^m\ 30^s$—$22^\circ\ 43'\cdot0$; December 8, $14^h\ 0^m\ 17^s$ —$32^\circ\ 1'.8$. Its elements are:—T = Dec., 4·1348, Berlin mean time; $\pi = 94^\circ\ 23'\ 14''$; $\Omega = 254^\circ\ 14'\ 9''$; $i = 27^\circ\ 2'\ 7''$. Mean Equinox, 1873·0 *log. q.* = 9·83810.

ONE of the special results of the United States geological and geographical survey of the Territories, in charge of Prof. F. V. Hayden, during the past summer, has been the discovery that Colorado Territory is the centre of the greatest elevation of the Rocky Mountain chain. In Central Colorado the chain proper is about 120 miles broad, made up of three lofty parallel ranges, running nearly north-north-west, and flanked from the west by great plateaus and groups of peaks. Between the ranges lie the great elevated basins known as "parks." The front range, which rises abruptly from the plains, is seen from Denver in a grand panorama 120 miles long. From its snowy serrated crest rise many peaks between 13,000 and 14,000 ft. high. On the west side of the parks is the Park Range, whose highest group is at Mount Lincoln, this and Quandary Peak each rising to about 14,000 ft. The survey has established a permanent meteorological station at Fairplay, 10,000 ft. above the sea, and another at Cañon City, about 6,000 ft. These stations are all connected by a spirit-level line, and the comparison of their observations will be of remarkable interest. The National Range lies east of the Park Range, and is separated from it by the Arkansas Valley. West of the National Range rises the great group of Elk Mountains, five of whose peaks are 14,000 ft. high. So far as known, there are in the district explored during the past season by the survey 72 peaks, ranging from 14,000 to 14,200 ft. in height.

IN the article on Local Societies (vol. ix. p. 24) we inadvertently confounded the Manchester Natural History Society with the Microscopical and Natural History section of the Manchester Literary and Philosophical Society. The former of these is extinct—having handed its collections over to the Owens College—and also contributed a handsome sum of money to promote, permanently, the study of Natural History in the Literary and Philosophical Society. This endowment now enriches the Natural History section of that society. Manchester science will gain rather than lose by these changes. The defunct society was never more than the creator and guardian of a museum. That museum will still be preserved and increased, as well as utilised, by the College, whilst the Natural History section affords promise of a healthy career of scientific work.

M. CHARREL, of Marseilles, writes as follows to the *Bulletin International*, of the Observatory of Paris, on the invention of balloons:—In the literary history of the City of Lyons, published by Father Colonnia (1830, vol. i. p. 112), it is stated that in the reign of Louis le Debonnaire, the Archbishop of Lyons learned that some aërial navigators had fallen with their boat on the banks of the Saone, and were going to be put to death as sorcerers. He ordered them to be brought into his presence, and after having heard them, he caused them to be nonsuited (*le fit mettre hors de procès*). The memoir of the prelate bears such a character of authenticity as leaves no doubt of the fact. The following words are taken verbatim from the memoir: "Videmus exhibere vinctos quatuor *homines;* tres viros et unam feminam, quasi qui de ipsis navibus ceciderunt, quos . . . exhibuerunt in nostra presentia tanquam lapidandos." It follows, then, from this memoir, that already, in the ninth century, aërial navigation was known; how it was accomplished the memoir does not give any indication.

THE first Annual Exhibition of the West London Entomological Society, established 1868, will be held on December 2 and 3, at the "Mason's Arms," Tichborne Street, Edgware Road.

A *Times* telegram from Teheran, November 24, says that Colonel Baker and Lieutenant Gill have arrived at Teheran, and leave immediately for England, *viâ* Tabreez and Erivan. Travelling to the north from Meshed, they passed along the Turcoman frontier by Kelat, Abiverd, Dereguez, Annau, Astrabad, and Nissa. Striking south, they discovered the source of the Attrek at Karakazan, an extraordinary spring near Shirvan, and followed the course of the river for a considerable distance northwest of Bojnoord, until stopped by hostilities between Bojnoord and the Turcomans. Striking into the mountains, they were enabled to trace the course of the river until it fell into the plains, and also to observe the great range of mountains which runs along the whole Persian frontier from Sarakhs to Kizil Arvat. Existing conjectural maps of this country are quite incorrect.

ON the 1st inst. the Earl of Dalhousie formally opened the Art Exhibition and Museum of the Albert Institute of Dundee, which, with the previously opened portions—free library and lecture-hall—form one handsome block of buildings. In the list of towns, with their scientific societies, published by us a week or two ago, we were surprised to see Dundee, so rapidly advancing in population and wealth, occupy so humble a place. We cannot see how towns like Leeds, Newcastle, Manchester, Glasgow, and others should have their flourishing and well-equipped scientific societies, while Dundee has only one small struggling society of young men, the Naturalists' Field Club. The neighbouring and comparatively stagnant town of Perth, with its large and efficient society, puts Dundee to the blush in this respect. We shall be disappointed if the opening of the Albert Institute in Dundee, a town so dependent for its commercial and manufacturing success on the applied results of Science, does not give an impetus to the study of Science. There are already Science and Art Classes in the town, and we hope to hear soon of the establishment of regular courses of scientific lectures, such as those which are found in several of the large English manufacturing towns, and the formation of at least one flourishing scientific society and field club around the small nucleus already existing. We hope also that the collections in the museum will be made worthy of the wealthy town and be really representative of the treasures of the various kingdoms of Nature. We feel sure that the citizens of Dundee only need their attention to be drawn to the backward state of their town in the matter referred to to rouse them to put it on a level in this respect with the large English towns.

THE additions to the Zoological Society's collection during the last week include an Eagle (*Spizaëtus?*) from Burmah, presented by Mr. H. Fielder; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. Gore; a pair of Jaguars (*Felis onça*) born in the Jardin des Plantes, Paris, received in exchange.

ON SOME RECENT RESULTS WITH THE TOWING NET ON THE SOUTH COAST OF IRELAND *

1.—*Mitraria*

ONLY a single specimen was obtained of the little *Mitraria*, which formed the subject of the present communication, and neither its structure nor development was made out as completely as could have been wished. From the Mediterranean species described in a former communication (British Association Report for 1872), it differs in some points of structure and in the mode of annulation of the developing worm. It possesses the usual *Mitraria* form, that of a hemispherical dome having its base encircled by a band of long vibratile cilia. In the side of the dome a little above the ciliated band is the mouth which leads into a rather wide pharynx clothed with a ciliated epithelium. The pharynx runs through the dome parallel to its base and opens into a capacious stomach which continues in the same direction until it joins the intestine. This then turns down abruptly at right angles to the previous portion of the alimentary canal, and then projects for a slight distance beyond the base of the dome, carrying with it hernia-like the walls of the base.

The true body walls of the future worm, of which the *Mitraria* is the larva, seem as yet confined to the intestinal segment of the alimentary canal. They already present the commencement of annulation, which, however, exists only on the dorsal and ventral sides, while two broad bands of very distinct fibres may be seen, one on the right and the other on the left side, extending transversely from the dorsal to the ventral surface.

The ciliated band which runs round the base of the dome possesses a rather complex structure. It consists of two concentric rings: an outer one composed of large oval distinctly nucleated cells, and an inner one of a granular structure and yellowish colour, in which no distinct cells could be demonstrated. The cilia form two concentric wreaths borne by the under side of the band, an outer wreath consisting of very long cilia, and borne by the inner edge of the outer portion of the band, and an inner wreath of much shorter cilia borne by the inner edge of the inner portion. The band with its cilia is interrupted for a very short space at the aboral side of the dome. There is probably at this spot an entrance into a water-vascular system. No such system, however, was observed in the specimen, though the author had described in another species of *Mitraria* a system of sinuses which appear to exist in the walls of the dome, and which he regarded as representing a water-vascular system (Brit. Assoc. Report for 1872).

Occupying the very summit of the dome is a large, somewhat quadrilateral ganglion, from which two distinct filaments are sent down, one on each side of the alimentary canal, but he was not able to follow these filaments to their destination. The bilateral symmetry of the ganglion suggests its formation out of two lateral halves. Though its very superficial position gives it the appearance of being a mere thickening of the walls, the view here taken of its being a nervous ganglion seems to be the only one consistent with its relations to the surrounding parts.

On each side of the pharynx, a little behind the mouth, is a small oval ganglion-like body from which a filament runs to the ciliated band. Some delicate filaments may also be seen lying between the pharynx and the walls of the dome on which they seem to be distributed, but the author could not trace them to any distinct ganglionic centre.

The great apical ganglion carries two very obvious black ocelliform spots, and besides these two clear vesicles enclosing each a clear spherical corpuscle. The two vesicles may probably be regarded as auditory capsules.

The further development of this larval form has not been observed. It probably consists chiefly in the continued prolongation of the alimentary canal beyond the base of the hemispherical dome, the completion of the annulation by its extension to the right and left sides, and the gradual contraction of the dome and final absorption of the ciliated band.

2.—*Tornaria*

Two specimens of the larval form originally discovered by Johann Müller, and described by him under the name of *Tornaria*, were obtained, but these unfortunately perished before a sufficiently exhaustive examination of them could be made. On the whole their structure agrees closely with what has been pointed out by Alex. Agassiz in his valuable and elaborate memoir on *Tornaria* and *Balanoglossus*. The species appears to be different from those hitherto described. The gills had not begun to show themselves, and there were but traces of the "lappets" described in other species as appended to the posterior extremity of the stomach.

The author believed that he could distinguish a minute ganglion on each side of the œsophagus; filaments were sent off from it to the neighbouring parts, and the two were connected to one another by a sub-œsophagal commisure. The water-vascular chamber was very distinct, but the so-called heart was not observed; while within the body-cavity, lying close to the dorsa pore and over the canal by which the great water-sac communicates with the external medium, was a small, closed, rather thick-walled vesicle containing numerous oval corpuscles. Of the nature of this vesicle the author could not offer any opinion.

The cushion-like body which occupies the summit of the larva exactly as in *Mitraria*, and supports the two ocelliform spots, was very distinct, and so also was the contractile chord which extends from this to the walls of the water-sac. The author, however, could not here, any more than in *Mitraria*, regard the cushion-like body as a mere thickening of the walls; he believed it to be a nerve-mass, and thought he could trace two fine filaments proceeding from it and running down, one towards the right and the other towards the left side of the alimentary canal, but he was not able to follow them for any distance, and he does not regard their existence as confirmed. The extremely superficial situation of this body, which makes it resemble a mere thickness of the walls, is paralleled by that of the great ventral nerve-mass in *Sagitta*.

The contractile chord which runs to the water-sac is probably attached to a capsular covering of the ganglion, rather than directly to the ganglion itself. This chord, though showing strong contractions by which the summit of the larva is drawn down towards the water-sac, is of a homogeneous structure, presenting no appearance of distinct fibrillæ or of other contractile elements.

The author instituted a comparison between *Tornaria* and *Mitraria*. We have in both the external transparent pyramidal or dome-shaped body, with a lateral oral orifice, and a basal anal orifice, enclosing an alimentary canal which is divisible into three regions, and takes a partly horizontal and partly vertical direction in its course from one orifice to the other;* we have in both, near the base of the body, the circular band which carries long vibratile cilia accompanied by a row of pigment spots, and in both the cushion-like ganglion carrying ocelli.

From *Mitraria*, *Tornaria* chiefly differs in the presence of the thick sinuous and convoluted bands which give it so close a resemblance to certain Echinoderm larvæ, and which are entirely absent from *Mitraria*, and in its water-vascular system with the contractile cord which extends from this to the apical ganglion. If a water-vascular system is present in *Mitraria*, it consists there of a system of sinuses excavated in the walls of the dome, but without any representative of the great central sac. In *Mitraria* the great apical ganglion carries not only the two ocelli, but also two capsules, probably auditory; these capsules do not exist in *Tornaria*. In *Mitraria* the two nerve chords which the apical ganglion sends down one on each side of the alimentary canal are very distinct; in *Tornaria*, if they exist at all, they are by no means obvious. Finally, the ciliary circlet is simple in *Tornaria*, while in *Mitraria* it is double.

According to Alexander Agassiz's account of the development of *Tornaria* into *Balanoglossus*, the great transverse circlet of cilia becomes, by the elongation of the body, gradually pushed backwards, so as to form the anal ciliated ring of the young worm; in *Mitraria* the great ciliary circlet remains unchanged in position, and is probably ultimately absorbed, the worm during its development acquiring a new anal wreath of cilia.

3. *Ametrangia hemispherica* (nov. gen. et spec.)

Among the most abundant products of the towing-net was a little hydroid medusa, remarkable for the want of symmetry in the distribution of its gastro-vascular canals. It is of a hemispherical form, with the base about half-an-inch in diameter, and provided with very numerous (more than 100) marginal tentacles, which are very extensile, and may at one time be seen floating away to a length of three or four inches and at another coiled into a close spiral against the margin of the umbrella.

* Paper read at the Meeting of the British Association, Bradford by Prof. Allman, F.R.S.

* In the species of *Mitraria* described by J. Müller and by Metschnikoff, both oral and anal orifices are basal, and the alimentary canal presents a U-shaped curvature

Each tentacle originates in a bulbous base with a distinct ocellus. No lithocysts are visible on the margin. The velum is of moderate width.

The manubrium forms a small projection from the summit of the umbrella, and terminates in four rather indistinct lips. From the base of the manubrium three rather wide offsets are sent off at equal intervals into the walls of the umbrella. These gradually contract in diameter, and then, as three narrow tubes of uniform diameter, run towards the margin, where they open into the circular canal. The symmetry of the radiating canals is confined to these three primary trunks. From their wide proximal ends each sends off branches, some of which may be traced to the margin where, like the three primary canals, they enter the circular canal, while others can be followed for various distances in the umbrella walls, in which they terminate by blind extremities without ever reaching the margin. These branches are very irregular in the number sent off from each primary canal, as well as in their length and directions.

The generative elements are formed in oval sporosacs developed one on each of the three primary canals at the spot where the wider base passes into its narrower continuation. The ova may be seen within them in various stages of development; they increase considerably in size before the commencement of segmentation, always showing up to that period a large and distinct germinal vesicle with germinal spot and with a distinct nucleolus in the interior of the germinal spot. The development of the ovum proceeds within the sporosac to the segmentation of the vitellus and the formation of the planula, which now breaks through the outer walls of the sporosac and remains for some time adhering to their external surface. The planula differs remarkably from the typical hydroid planula. It remains of a nearly spherical form, never acquiring cilia, and possesses little or no power of locomotion. The gastric cavity, however, is fully formed. The author was unable to follow the ova in their further development.

The little medusa now described, departs in several important points from the typical hydroid medusa. From this it differs in the ternary disposition of the primary radiating canals, and in the irregular non-symmetrical arrangement of those which are subsequently formed. Among the very many specimens examined, the author never found any in which the canals had become regular in their disposition, even in those which had discharged the contents of their sporosacs, and had evidently attained the term of their existence. It differs also from the typical medusa in the form and non-ciliated condition of the planula; and still further in the fact that while the generative elements are borne on sporosacs, developed on the radiating canals, the marginal bodies are ocelli and not lithocyst.

4.—*Circe invertens* (nov. spec.)

Among the hydroid medusæ captured in the towing-net, were two or three specimens of a species referable to the genus *Circe* of Mertens. It measures about half-an-inch in its vertical diameter, and about a quarter of an inch transversely. It is cylindrical from its base upwards, for about two-thirds of its height, and then contracts abruptly, and arches dome-like towards the truncated summit, which is surmounted by a solid cone of the gelatinous umbrella substance. From the summit of the umbrella-cavity, a solid somewhat fusiform extension of the roof hangs down in the axis of its cavity for about two-thirds of its depth, and at its free end carries the manubrium, which extends nearly to the codonostome. The margin of the umbrella carried eighty very short and but slightly extensile tentacles, which were connected at their bases by a very narrow membraneous extension of the margin, with rather irregular free-edge. Lithocysts are situated at irregular intervals upon the margin. There are about sixteen of them; they consist each of a minute spherical vesicle with a single large spherical concretion. There are no ocelli. There is a moderately wide velum.

The radiating canals are eight in number. They spring from the base of the manubrium, run up the sides of the solid process which hangs from the summit of the umbrella; pass from this to the walls of the umbrella, and then run down towards the margin in order to open into the circular canal.

The generative elements are borne in pendent sporosacs, which spring from the radiating canals close to the summit of the umbrella cavity.

The motion of the medusa takes place by means of sudden jerks, reminding us of the way in which certain Diphydæ dart through the water.

The medusa possesses also a very singular habit of partial inversion. This takes place along the line which separates the dome-like portion of the umbrella cavity from the lower cylindrical portion, and consists in the withdrawal of this dome-like summit and the lower portion of the cavity. When thus inverted the little animal presents a drum-shaped form, with the manubrium hanging far out of the codonostome.

Alexander Agassiz considers the genus *Circe*, of Mertens, as synonymous with *Trachynema* Gegenbaur, and points out that the name of *Circe* had been already used for a genus of mollusca. He further removes it from among the true hydroid medusæ, and regarding it as closely allied to the *Æginidæ*, places it along with those in the *Haplostomeæ* Agassiz, a sub-order of the *Discophora*.

The author, however, could not see sufficient grounds for the removal of Mertens' genus from the true *Hydroida*, with which the medusa now described agrees in all essential points, including the form and disposition of the gastro-vascular and generative systems and the structure of the marginal lithocysts. Neither could he agree with Alexander Agassiz in identifying it with *Trachynema*. The greatly developed solid peduncle by which the manubrium in *Circe* is suspended from the summit of the umbrella-cavity in a way, however, which has its parallel in *Tima* among others, is of itself a character of generic importance by which *Circe* must be kept apart from *Trachynema*. It is true that Gegenbaur's *Trachynema* has the character of a young form, and until we have further evidence of its adult state its affinities cannot be regarded as established.

Gegenbaur believes that he has established the direct development of *Trachynema* from the egg without the intervention of a hydriform trophosome, but unfortunately we have no data by which to compare in this respect *Circe* with *Trachynema*.

It must be admitted too that in the imperfect contractility of the marginal tentacles and in the somewhat greater firmness of the umbrella walls the little medusa described in the present communication possesses characters which look towards the *Æginidæ*, but these are by no means sufficiently strong to justify its separation from the ordinary hydroid medusæ.

5.—*Tomopteris*

A few young specimens of this beautiful little worm were obtained, and the author was enabled to confirm the statements of Grube and of Keferstein, who describe in it a double ventral nerve chord, though other observers have failed to discover this part of the nervous system and throw doubt upon its existence. In adult specimens examined some years previously by the author no ventral chord could be detected.

The ventral portion of the nervous system consists of two flat ribbon-shaped chords which are given off from the inferior side of the nerve ring which surrounds the pharynx just behind the mouth. These run parallel to one another, separated by a narrow interval; they lie on the ventral walls of the animal, and may be traced through the narrow tail-like termination of the body as far as its extremity. They present no ganglionic swellings, but opposite to every pair of feet each sends off a filament which passes to the foot of its own side in which it is distributed.

Dr. Anton Dohrn has just informed the author that he too had distinctly seen the ventral chord of *Tomopteris*.

SCIENTIFIC SERIALS

AMONGST the papers in the October and November numbers of the *American Naturalist*, are included Dr. J. L. Smith's Address to the American Association for the Advancement of Science, on Science in America and Modern Methods of Science. —Mr. R. Ridgway describes some new forms of American Birds, which he considers as geographical races, and not distinct species. Included are *Catherpes mexicanus*, var. *conspersus*; *Helminthophaga celata*, var. *lutescens*; *Dendroica vieillotii*, var. *bryanti*; *D. dominica*, var. *albilora*; *D. graciæ*, var. *decora*; *Myiodioctes pusillus*, var. *pileolata* (Pallas), and *Collurio ludovicianus*, var. *robustus* (Baird), which are described and followed by a synopsis of the genera of *Certhiola*, *Junco*, and *Cardinalis*.—Prof. C. A. Riley has a paper on the Oviposition of the Yucca Moth, in which he shows that the female conveys her eggs into the young fruit by a lateral puncture. The Structure and Growth of Domesticated Animals, forms the subject of a popular lecture by Prof. Agassiz, which is followed by one on Staurolite

Crystals and Green Mountain Gneisses of the Silurian Age, by Prof. Dana.—The Rev. D. T. Hill gives instances of intelligence in *Bufo americanus*.—Mr. G. W. Morehouse analyses the structure of the scales of *Lepisma saccharina*.—Mr. D. Scott gives a popular explanation of the differences between the two genera of North American Goatsuckers, the Whippoorwills (*Antrostomus*), and the Nighthawks (*Chordeiles*), which is followed by a short note from Mr. Packard, jun., on the Embryology of Limulus, with remarks on its affinities. His results are confirmatory of those of M. Alphonse Milne-Edwards.

The fourth and concluding part of vol. xxviii. of the *Transactions of the Linnean Society*, is chiefly occupied by a supplementary paper by the Rev. O. P. Cambridge, on New and Rare British Spiders; but also contains some short papers of importance.—Prof. Oliver describes a new genus of Begoniaceæ from New Granada, under the name of *Begoniella*, a monotypic genus of great interest as respects the geographical distribution of the order; and three new genera of Malayan plants from the herbarium of Dr. Maingay—*Pteleocarpa* and *Ctenolophon* (Olacineæ), and *Maingaya* (Hamamelideæ).—Dr. M'Nab publishes his important paper on the Development of the flowers of *Welwitschia mirabilis*. Dr. M'Nab considers that in the male flowers of this very remarkable plant we have a very close approach to the Angiosperms, the axis of the flower ending in a mass of tissue which, in the female flower, is the terminal ovule; while, in the female flower, we have the truly gymnospermous condition, there being no carpels, but a terminal ovule, the modified end of the axis of the flower, with a single ovular integument, the pollen grains being applied directly to the naked nucleus.

SOCIETIES AND ACADEMIES

Royal Society, Nov. 20.—"Note on the Electrical Phenomena which accompany irritation of the leaf of *Dionæa muscipula*," by Dr. J. Burdon Sanderson, F.R.S.

1. When the opposite ends of a living leaf of *Dionæa* are placed on non-polarisable electrodes in metallic connection with each other, and a Thomson's reflecting galvanometer of high resistance is introduced into the circuit thus formed, a deflection is observed which indicates the existence of a current from the proximal to the distal end of the leaf. This current I call the *normal leaf-current*. If, instead of the leaf, the leaf-stalk is placed on the electrodes (the leaf remaining united to it) in such a way that the extreme end of the stalk rests on one electrode and a part of the stalk at a certain distance from the leaf on the other, a current is indicated which is opposed to that in the leaf. This I call the *stalk-current*. To demonstrate these two currents, it is not necessary to expose any cut surface to the electrodes.

2. In a leaf with the petiole attached, the strength of the current is determined by the length of the petiole cut off with the leaf, in such a way that the shorter the petiole the greater is the deflection. Thus in a leaf with a petiole an inch long I observed a deflection of 40. I then cut off half, then half the remainder, and so on. After these successive amputations, the deflections were respectively 50, 65, 90, 120. If in this experiment, instead of completely severing the leaf at each time, it is merely all but divided with a sharp knife, the cut surfaces remaining in accurate apposition, the result is exactly the same as if the severance were complete; no further effect is obtained on separating the parts.

3. *Effect of constant current directed through the petiole on the leaf-current*.—If the leaf is placed on the galvanometer electrodes as before, and the petiole introduced into the circuit of a small Daniell, a commutator being interposed, it is found that on directing the battery-current down the petiole (*i.e.*, *from* the leaf), the normal deflection is increased; on directing the current *towards* the leaf, the deflection is diminished.

4. *Negative variation*.—*a*. If, the leaf being so placed on the electrodes that the normal leaf-current is indicated by a deflection *leftwards*, a fly is allowed to creep into it, it is observed that the moment the fly reaches the interior (so as to touch the sensitive hairs on the upper surface of the lamina), the needle swings to the right, the leaf at the same time closing on the fly.

b. The fly having been caught does not remain quiet in the leaf; each time it moves the needle again swings to the right, always coming to rest in a position somewhat farther to the left than before, and then slowly resuming its previous position.

c. The same series of phenomena present themselves if the sensitive hairs of a still expanded leaf are touched with a camel-hair pencil.

d. If the closed leaf is gently pinched with a pair of forceps with cork points, the effect is the same.

e. If the leaf-stalk is placed on the electrodes, as before, with the leaf attached to it, the deflection of the needle due to the stalk-current is *increased* whenever the leaf is irritated in any of the ways above described.

f. If half the lamina is cut off and the remainder placed on the electrodes, and that part of the concave surface at which the sensitive hairs are situated is touched with a camel-hair pencil, the needle swings to the right as before.

g. If, the open leaf having been placed on the galvanometer electrodes as in *a*, one of the concave surfaces is pierced with a pair of pointed platinum electrodes in connection with the opposite ends of the secondary coil of a Du Bois-Reymond's induction apparatus, it is observed that each time that the secondary circuit is closed, the needle swings to the right, at once resuming its former position in the same manner as after mechanical irritation. No difference in the effect is observable when the direction of the induced current is reversed. The observation may be repeated any number of times, *but no effect is produced unless an interval of from ten to twenty seconds has elapsed since the preceding irritation.*

h. If the part of the concave surface of the leat which is nearest the petiole is excited, whether electrically or mechanically, the swing to the right (negative variation) is always preceded by a momentary jerk of the needle to the left, *i.e.* in the direction of the deflection due to the normal leaf-current; if any other part of the concave surface is irritated, this does not take place.

i. Whether the leaf is excited mechanically or electrically, an interval of from a quarter to a third of a second intervenes between the act of irritation and the negative variation.

"On the Algebraical Analogues of Logical Relations," by Alexander J. Ellis, F.R.S.

The object of this paper is to examine the "mathematical theory of logic," thus laid down by Dr. George Boole in his "Laws of Thought," p. 37:—"Let us conceive of an Algebra in which the symbols x, y, z, &c. admit indifferently of the values 0 and 1, and of these values alone. The laws, the axioms, and the processes of such an algebra will be identical in their whole extent with the laws, the axioms, and the processes of an Algebra or Logic. Difference of interpretation will alone divide them." For this purpose, first the laws of such an algebra have been investigated independently of logic, and secondly the laws of primary and secondary logical propositions as laid down by Dr. Boole, have been developed in an algebraical form, and compared with the former. The main results presumed to be established are:—

1. That there is a fundamental difference between such an algebra and logic, inasmuch as the algebra admits of only *two* phases, 0 and 1, and logic admits of *three* phases, namely, not only *none* and *all*, corresponding to 0 and 1, but also *some*, "which, though it may include in its meaning *all*, does not include *none*" (*ibid*, p. 124), and hence has no analogue in such an algebra; that is, an algebra of 0 and 1 can correspond only to a logic of *none* and *all*.

2. That, notwithstanding this difference, there are certain formal relations of equations which allow the algebra of 0 and 1 to be used as an *algorithm* for the purpose of arriving at certain logical forms, which, however, have then to be interpreted on a basis which has not even any analogy to the algebraical.

3. That the introduction of this algorithm introduces theoretical difficulties, adds to the amount of work, and is entirely unnecessary even for the purposes of the theory of probabilities founded upon it by Dr. Boole.

Mathematical Society, Nov. 13.—Prof. Cayley, and subsequently Prof. Sylvester, in the chair.—The following gentlemen have been elected officers of the new council:—President, Dr. Hirst; Vice-Presidents, Prof. Cayley, and Messrs. Spottiswoode and Sylvester. The retiring members were Prof. Crofton and Mr. J. Stirling, in whose room Mr. Sylvester and Lord Rayleigh were elected.—Mr. Sylvester then gave a description of a new instrument for converting circular into general rectilinear motion, and into motion in conics and other plane curves. (A brief sketch of the historical aspect of the communication, from the pen of Mr. Sylvester, forms the subject of a paragraph in NATURE of Nov. 13.) Several instruments were placed on the table for inspection.—Mr. W. Marsham Adams

exhibited his Mensurator and Cælometer, and gave a short account of the objects to which they could be applied. The Mensurator is an instrument designed primarily for the instantaneous solution of triangles, but capable, from its construction, of many other uses; such as illustrating most of Euclid's theorems with regard to the triangle, of performing addition, subtraction, rule of three, and extraction of square roots, of solving quadratics and simple binomial equations, and of reducing to mechanism some part of analytical geometry. The Cælometer is an apparatus consisting of a stand carrying a globe mounted somewhat like a sea compass, and illustrates celestial longitude and latitude, the phenomena of the seasons, the correspondence of the calendar with the solar year, the precession of the equinoxes, the times of sunrise at any place on any day, the position of the principal stars during the night, and the general relations between the conceptions necessary for nautical astronomy. Medals were awarded for both instruments at the Vienna Exhibition. —Mr. S. Roberts (treasurer) read a short note "On the expression of the arc of a Cartesian by elliptic functions." The author showed that the hyper-elliptic part of the integral which gives the value of an arc of a Cartesian, is reducible to the form which Jacobi has shown to depend on elliptic functions.

Zoological Society, Nov. 19.—Dr. A. Günther, F.R.S., vice-president, in the chair. Mr. Sclater exhibited and pointed out the characters of two new species of birds obtained by Mr. Salmon during his expedition to the State of Antioquia, Columbia. These were named *Chlorochrysa nitidissima* and *Grallaria ruficeps*.—A letter was read from Mr. R. Swinhoe, H.B.M. Consul at Chefoo, containing a note on the White Stork of China, and stating that he had recently obtained a live Pitta in China, which appeared to be *Pitta nympha* of the Fauna Japonica.—Mr. A. H. Garrod exhibited and pointed out certain peculiarities in the cæcum of a Crab-eating Fox (*Canis cancrivorus*).—Mr. Sclater exhibited and made remarks on a pair of horns of the new Bubaline Antelope from the Bogos country, lately named *Alcelaphus tora* by Dr. Gray.—A paper was sent by Dr. Edward L. Moss, Surgeon in charge R.N. Hospital at Esquimalt, on a singular Virgularian Actinozoon taken at Burrard's Inlet, close to the northern mouth of the Fraser River.—A communication was read from Dr. O. Finsch, containing the description of a most remarkable and interesting new Passerine Bird which he had received from Mr. T. Klinesmith of Levuka, Ovalou, Feejee Islands. This little bird, which was not only new as a species, but also the type of a new genus, he proposed to call *Lamprolia Victoriæ*.—A communication was read from Mr. W. S. Atkinson, of Darjeeling, containing the descriptions of two new species of Butterflies from the Andaman Islands, which were named respectively *Papilio mayo* and *Euplœa andamanensis*.—Dr. Cobbold communicated the first of a series of papers entitled "Notes on the Entozoa;" being observations based on the examination of rare or otherwise valuable specimens contributed at intervals by Messrs. Charles Darwin, Robert Swinhoe, Charles W. Devis, the late Dr. W. C. Pechey, Dr. Murie, and others.—Mr. Edwin Ward exhibited and gave the description of a new Bird of Paradise, of the genus *Epimachus*, which he proposed to call *E. ellioti*.—A communication was read from Surgeon-Major Francis Day, containing remarks on Indian Fishes, mostly copied from the original manuscripts of the late Dr. Hamilton Buchanan.—Mr. J. W. Clark read a memoir on the Eared Seals of the Auckland Islands, one of which he recognised as *Otaria hookeri*, thus fixing the locality of this species.

Linnean Society, Nov. 20.—Mr. G. Bentham, president, in the chair.—Prof. Dyer exhibited a specimen of the fruit of *Luffa ægyptiaca*, a gigantic species of gourd, grown in this country.—An account of the flora of Monte Argentaro, on the borders of Tuscany, by Mr. Henry Groves, of Florence, was read.—On the Algæ of Mauritius, by Dr. Dickie. The total number of species recorded is 155. These include 17 well-known European species, most of which are cosmopolitan; 23 South African species; 12 Australian; 15 East Indian; 14 species found in the Red Sea; 12 being peculiar to the island.—On a peculiar embryo of Delphinium, by the Rev. C. A. Johns. The interesting point in the structure was the non-separation of the two cotyledons, the plumule forcing itself through a chink in the undivided cotyledon. Dr. Masters stated that this peculiarity is well known to occur occasionally in Ranunculaceæ, as well as in some other plants.—On the buds of Malaxis, by Dr. Dickie. This is supplementary to the paper already published in the "Journal" of the Society. —On the Algæ of St. Thomas and Bermuda, by Mr. H. N. Moseley. These were the results of the explorations on board the *Challenger*, one marine flowering plant being also found in flower for the first time.

Chemical Society, Nov. 20.—Dr. Odling, F.R.S., president, in the chair.—A paper on "the coefficient of expansion of carbon disulphide," by J. B. Hannay, was read by the secretary. —Dr. Russell then communicated his researches on the action of hydrogen on silver nitrate, giving an account of the precipitation of metallic silver in the crystalline state by means of hydrogen. —There were also a note on the action of zinc chloride on codeine, by Dr. C. R. A. Wright; on the chemical properties of ammoniated ammonia nitrate, by E. Divers, M.D.; and on the analysis of a meteoric stone and the detection of vanadium in it, by R. Apjohn.

PARIS

Academy of Sciences, Nov. 17.—M. de Quatrefages, president, in the chair.—The following papers were read:—An answer to M. Tarry's remarks on the theory of the sun's spots, by M. Faye. M. Tarry's objection to M. Faye's theory was that, instead of a down-rush, he ought to have employed an up-rush as the cause of the spots, as a terrestrial cyclone rushes up, and not down. M. Faye answered the objections in detail.—Second memoir on the way in which water intervenes in chemical reactions, and on the connection between electro-motive force and affinity, by M. Becquerel.—Studies on beer; a new method of brewing it and rendering it unchangeable, by M. L. Pasteur. The author considers the spoiling and souring of beer to be due to germs, and suggests methods for preventing their access or destroying them during the processes of brewing.—An answer to M. Oudemans' observations on the influence of refraction, &c., during the transit of Venus, by M. E. Dubois.—On the use of the prism for the verification of the law of double refraction, by Prof. G. G. Stokes.—On certain metallic spectra (lead, chloride of gold, thallium, and lithium) by M. Lecocq de Boisbaudran. The author found that the combination of a metal was attended with the loss of some of the lines it exhibited when in the free state.—On the maximum density of water, by M. Piarron de Mondesir.—On the cooling effects of the joint actions of capillarity and evaporation, by M. C. Decharme.—On the quantity of ammonia contained in atmospheric air at different altitudes, by M. Truchot. The author stated that the ammonia increases as the cloud region is approached, and gave tables of determinations in support of his views.—Remarks on the paper of Pelouze and Audouin on the condensation of liquifiable matters held in suspension by gases, by M. D. Colladon.—Remarks on the paper of M. Derbès on the *Pemphigus* of *Pistacia terebinthus* compared with the *Phylloxera quercûs*, by M. Balbiani.—On the swellings produced on vine rootlets by the *Phylloxera*, by M. Max. Cornu.—On triple planes tangent to a surface, by Mr. W. Spottiswoode.—On the direction of the propagation of electricity, by M. Meyreneuf.—An answer to M. Mercadier's last note on the study of the vibratory movements of an elastic wire, by M. H. Valerius.—Observations on the molecular structure of meteoric iron and on solid ferrous chloride in meteorites, by Mr. J. Laurence Smith.—On the tertiary supranummulitic formations of the department of Hérault, by M. Rouville.—The death of M. Cl. Burdin, correspondent of the mechanical section, was announced.

CONTENTS PAGE

THURSDAY, DECEMBER 4, 1873

DR. MEYER'S EXPEDITION TO NEW GUINEA

BEFORE giving to the readers of NATURE a brief account of my own voyage to New Guinea, from which island I have just returned, I shall say a few words about some other expeditions to this "far-east" and interesting island, undertaken within the last two years by various governments and private individuals.

In 1871 the Dutch Government sent out a steamer and specially appointed officials, to circumnavigate the entire island of New Guinea, land from time to time, and take formal possession of those parts of the country which did not yet belong to the Dutch. It is known that this nation has hitherto had only a certain right over the western part of New Guinea as far as 141° E.; and before going farther the expedition had to erect sign-posts in the name of the Dutch Government at different parts of western New Guinea. But this first expedition did not attain its end; a few posts were set on the north coast, the farthest east being on Humboldt Bay, on the frontier of the Dutch territory; the expedition tried to go still farther east, but was obliged to return in a very bad condition, without having fulfilled its task.

In 1872 the Dutch sent out a second expedition in a small steamer for the same purpose; but this one did not succeed in going even so far east as the first, and was likewise obliged to return, after a very short time, without any result.

It is now proposed to try another expedition on a larger scale in 1874, which will go first through Torres Strait to the east, and afterwards, along the north coast, to the west; but I am not sure that this plan will be carried out.

In 1870 some Italians, under the guidance of M. Cerruti, who had been several times in New Guinea before (1861, 1865, and 1866), visited in a little schooner a part of the south-west coast, for the purpose of looking out for a convict settlement for their Government, and explored chiefly the straits between the island of Salwatty and the mainland. They were attacked in MacCluer Gulf, and the combat that took place was much spoken of in Dutch India during my sojourn there.

In 1872 two Italian naturalists, M. Beccari and M. d'Albertis, endeavoured to visit the mainland of New Guinea at a place on the south-west coast, called Utanate, which had been previously visited by the Dutch; but they could not reach it, on account of currents and winds. They remained for some time longer to the westward of the south-west coast and at Sorong, between the island of Salwatty and the mainland (where in the beginning of 1873 eighteen Europeans from an Australian pearlfisher were murdered by the Papooas*), then proceeded to Dorey, in the north, and made a station on the Arfak Mountains. They returned in November 1872, an Italian man-of-war being sent by their Government to look after them.

During the same time a Russian traveller, Mr. Maclay, had been on the north-west coast of New Guinea, in Astrolabe Bay. He was brought thither, and fetched away after more than a year's stay, by a Russian man-of-war; his plan to cross the mainland of New Guinea in any direction could not be effected, as was to be foreseen by those who know something about the special difficulties of travelling in New Guinea. He only moved about the district extending some miles round his station. Before I started on my expedition I met, in the beginning of this year, in Ternate (Molukkas Islands), the Russian man-of-war, coming back from New Guinea. Although she had only stayed in Astrolabe Bay for five days to take in water and wood, still, two months later, more than eighty of the ship's officers and crew were attacked by fever.

Finally, the news which reached Europe from Australia in respect to New Guinea, and which had already in 1871 made the Dutch send a man-of-war round that continent, to inspect how far the plans of the "New Guinea Prospecting Association" were ripening, this news, as well as the end of the expedition of this Association in 1872, are better known in England than the other undertakings which I have roughly sketched above.

The proposed and partly effected settlement of missionaries of the London Missionary Society on the islands of Torres Strait, and that proposed to be made on the south coast of New Guinea itself, are likewise known.

Whether the news, published in an Australian paper, that the English had taken possession of the extreme south-east shore of New Guinea, be true or not, I am not able to say. But from what has been said it may be concluded that the eyes of civilised nations are now fixed more on New Guinea than ever, and that results will be sure to follow. What these results may be, and what prospects all these exertions may present in respect to the character of the country and its inhabitants, I will not take into consideration now, but proceed to a sketch of my own voyage.

On my previous travels, which went as far as the Island of Celebes and the Philippine Islands, I had gathered sufficient information to know which would be the easiest way to reach New Guinea, and how to find the best place for a station. I was aware of the impossibility of penetrating into the interior of the larger part of this large continent, if my expedition were not of much larger dimensions, and if it could not command much ampler means than are available to a private person like myself, and chiefly if it would not lose its character of a natural history expedition, and become solely a geographical exploration. On another occasion I shall show how such a geographical expedition through New Guinea could be started by one individual or by a company of travellers, and to what parts it would be most advantageous to proceed at first. The peculiarities of the country and the natives are such, that there are even more difficulties for travellers here than there are in Australia, where the best-fitted-out expeditions and the most able and courageous men have failed. In New Guinea it is even a question, whether the scientific or practical results are likely to be at all equal to the expenditure and the great danger connected with such an undertaking.

Being obliged, therefore, to resign the eastern and larger half of the island, I had to choose for a starting-point only between the south-west coast, from opposite the Aru Islands to Salwatty, and the coasts of Geelvinks Bay. I preferred the latter, for several strong reasons which weighed against the south-west coast, and

* I write Papooas, and not Papuas, because the Malays pronounce the word "Papooa," and not "Papua."

in favour of Geelvinks Bay; among others were the unhealthiness of the swampy shores of the south-west coast, the fact that the natives of these parts have been more influenced by Malay traders for centuries than those of the northern regions, and therefore are less original, and that the south-west coast has been visited oftener by Europeans.

In consequence of the time consumed in making all necessary preparations, I only reached New Guinea in the beginning of March of this year, and anchored the little schooner, which I had hired in Ternate—(I preferred this place as a starting-point to Amboina)—in the harbour of Dorey, in the north-west corner of Geelvinks Bay, the only part of all New Guinea where any Europeans, German and Dutch missionaries, are settled. With me, and in my service on board the ship, over which I had full disposal, were, besides about fifteen Malay sailors and a Malay captain, twenty natives from different parts of the Malay Archipelago.

Dorey has been described, among others, by Mr. Wallace, but he has, in my opinion, not given a correct impression of the natives of the surrounding hills and mountains, separating them in some way from the inhabitants of the coast, as smaller, uglier, not mop-headed, &c. As I afterwards spent a long time among the natives of the Arfak Mountains, near Dorey, and the inhabitants of the different parts of the coast of Geelvinks Bay, the islands in the north of it, and the interior of this whole north-west part of New Guinea, I may state, that there is no generic difference at all between the Papooas of the mountains and the Papooas of the coast—except such differences as we find everywhere between the highlanders and coast inhabitants of the same race.

The changing of the West into the East Monsoon, to be expected in April, obliged me to visit first the islands in the north of Geelvinks Bay, if I wished to visit them at all; and therefore, after a three days' stay at Dorey and neighbourhood, I immediately started for Mafoor, a smaller island, only about sixty miles from Dorey. It took me more than forty-eight hours to reach it. Mafoor offered me nothing particular, besides its zoological productions; it is only interesting, for having been at an earlier period the chief seat of the Mafoor tribe, which now inhabits all the coasts of the western part of Geelvinks Bay.

The island of Mysore (Willem Schouten's island), the furthest north and a larger one, was far more important for my purposes. The natives were at first of a hostile disposition, but we soon became friends, and I spent here a most interesting time, in consequence of the results of my collections and what I saw of the Papooas, wild and nearly unmodified tribes, with all the virtues and vices of such. I commenced to make a collection of Papooan skulls here, in which at last I was so successful, that I hope to be able now, by means of my large materials, to trace at least the limits of the variation which the skull of this race undergoes, and finally to fix the type of the Papooan skull,—important questions, which craniology can solve.

On Mysore, Birds of Paradise, as well as the Kasuary, are unknown; but it as well as the large island of Jobie, which I now visited, is the home of the fine Crown pigeon (*Goura victoriæ*). This beautiful bird occurs in such quantities, that it furnished us with our daily meals during nearly the whole of our stay on Mysore and Jobie. The flesh is most tender and delicate, preferable to any fowl I know of.

Jobie has for long had the reputation of being the home of many species of rare birds of Paradise; I am sorry to be obliged to rob it of this glory. I only got *Paradisea papuana* (but with more splendid, deeper orange and longer side feathers than from the mainland of New Guinea), *P. regia* and *Diphyllodes speciosa*. *P. papuana* is not rare, but very local, so that one may hunt for weeks in the mountains, without finding a single specimen (females and young males are seen and heard much oftener than males in their plumage); but if once a tree is found where they feed and "dance," a lot of them can be got together. *P. regia* is rare, and *D. speciosa* very difficult to get here.

I am sure that no other species of Birds of Paradise come from Jobie, as no other species are in the hands of the Papooan traders. I am convinced of this, because I stayed a long time at the chief place of the island, Ansus, a very populous settlement, where I saw and heard everything; more than two thousand Papooas are living here together, all in those large, curious houses, standing entirely on the water. But other species of Birds of Paradise which I showed (I had obtained some in Ternate and Dorey on my way), were unknown even to the inhabitants here, except to those who had been on the mainland. I mention this fact, notwithstanding that I had not the intention of giving any zoological details in this account, because it may be seen, how erroneous it was to give credit to the natives of New Guinea, who pretended that some rare birds of Paradise came from Jobie, certainly with the purpose of withdrawing attention from their own country, where these birds are to be found.

In general the fauna of Jobie is very poor, as well in respect to different species as to the mass of individuals of one species.

The inhabitants of the mountainous parts of Jobie are known to be cannibals, as well as the tribe of the Karoans, in the mountains of the north coast, between Amberbaki and the two small islands Amsterdam and Middelburg,* and the tribe of the Tarúngarays on the east coast of Geelvinks Bay. Here on Jobie, as everywhere on New Guinea, the coast Papooas are in perpetual war with the mountain tribes. Perhaps because some individuals of the latter believed us to be more friendly to the inhabitants of Ansus than to themselves, or that they required no special reason for fighting, once without any warning or provocation we were attacked with spears and arrows; but I afterwards took such precautions and frightened them to such a degree, that during our whole stay here we experienced nothing further disagreeable. The Papooas of Jobie have everywhere the bad reputation of being wild and quarrelsome.

After having left Jobie, from which I set ou with a heavy heart—I should have liked to remain longer—I went as

* When back at Dorey in July, the natives here were very much frightened, because the Karoans near Amberbaki had just robbed and destroyed a trading vessel, and killed or enslaved the crew.

far to the east as the river Amberno, in fact to the north-east corner of Geelvinks Bay, and then shipped to the south-west, along the coast, landing and hunting from time to time, and trying to find a favourable place for a longer stay, and a spot from which it would be possible for me to penetrate into the interior, or to cross the island.

I did not succeed till I reached the south point of the bay. Here I found a little tribe of Papooas, who treated me from the beginning to the end in the most friendly way. On this account, and because I enjoyed a very favourable hunting-ground (immediately after going ashore I got four different species of birds of Paradise), I remained here for some weeks. Shortly after having anchored, even the young girls came on board the ship together with the men, and remained there for hours, whereas, in other parts, the women generally are very shy and keep aloof.

Seeing that I could trust the natives here, I tried to carry out my project of crossing the country to the coast opposite the Aru Islands. But even if I had not come so far, for reasons which it would be out of place to give in this brief account of my journey, I got some interesting additions to our geographical knowledge,* and was very much satisfied with my zoological collections.

But I would not give up my plan of crossing New Guinea, and therefore proceeded near the coast to the north-west, looking out everywhere for a convenient starting-point, and gathering every possible information from the natives. But the island was still too broad here; the Papooas knew nothing of the opposite coast, as they do not migrate so far.

The natives of these western coasts of Geelvinks Bay are all afraid of the Wandamman tribes, whereas those of the eastern coasts are afraid of the Waropin tribes; but generally the vast country here is very poorly populated, there being few settlements, and these few small ones.

The point where I crossed the island at last into MacCluer Gulf of the south-west coast was situated 134° 18′ E., 20° 38′ S. I went first to the north-west, and then, after having passed several mountain chains (2,000 ft.), to the west, down a fine river called the Jakati, through the country of Onim. It was, perhaps, lucky for me that I could only get a very small native prau here, else I would have proceeded farther west by sea, (the swamps render it impossible to go by land), and possibly encountered dangers from the natives of the MacCluer Gulf, who have not the best reputation, and who certainly would have felt inclined to revenge their countrymen, killed by the Italian Cerruti and his company, some years ago.

I need not say that this journey from one side of New Guinea to the other has never been made before; and I should hardly myself attribute any importance to the fact, were it not for the reason that till then we did not know exactly whether there existed a communication by water from Geelvinks Bay to MacCluer Gulf or not. We may be convinced now that it does not exist.

From Geelvinks Bay I tried to ascend the Arfak Mountains from the south, but did not succeed, because I ran short of provisions. The country seemed uninhabited, or, without Papooan guides as I was, and with only some of my Malay companions, I missed the few native houses and small plantations in the neighbourhood, scattered here and there, so that it was not advisable to go too far into the country. Besides, I did not find in the forests on the southern slopes of the Arfak Mountains those gems of the bird-world which I hoped to find, and therefore left these regions and penetrated from the north with better success. It will be interesting for English ornithologists to learn that I succeeded in finding here (3,000—6,000 ft.) all the known Birds of Paradise of New Guinea (except the species from the islands), besides a new one, and a quantity of other most curious and rare specimens, the ornis of the mountains being quite different from that of the seashore. But here also, as on the whole of New Guinea, I was astonished to see that the fauna generally is not rich. The forms found in the country certainly are curious and characteristic, but, in comparison with the enormous mass of forest, they are everywhere very scarce, and it is an exception to find a hunting-ground where much is to be got in a short space of time. It is the same in New Guinea as I found it in Celebes, where more of the life of nature is to be seen and heard near the seashore and the settlements than in silent virgin forests.

I hope that now, since the interior of New Guinea is opened, at least as the way is known how to penetrate into one part of it, other naturalists will soon succeed in reaping more important results than it was my lot to obtain.

ADOLF BERNHARD MEYER

* The geographical part of my expedition will be published very soon, accompanied by a chart, in Petermann's *Mittheilungen*.

MICROSCOPIC PETROGRAPHY

Mikroskopische Physiographie der petrographisch wichtigen Mineralien ein Hülfsbuch, bei mikroskopischen Gesteinstudien. H. Rosenbusch. With 102 woodcuts and ten coloured plates. (Stuttgart.)

SINCE we last called attention to this subject in the columns of NATURE it has been making steady progress, chiefly among our German, that is, of course, German-speaking, brethren of the hammer and lens. The various serials which treat of Geology and Mineralogy bear witness to this progress, and to the wonderful activity of some of the workers, such as our good friends Zirkel and Tschermak, to whom it is so largely due. And now here comes a goodly octavo of some four hundred pages as a further contribution to our knowledge, and a fresh proof of the strong hold which the microscopic study of minerals and rocks has taken of the German geognostical mind. This activity need not be matter for wonder when one considers the chaos into which matters petrographical had got even in Germany. Those who studied rocks in that country had become a sort of bound thralls to chemists and chemical analysis. They dared not trust their eyes to discriminate the differences of species and varieties. The specimens must be handed over to the laboratory, and on the judgment thence obtained depended the names by which the compounds should be known thenceforward throughout Christendom. By this means, as the composition of a rock often differs considerably in different, and even in closely-adjoining, parts—variations resulting partly from original discrepancies, and partly from internal changes due to the subsequent infiltration

of water or other metamorphic influences—it was not difficult to make out half-a-dozen distinct varieties of rock from the same mass and even from the same quarry. And so analysis of rocks grew and multiplied, chemists became more and more nice in their discrimination of the veriest fractions of a per cent., petrography seemed in a fair way of being annexed as a dependent province of chemistry, and the petrographers, who ought to have been geologists, and to have set themselves strenuously to find out what had been the history of the rocks as parts of the architecture of the globe, came gradually to accustom themselves to the notion that, after all, it was really true that rocks were merely so many chemical compounds to be analysed and labelled accordingly.

In the midst of the darkness wherein the poor petrographers ticketed their specimens, carefully arranged their cabinets, and elaborated their dreary treatises, there fell among them (not from heaven, but from the hands of a worthy citizen of Sheffield) a microscope and a few glass slides, with a description of what could be done therewith. Eyes which had seen no light for so long could not at first make anything of the apparition, but after a few years it began to take shape before them; and now the microscope promises to do as much in comparison for mineralogy and petrography as it has done for the biological sciences.

From town to town this new light has spread, or rather rushed, all over Germany. There is now a sort of neck-and-neck race who will make the most slices of rocks and minerals. A cutting or rubbing-machine and a microscope have become as necessary implements as a hammer or a lens. Every month brings to light some new "mikromineralogische" contribution, insomuch that if the fever lasts we shall ere long be as over-weighted with microscopic analysis as we used to be with chemical. Both are excellent and necessary, and yet we may be allowed to believe that neither singly nor together do they disclose to us anything like the whole history of the rocks, and that they cannot by themselves yield a sufficiently broad foundation for a truly philosophical classification in petrography.

The advantages of microscopic analysis applied to rocks are so many and obvious that we cannot be surprised that they should have been so widely recognised and put in practice. This method of investigation throws a direct light upon the construction of rocks in a way which chemical analysis can never do. Moreover, it is easily adopted. Anybody can make microscopic sections, and with due care and experience may become a skilful analyst. And then this mode of research is so cheap. Even if the observer does not care to give the trouble and time necessary for the construction of his own sections, he can get them made for him at small cost. And once in possession of them and his microscope, he obtains his results at once. No need to wait for days upon a solution, or to weigh and re-weigh his precipitates.

It is plain that as rocks are composed of aggregates of minerals in many various combinations, the first preliminary step in our investigation of their minute structure should be devoted to the study of the microscopic character of the minerals which compose them. We must know how these minerals are built up in themselves before we can adequately comprehend the manner in which they are mingled together to form rocks. Besides, in a crystalline rock, such, for example, as basalt, the component minerals are crystallised on so minute a scale, and often so imperfectly, that their ordinary and characteristic peculiarities may be so veiled that, unless from previous experience, we could not with certainty recognise them. Hence every student who sets himself, microscope in hand, to find out how the materials of the rocky crust of the earth have been put together, ought unquestionably to begin the search by accustoming his eye to the variations which the simple minerals present when viewed in different positions under a strong magnifying power. It will not be necessary for him to cut slices of every known mineral. He will have done enough for his immediate purpose if he has sliced in all directions, and examined with polariscope and otherwise the comparatively few simple minerals which are of prime importance, as those of which most of the visible rocks of the globe have been formed.

A text-book which will guide him in this most interesting and important research has never hitherto appeared. Descriptions of the methods to be employed in the preparation of translucent sections have been published both in this country and in Germany. Indeed, it was Nicol, of Edinburgh, who, besides giving us the prism named after him, invented and made known more than forty years ago this most ingenious method of investigation. Abundant notices have also been published during the last dozen years, chiefly in Germany, regarding the microscopic characters of many minerals and rocks, so that a student who had time and opportunity to consult this very scattered literature, might gain amply sufficient knowledge to start him in his research. But none the less has a general text-book been required to save such needless expenditure of time, and to give the student those practical hints which he is not likely to meet with in mere scientific communications on special subjects. It is this want which Mr. Rosenbusch endeavours to supply in the volume now before us.

From his preface we gather that living at Freiburg he caught the microscopic fever, and has had it for a number of years. Anxious to communicate the infection as safely and effectually as possible to the younger mineralogists, he has compiled a text-book which ought to serve its purpose well. It is well arranged, neatly printed, excellently illustrated, and cheap. After some introductory pages which skim over the history of his subject, the author proceeds, in the first or general part of his treatise, to give the student directions how to cut and prepare his slices of mineral or rock for microscopic examination. Then, having the slices prepared, he shows how they are to be used, and what may be looked for in them. With characteristic German completeness he speaks of the general morphological peculiarities of minerals crystallised and amorphous, and shows how singular and varied are the anomalies in internal structure revealed by the microscope even in what seem to be the most regularly built crystals. The optical properties of minerals are discanted upon with a fulness perhaps hardly in keeping with the other parts of the book, but the importance of this branch of the subject, particularly in reference to the analysis by means of polarised light, may well be pleaded in excuse by the author. The third section of the general descrip

tion of minerals deals with their chemical peculiarities. It occupies not quite four pages, and has evidently been inserted for the sake of completeness, that the learner, even though specially intent upon microscopic work, should not be left wholly in the dark as to what he can accomplish himself in the way of chemical analysis.

The second and by much the more important and useful part of the treatise deals with the microscopic characters of minerals, and more particularly of those which enter largely into the composition of crystalline rocks. Considerably over a hundred minerals are treated in this way, and these, of course, include all those which are of prime consequence to the petrographer. For example, the felspars, augite, hornblende, calcite, quartz, pyrite, and other common ingredients of rocks are fully described. The author has worked hard at the subject himself, though he has not hitherto published much. One excellent feature of his volume is the full references which he gives to the papers of previous writers on the same subject. Not only at the beginning of the description of each mineral does he quote, in legible print, the titles of the papers in which information about the microscopic characters of that mineral may be found, but at the end of the volume he inserts a long alphabetical list of authors, with the names and dates of their papers. This is a most welcome boon to all those who, especially in our own country, have the courage to attack the voluminous, but hitherto hardly known or accessible literature of the subject. Two sorts of illustrations are given—woodcuts and coloured plates. Of the former rather more than 100 occur, mostly illustrative of the crystalline forms or optical characters of the minerals. They do not call for special remark, except that they might with advantage have been more numerously inserted to explain the internal peculiarities of some of the numerous species described. The coloured plates are singularly effective. Ten in number, they contain sixty figures of the microscopic structure of upwards of thirty more or less common minerals. We have seen nothing so good since Vogelsang's large and admirable drawings published six years ago at Bonn. It appears that it was originally intended to have included more plates, but that the cost proved so great that the number had to be restricted to ten. This, no doubt, is the reason why some not very important minerals have a place on the plates, while others of greater consequence have been left out.

This volume, even had it been less painstaking than it is, would have deserved commendation as an introduction to a study for which no text-book at all previously existed. But, as its author frankly acknowledges, it will not and is not intended to supply the place of actual personal work—"he who would learn microscopic mineralogy must to the cutting-lathe and the microscope." The greater the number of observers who can be induced to betake themselves to this pursuit, the sooner may we hope for some definite and broad well-established results. At present the work accomplished, most excellent and praiseworthy though it be, belongs rather to the hewing-of-wood and drawing-of-water order. The facts are weekly accumulating out of which, in the end, a flood of light will unquestionably be cast upon the genesis of rocks, and consequently upon the history of the earth itself. All honour, therefore, to the enthusiastic workmen by whom this labour is so cheerfully and actively undertaken, and none the less to Mr. Rosenbusch for publishing a most useful volume, which will, no doubt, increase their numbers.

OUR BOOK SHELF

Solid Geometry and Conic Sections, with Appendices on Transversals, and Harmonic Division, for the Use of Schools. By J. M. Wilson, M.A. Second Edition. (Macmillan and Co., 1873.)

Elementary Geometry, Books i. ii. iii., following the "Syllabus of Geometry," prepared by the Geometrical Association. By J. M. Wilson, M.A. Third Edition. (Same publishers, 1873.)

THE portions of the title-pages we have above given sufficiently indicate the scope of the two works under review and the measure of acceptance they have met with. As we have already given an account of the former work it will not be necessary to give any detailed account of it now. It has been considerably improved by the addition of some eighteen pages of new matter, consisting of a slight rearrangement of Section I., which treats of planes, the addition of a section (IV.) on the sphere, which is almost entirely new to the work, and some slight changes in the articles on the Ellipse and Hyperbola. The result is a close approximation to the views we expressed in our previous notice, and the book can be recommended as an excellent, if not the only English, treatise suited to the requirements of candidates for the first B.A. Pass Examination of the London University. We point out an obvious slip of *inscribed* for *circumscribed* circles, on p. 55; in the fifth paragraph, p. 56, all the A's but one should be accented; the last exercise, on p. 68, is misplaced, and repeated in its proper place, as Exercise 29 on p. 71; other minor slips can be easily corrected.

The "Elementary Geometry" is to our mind a vast improvement upon the first edition; the changes are all, we believe, in the right direction. We never took kindly to that first edition; the most confirmed euclidophilist must be led by a perusal of this to a more favourable view of the aims of anti-euclidean agitators. Seeing that the aim of teachers of both parties, if they are in earnest, should be the *improvement* of geometrical teaching, we trust that neither party will lose sight of this high mark through intervening clouds of dust raised on irrelevant grounds.

The "get-up" of both books is excellent, the printing of the "Elementary Geometry" most accurate (we have detected but one or two slight errors). We wish to add a closing remark on this subject of *errata*: we consider that an author is bound to bestow every care in this matter, and it is with regret that we find some works of recent date have been brought out, it is reasonable to suppose, in such haste to meet a possible demand for them that they may be said to teem with mistakes. This entails great waste of time and trial of patience upon junior students and appears to us unfair treatment. R. T.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

The Southern Uplands of Scotland

To the able articles on this subject contributed to your pages by Prof. Harkness, I should like to be permitted to make an addition. He has referred to some opinions and observations of mine, but I am anxious that it should be generally known to what an extent the results obtained by the Geological Survey

are due to the zeal and ability of my colleagues. Thus, Mr. R. L. Jack has the merit of detecting and tracing the Caradoc basin of the Leadhills, and of working out the structure of that region which has been of so much service in the subsequent progress of the Survey. Mr. John Horne has carried the lines far into Galloway, and Mr. D. R. Irvine has traced them across a great part of Wigtownshire. Mr. H. Skae has mapped them across Dumfriesshire into Selkirkshire, while Mr. B. N. Peach, besides doing excellent service in the west, is now running them across the rest of the country towards the sea on the east.

Allow me also on the part of my colleagues, as well as for myself, to take advantage of this opportunity to thank Prof. Harkness for his most valuable and welcome papers, and to express our gratification that the labours of the Survey should have found so courteous an exponent, and one whose knowledge of the country which we have mapped is so minute and extensive.

ARCH. GEIKIE

The Huemul

IN Vol. viii. p. 253 of your valuable journal, I find it noticed that the Chilian Exploring Expedition has taken a specimen of the Huemul, an animal which had altogether been lost sight of, and first described by Molina under the name of *Equus bisulcus*. This notice is not correct, as the animal has been described already in 1846 by Messrs. Gray and Gervais, in the *Annales der scient. natur.* iii. Ser. Tom. v. page 91, under the name of *Cervus chilensis*, and compared with *C. antisiensis* of D'Orbigny, as the species most nearly allied to the Huemul or Guemul or Guamel, different names for the same animal in different parts of the country. This first description was repeated the following year in the "Historia fisica y Politica de Chile," Zoology, vol. i. page 159, and accompanied by the figure of the animal (pl. 10, and its skull pl. 11), from the only known specimen of a young male of half-grown size, brought to Paris by Mr. Gay. On the same specimen Mr. Pucheran has founded his description in his valuable monograph of the genus Cervus, published in the *Archives du Museum*, vol. vi. page 965 (1862), and from these two descriptions Mr. A. Warner has given a combined extract in his "Saugethiere," &c. Tom. v. (supplement), page 382, under the same name of *Cervus chilensis*. Meanwhile Dr. J. E. Gray had described a species of deer, received by the Earl of Derby from Chili as *Cervus leucotis* (Annals of Nat. Hist. ii., Jer. Tom. v. page 324, 1840, and Proceed. Zool. Soc., 1849, page 64, pl. 12), which name he soon changed to *Furcifer Huamel* (Annals chr. iv. 427), and at last to *Xenelaphus huamel*, adding to his first description new notices, with the figures of the horns of the male (Proceed. Zool. Soc., 1869, page 496), and the skull of the female, and stating that his *Cervus leucotis* is identical with the *Cervus chilensis* of Gay. This exposition proves that the Huemul or Guemul is already a very well known animal, and has by no means been overlooked by naturalists.

A young collector in Buenos Ayres, Mr. Franc Moreno, has lately received a pair of these animals from Patagonia, where they were caught by the Indian Pehnelches, who live on the western foot of the Cordilleras, near the sources of the rivers Negro and Colorado. These two specimens have been brought to the public Museum, where I have examined them carefully. The male is a young one, with horns still covered by the skin, and only 3 in. long, without branches. I regret that therefore I can say nothing about the figure of the adult's horns, which are according to the drawing given by my dear friend, Dr. Gray, very like that of the roebuck, although the specimen he has figured may be regarded as in an abnormal state, from the great difference between their two sides. Both sexes of the animal are of equal size—3 ft. high on back, and $4\frac{1}{2}$ ft. long, the head being 10 in. long, the ears and the neck 7 in. every one, and the body 3 ft. without the tail, which measures 7 in. with its hairs, but only 4 in. in the axis. Great naked lachrymal pits are seen below the eyes. The fur is of the same quality in each, but very different in the cold and in the warm seasons; then both skins are in the time of hairing, the female with the prevailing hair of the winter, and the male with the prevailing of the summer. Each hair is not entirely straight, but some are undulated, principally on the under half, and this undulated portion has a clear greyish-brown colour; over this clearer portion comes a broad dark-brown or black ring, and the end is clear reddish yellow, with a fine blackish tip, generally broken off in old fur. For the winter dress the hairs are 2 in. to $2\frac{1}{2}$ in. long, and of a less characteristic colour, being over the whole skin of an undistinguished greyish-brown colour; but in the summer dress the hairs measure no more than $1\frac{1}{4}$ in. or $1\frac{1}{2}$ in., and all their colours are cleaner and better pronounced. Therefore the animal is darker and more distinguished in colour in the summer than in the winter. The hairs on the face are very short, as are those on the outside of the ears, somewhat longer on the legs, but nearly as short on the under half part of the extremities. The breast and the tail have the longest hairs. Different in colour are the naked nose and upper lip, both entirely black; the breast is dark blackish-brown, the genital region to the tail, with the inside of the hinder upper legs being white. The same colour also pervades the inside of the ears, which are coated with long hairs; the hoofs are black. No tinge of the particular stripe of longer hairs on the tarsus of the hinder legs is conspicuous in either sex; but I find, with Dr. Gray, a large tuft of longer hairs on the hock, on the inside behind, which makes this part of the legs very thick.

The animal lives principally in the valleys of the Cordilleras, but on both sides, the eastern and the western, and rarely goes down to the flat country of the Argentine pampas. Its proper range is between 35° and 45°. It is well known by the Indians, who not only make use of its strong skin for war-dress, and its meat for food, but also tame young animals, using them for domestic employment, like the Guanaco, which lives in the same territory, but is much more common, and therefore almost the only animal used for hunting by the same people.

Buenos Ayres, Sept. 20 DR. BURMEISTER

The Diverticulum of the Small Intestine considered as a Rudimentary Structure

I MUST claim the opportunity of reply to the article which appeared in your number of October 16 (vol. viii p. 509), entitled "On the Appendix Vermiformis and the Evolution Hypothesis," which the writer offers as a commentary on my little paper at the recent meeting of the British Association, "On the Diverticulum of the Small Intestine considered as a Rudimentary Structure."

The writer seems to have been misled by newspaper reports. None of these were furnished by me, or submitted to me before publication, and in those which I saw after their publication both the anatomy and the argument were grossly and indeed absurdly blundered. This applies not only to my paper and remarks, but to the remarks made by those who spoke on my paper. It was, perhaps, too much to expect newspaper reporters not to get confused among scientific terms, and I may have erred in not having the usual abstract of my little paper ready to hand to the reporters.

Newspaper reports may be passed without notice, but I cannot allow an article in a scientific periodical to pass in which the writer uses such language as the following, with which the article in your columns concludes:—

"To quote the words of one of the greatest of our physiologists, it can only bring ignominy on the body of scientific workers if they are supposed to countenance such an argument as that of Prof. Struthers, which assumes that because one or two individuals have died from the impactation of cherry-stones in the appendix vermiformis, therefore there is no God!"

The "no God" was certainly not in my paper or in anything I have ever written or spoken, and the accusation is to me so offensive that I repudiate it with indignation. How anyone should suppose that the evolution hypothesis implies that there is "no God" I am at a loss to understand. I supposed it to be well understood that, on the contrary, that great hypothesis enables us to rise to higher conceptions, the only question being the mode of proceeding.

As to the scientific argument, it seems hopeless to attempt to unravel the confusion into which newspaper reports and my critic have brought it, except by re-stating my argument. But this is for the most part unnecessary after your publication of my abstract in the number following that in which the article of which I complain appeared. It cannot be absolutely proved that the appendix vermiformis is useless, though a survey of the facts in comparative anatomy and development leads to the inference that it is a rudimentary structure. But my paper was on the diverticulum, the appendix being referred to only collaterally, and more for the sake of clearing away the most unnecessary teleology with which it has been encrusted, than with the view of resting the argument on it. The diverticulum, like the appendix, has glands and muscular layers, secreting and expelling; it has villi, actively absorbing; and it is large, which the appendix is not. Yet, notwithstanding all this elaborate construction and this activity, who will maintain that this unclosed bit of the vitelline duct has been left

unclosed in some of us for use? But one is sometimes met with the remark that, if these rudimentary and variable structures are useless, they are at any rate not injurious. But is it so? May they, and do they, not become injurious under disease or accident? There is the male mamma, for instance, which we have sometimes occasion to excise for disease. Whatever may be the law which regulates the evolution of the sexual organs, no "use" theory can account for the presence of that rudimentary organ. But the diverticulum is a possibly injurious structure not merely as a tissue, but in addition, specially, as forming, if I may use the word, a kind of trap, by lodgment or by strangulation. Thus we find that we have, whether we will or no, reached the conclusion that there are parts in the animal body which are not only useless but worse than useless because dangerous.

I do not see any reply to this in my critic's remark that it proves too much for the argument, that, for instance, because some people have died from wounds of the scalp, therefore the head might be dispensed with. For, however much the head may vary among us, it is not a rudimentary structure. No argument can affect the fact that the diverticulum is not only a useless structure, but worse than useless because dangerous. The object of putting it thus emphatically is both to establish and to call attention to the conclusion that there are such things in animal bodies as rudimentary structures, things which are of no use to the animal body which contains them, and which can be understood only by referring to other animal bodies in which they are in full play; and that we must therefore rise to higher conceptions of the mode in which these things are regulated. It was carefully stated in my paper that the consideration of such parts as the diverticulum does not carry us further than to clear away the old argument, but that, on taking a survey of rudimentary structures generally, we are led on to the conclusion that the evolution hypothesis is the more probable one in regard to the mode of origin of animal bodies.

The nature of the diverticulum and its sources of danger are well known to the readers of Meckel, Monro, Lawrence, Rokitanski, and Cruveilhier. I may be allowed to mention that nearly twenty years ago I published (Edin. Med. and Surg. Journal, April 1854) twenty cases of diverticulum, with a drawing of each. In three of these it was the cause of death, and I referred to some other cases in which it caused death as reported by previous writers. Anyone in London who is desirous of seeing a case in which it caused death, may do so by looking into the museum of St. Bartholomew's Hospital. There is, I may mention, a diverticulum, at the usual place, in a subject now being dissected in my anatomical rooms. If my critic will come to Aberdeen I will show him a large collection of them, and also of specimens showing the various positions and conditions of the appendix vermiformis, and, indeed, many other interesting rudimentary structures and variations which, I infer, he has not yet seen.

My critic's objection that such discussions are unnecessary, that the true theory will ultimately prevail from its own intrinsic value, might be urged against all discussion; and I differ from him very much if he thinks that the question does not require to be stirred among and by the teachers of human anatomy in this country. The cause of my little paper, in fact, was my having, not long before, heard a teacher of human anatomy, at a similar meeting, call in question the whole argument from rudimentary structures. I attributed no importance to my paper further than that, in bringing forward the diverticulum, it submitted an illustration for the argument which does not admit of cavil.

Aberdeen, Nov. 22 JOHN STRUTHERS

The Atmospheric Telegraph

WILL you permit one of your subscribers who is interested in the credit of the English telegraphic system, to supplement your article of November 27 by a few remarks?

The distribution of telegraphic messages by means of air was introduced by Mr. Latimer Clark, and had been employed by the Electric Telegraph Company long before it was adopted either in Berlin or Paris.

The *Times* article of November 15 deals with the undertaking of the Pneumatic Despatch Company for the conveyance of parcels and goods, not messages. The writer incidentally mentions the transmission of messages, but scarcely seems to have been aware of the extent of the London message system.

If I might encumber your valuable space by statistics, I could show that the pneumatic system of the Postal Telegraphs, or even that of the Electric Telegraph Company at the time of the transfer of their undertaking to the State, will bear comparison, both as to extent and efficiency, with that of Paris, effective as the latter is.

The system is employed in Manchester, Liverpool, Birmingham, Glasgow, and Dublin. R. S. CULLEY

Engineer-in-Chief of Postal Telegraphs

General Post Office, Nov. 29

SENSATION IN THE SPINAL CORD

THE principle which I endeavoured some years ago to get recognised as the directive principle of research in Nerve Physiology, was that everywhere identity of Tissue carried with it identity of physiological Property, and that similarity in the structure and connections of Organs involved corresponding similarity in Function. Although these premisses were almost truisms, the conclusion drawn—that all nerve-centres must have a *common* Property, and *similar* Functions—was too much opposed to the reigning doctrine, to find general acceptance. Especially was it resisted in its application to the functions of the Spinal Cord; and this because of the two hypotheses current, namely, that Reflex Action did not involve Sensibility, and that the Brain was the sole Organ of the Mind. Following in the track so victoriously opened by Pflüger, I brought forward what seemed to me decisive evidence of the sensational and volitional functions of the Spinal Cord; but this evidence has not been generally deemed conclusive by those whose verdict is authoritative. Neither in Germany nor in England have the majority of physiologists consented to regard the actions determined by tthe Spinal Cord in the absence of the Brain as sensitive actions.

This is not the place to examine the insufficiency of the evidence which is held to exclude sensation from Reflex Action, nor to exhibit the irrationality of the conception of the Brain as the Organ of Mind—which, as I have elsewhere said, is not more acceptable than would be the parallel conception of the Heart as the Organ of Life. The purpose of the present paper is restricted to the examination of the most striking experimental evidence *against* the sensational function of the Spinal Cord, which to my knowledge has hitherto been advanced. I had intended reserving the criticism for its appropriate place in the "Problems of Life and Mind," but an article by Mr. Michael Foster which has just appeared (*Journal of Anatomy and Physiology*, November), on the Effects of rise of Temperature on Reflex Action, induces me to bring the subject before the readers of NATURE, in the hope that some of them may re-investigate it and record their results.

I will merely remark that the microscopic investigations which have recently been made with greatly increased powers and better methods of preparation, have more and more confirmed my assertion of the histological identity of Spinal Cord and Brain. On the other hand the experiments of Goltz (*Functionen der Nervencentren des Frosches*, 1869, p. 128) seem to supply direct evidence against the identity of property; and this evidence cannot be ignored.

Goltz observed that a frog, when placed in water the temperature of which is slowly raised towards boiling, manifests uneasiness as soon as the temperature reaches 25° C., and becomes more and more agitated as the heat increases, vainly struggling to get out, and finally, at 42° C., dies in a state of rigid tetanus. The evidence of feeling being thus manifested when the frog has its brain, what is the case with a brainless frog? It is absolutely the reverse. Quietly the animal sits through all the successions of temperature, never once manifesting uneasiness or pain, never once attempting to escape the impending death. "The spinal soul sleeps, perhaps; it takes no heed of the danger. One must waken it. I touch with acid the skin of its back in that part which is raised above the surface of the water. *Swiftly and surely the hind paw is brought to bear on it, and the acid on the irritated spot is wiped away;* then the leg resumes its comfortable position."

The water grows hotter and hotter, but the brainless frog never moves, till, at 56° C., it expires in a state of tetanus.

This contrast is assuredly marked enough, and most readers will be disposed to admit that if the brainless animal can endure, without manifesting even uneasiness, what in the normal animal produces every sign of intense pain, the conclusion that the brainless animal feels nothing, and therefore that his Spinal Chord is not a sensational centre, is irresistible. This conclusion I altogether reject. Not that I question the facts, for I have verified their accuracy; and Mr. Foster, who has repeatedly verified them, only points to the new difficulty which they raise, namely, why the brainless frog is not excited to reflex action by the stimulus of hot water? It is, therefore, the interpretation of the facts to which attention must be drawn; and to make this complete, let me here note counter facts which my experiments presented.

The brainless frog is *not* insensible to the heat, *unless* the insensibility be gradually produced. If its foot be dipped into the hot water the leg is violently retracted; and if the whole or greater part of the body be immersed, the frog struggles vehemently, and rapidly passes into a state of tetanus. The difference between the behaviour of a normal frog and a brainless frog when *suddenly* immersed in very hot water is not greater than might reasonably be anticipated between animals uninjured and animals with one great sensitive centre removed.

These facts are substantially confirmed by the facts brought forward in Mr. Foster's paper. He also finds the legs of a decapitated frog withdrawn by reflex action, as soon as the temperature of the water reaches a little over 30° C. "However slowly the water be heated, the feet are always withdrawn at a temperature of 35° or earlier." But he observes that when the whole body is immersed and the water gradually heated, no movement, or only the very slightest spasm of the muscles of the legs takes place.

The point to which he draws attention is, that whereas the stimulus of hot water applied to the *foot* causes reflex action, applied to the whole leg or the whole body it causes none; his explanation is that the depressing influence of heat on the Spinal Cord destroys its reflex powers. This explanation seems to accord very well with all his observations, but is not in accordance with the fact mentioned by Goltz of the frog's wiping away the acid which is dropped on its back; a fact clearly manifesting the presence of reflex sensibility.

It is this fact which I should urge against Goltz, and all who share his views. It proves, to my mind, that although the frog remains motionless in the heated water and shows no sign of pain from the stimulus of heat, this is assuredly not because Sensibility in general is gone, but simply because Sensibility to *temperature* is gone. It is not necessary to refer to the many well-authenticated cases of analgesia without anæsthesia, of insensibility to pain or temperature without insensibility to touch; I will parallel Goltz's case of the brainless frog suffering itself to be boiled without moving, by the case of the frog with its brain and other nerve centres intact, allowing its legs to be burnt to a cinder without moving. In a paper read at the Aberdeen Meeting of the British Association, I brought forward some experiments on frogs after their skins had been wholly or partially removed. (There were small patches of skin left on the head wherewith to compare the effects of stimuli). These frogs assuredly had not lost their Sensibility; they responded, as usual, to any stimulus applied to the patches of skin which remained; and as these responses were the responses of animals in possession of a brain, no one would explain them away as *mere* reflexes. Yet these sensitive frogs allowed their flayed limbs to be pinched, pricked, cut, burnt with acids, and even burnt to a cinder with the flame of a wax taper, yet remained motionless under all these stimuli, though a touch on the patch of skin would make them wince or hop away.

I did not try the experiment of boiling one of these frogs, but who can deny that the insensibility they presented with their brains and without their skins, is even greater than that presented by brainless frogs with their skins? The point urged is that the frog without its brain is incapable of feeling the stimulus of hot water, which, when the brain is intact, is felt intensely; and the conclusion drawn is that the spinal cord is not a sensational centre. But this point is blunted when we find that the frog is equally insensible to the heat, when its brain is intact and only the skin removed. Ought we to conclude that the skin is the sensational centre? The one conclusion would be as logical as the other.

Mr. Foster, who is only treating of the influence of temperature, asks why the sensations and *cerebral* processes are not dulled in the same way as he supposes the *spinal* processes to be dulled by heat? "The answer," he says, "is that a less intense sensory impulse is needed to call forth a movement of volition, that is, a movement carried out by the encephalon, than an ordinary reflex action, that is, a movement carried out by the spinal cord alone. The water as it is being warmed suggests a movement to the intelligent frog long before it is able to call forth an unintelligent reflex action. The very first movement of the frog, the removal of any part of his body out of the water, increases the effect of the stimulus; for the return of the limb to the water already warm gives rise to a stronger stimulus than contact with the water raised to the same temperature while the limb is still in it; and thus *one movement leads to another* and the frog speedily becomes violent. It is nearly the same with the brainless frog when a movement has for some reason or other been started; only in the observations we have been dealing with this initial movement is wanting."

Let us compare the energetic movements of the normal frog and the absence of movement in the brainless frog, with the energetic movements of a waking man in a suffocating atmosphere, and the absence of movements in the sleeping or stupefied man in the same atmosphere, and all the phenomena are clear. The waking man and normal frog are alert and alarmed. The sleeping man and brainless frog remain motionless. Instead of our being surprised at the brainless frog manifesting so little Sensibility when the gradually-increasing heat is threatening its existence, we ought to be surprised at its manifesting so much Sensibility as a thousand experiments disclose; especially when we see that if the heat be suddenly applied the Sensibility is manifested as *equally* energetic in normal and in mutilated frogs.

In conclusion, let it be observed that unnecessary obstacles are thrown in the way of rational interpretation when connotative terms such as Spinal *Soul* (*Rückenmarkseele*) are adopted. It is one thing to assign a general physiological Property, such as Sensibility, to the nervous centres; another thing to assign a term which is the abstract expression of the connexus of sensibilities, to any one centre. In saying that the Spinal Cord is *a* seat of sensation, it is not meant that it is *the* seat, nor that the sensations are *specifically* like the sensations of colour, of sound, of taste, of smell; but they are as like these as each of these is like the other.

GEORGE HENRY LEWES

THE ARTISTIC REPRESENTATION OF NATURE*

THE late autumn of every year introduces to the public a large supply of gorgeous volumes, "got-up" in lavish fashion with handsome plates and lightly-written letter-press, which are generally spoken of as Christmas Books, and are intended to be the means for the material expression of the generous feelings which that season is

* "The Life and Habits of Wild Animals." Illustrated by Designs by J. Wolf. (Macmillan, 1873.)

supposed to evoke. The work to which we wish to call attention is not intended to be one of these, though its exterior appearance might, at first sight, be thought to warrant the supposition. It is a special work brought out under special circumstances, and, as we are told in the preface, the plates have been engraved for nearly seven years. We refer to it, and shall speak of some of the pictures in detail, as showing the service which Art can render to Science by a faithful representation of Nature. The more scientific Art is, the more successful and the more impressive she will be; only by a thoroughly scientific study of his subject and its surroundings can an artist hope to achieve complete success.

The book derives a special, though a painful interest, from the fact that it contains the last series of illustrations which will be drawn by a highly-talented German artist—Mr. Wolf—the previous productions of whose pencil are so well known to all who find pleasure in the study of the animal world. The volume is illustrated by twenty plates, beautifully engraved by Messrs. J. W. and E. Whymper, each of which depicts some stirring scene in the life of "our four-footed friends," or puts before us some picture of the life of birds, some of them representing in a terribly graphic manner the struggles which pervade the existence of beasts, and render its tenure so precarious. Witness the subject of plate iii.—one of the most powerful in the whole series—the death-grip of the crocodile's cruel jaws upon the handsome head of the tiger drawn slowly and resistingly beneath the stream where the conqueror will make his banquet. There is no one who would not feel, in gazing at this picture, a strong sympathy with that most splendid of the feline tribe in this his death-agony. We do not select this plate as superior in draughtmanship to its fellows; they are all of the same high order of merit, though some naturally arrest the attention more forcibly than others, in proportion as the feelings which connect man *quâ* animal with his fellow-animals find fuller expression with regard to the nobler and higher specimens of animal life.

And here we would say that pictures like these—not mere passive delineations of the outward shapes, but illustrations of the habits of wild animals—have an instructive and suggestive value. They are pictures which set one thinking. There is a dramatic reality about them which leads the mind into the by-paths of contemplation as no still outline can—they irresistibly compel us to compare with ourselves these denizens of the forest and the prairie, of the river and the sea. We seem at once to be impressed with the consciousness of their irresponsibility, of their independence of ethical restraints, obeying as they do but one law—the law of their kind—which incidentally leads them to the destruction of other kinds inferior to their own. The half-human looking ape does not allow us to predicate the conception of morality of any of its actions; the care of its young which it evinces is but an exhibition of the instinct of self-preservation which pervades all species of the higher animal forms; it is difficult to realise that the gap between man and monkey is anything less than a so-called difference of kind. Many other reflections are suggested by a sympathetic survey of such animated drawings as these, but we will not weary our readers with subjective digressions, which must necessarily vary with the individuals who indulge in these reflections; we are only eager to impress the superiority in this regard of delineations of active life and habits over mere portraiture, however well executed, of individual forms of life.

We are glad to be able to reproduce one of the most pleasing of the plates which adorn Mr. Wolf's work—"The Island Sanctuary." There is a peaceful lonely beauty about this representation of the osprey's haunt, which at once arrests the attention and forms a strong contrast with the depictions of the more savage warfare of species against species, of panther against doe, of lion against deer, of wolf against boar, which are contained in the same volume with it. The siesta of the jaguar (plate ix.) and the bath of the large pachyderms, elephants and hippopotami (plate x.), are two of the most striking drawings in this volume, the former especially we think inimitably excellent. There is an idyllic completeness in the representation of the largest of the American cats taking its ease during the midday heat on the branches which overhang the river. Without going into further detail concerning the separate plates, which require to be seen to be appreciated, we would mention one more, Catching a Tartar (plate xviii.), the most sensational in the series, very forcibly drawn, the dead or dying owl's wings have lost their motive power, but in their outstretched hugeness serve to break the rapidity of the descent and save the weasel, whose "cunning has proved more than a match for the strength of the more powerful" bird.

We speak in a somewhat popular strain of Mr. Wolf's work, not with any intention of treating it as one of the hastily concocted products of the winter season, which, as we have said, it is not meant to be, but rather from a belief that it will appeal to those who, without a special scientific or zoological training, have yet a genuine love of contemplating the varied phases of life in beast and bird, who believe with Coleridge, that

> "He prayeth well who loveth well
> Both man and bird and beast,"

and to such as these we can say that this volume is of no common sort; the pictures are such as stir the imagination and please the taste, while, as justly remarked by Mr. Whymper in his preface, their value is greatly enhanced by the "power of delineating specific characters" which is displayed.

We must not omit to mention, in connection with Mr. Wolf's plates, the letterpress which accompanies them, and which is from the pen of Mr. Daniel G. Elliot, of the United States. It is, of course, in this case subservient to the drawings which it interprets. In his outspoken preface, to which we have already referred, Mr. Whymper tells us that Mr. Elliot has laid aside the scientific treatment of his subject, for which he is fully capable, as bearing in mind that "the book is intended for the general public, and not for a class." Our American cousins are always masters of the art of depicting in animated and picturesque fashion all that is of interest in life and action, whether in man or in beast; and Mr. Elliot has not failed in the task set before him; he has steered clear of fulsomeness, and cannot be accused of padding; his writing is instructive with respect to the habits of animals, and is not of that ejaculatory kind which too often accompanies pictures and seeks to impress the character of eloquence by a copious interlarding of interjections. We can give in one quotation a fair example of his portion of the work. Speaking of the gorilla he says:—"In the pathless tracts of those ancient woods, distant even from the primitive abodes of hardly less savage men, in company with the fierce inmates of the jungle, the gorilla dwells, surrounded by his family. Peacefully they pass the day, seeking the various fruits that in many a cluster hang from the lofty trees, paying generally but little attention to what is passing below them. But if any unusual sound breaks the stillness of the woods, or a strange form be seen approaching their vicinity, then the females, bearing their young clinging fast to them, flee away into the still deeper recesses of the forest; while the father and protector of the small community, swinging himself rapidly from tree to tree, tearing loose the vines that stretch across his passing form, advances towards the object of their fears, and before imitating the rest in their speedy flight, satisfies himself in regard to its presence, and then with many a hideous grimace, and short hoarse call, demands to know, in impatient tone, Who comes here?"

THE ISLAND SANCTUARY

ON THE SCIENCE OF WEIGHING AND MEASURING, AND THE STANDARDS OF WEIGHT AND MEASURE *

IX.

IN the comparison of standard weights, the difficulty and risk of error in determining the weight of air displaced by them is to be avoided by weighing them not in air, but in a vacuum. Two methods are employed for this kind of weighing.

In the first and simplest method, when an ordinary balance of precision is used, each standard weight is placed in an exhausted receiver just large enough to hold it, and is weighed separately against a counterpoise by Borda's method. Sensible discordances have, however, been found in the results of this method of weighing in exhausted receivers, which render its use inexpedient when scientific accuracy is required. These discordances are perhaps attributable to a small quantity of air being present in the receiver during the weighings, the amount of which cannot be accurately determined. Another probable cause is a change in the temperature and atmospheric pressure affecting the balance itself and the weights in the pans during the long time necessarily occupied in the whole process of this method of weighing. Indeed it may be generally stated as a rule that the risk of discordances in the results of weighings is in proportion to the time occupied in the operation. Such discordances are not found when the weighings are made by the second method, when a vacuum balance is used, that is to say, when the balance case itself is made an exhausted receiver.

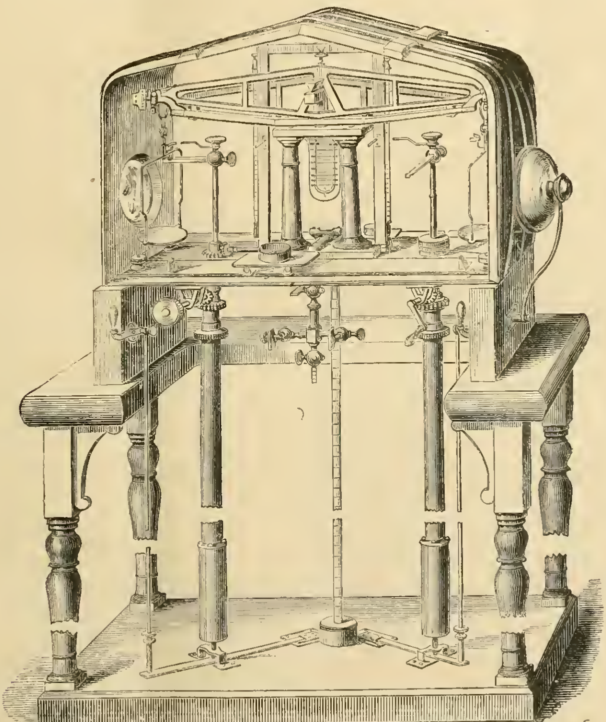


Fig. 19.—New Vacuum Balance of the Standards Department.

A vacuum balance has been constructed at Paris by M. Deleuil, and is now used at the Conservatoire des Arts et Métiers, consisting of a balance of the best construction placed in a very strong cast-iron case that can be made perfectly air-tight. This case has four circular openings for giving admittance and light to the inside, which are closed with strong glass covers. It has a stuffing box for the handle of the lever by which the balance is put in action and arrested. This balance has been found to give very accurate results of weighing in a vacuum. But the comparison of standard weights in this vacuum balance takes a considerable time from the necessity of opening the case and re-establishing a vacuum at least a second time in order to change the weights in the pans even when Borda's method is used; and occasionally this must be done again if a small additional balance weight is required to be placed in either pan, in order to obtain a sufficiently approximate equilibrium, so that the pointer may not exceed the limits of the index scale.

* Continued from p. 49.

Some improvements on Deleuil's vacuum balance have been designed by Prof. W. H. Miller, and have been practically carried out in a vacuum balance constructed by Mr. Oertling for the Standards Department. The balance case consists of a strong brass frame cast in one piece, with a rectangular base, two sides, and an arched top. Two solid glass plates, each $1\frac{3}{4}$ in. thick, form the front and back of the case, being clamped to plane surfaces of the brass frame, and made air-tight by interposing thin india-rubber. They are thus removable when required, for instance, when any alteration is needed in the balance. There is a circular opening $4\frac{5}{8}$ in. in diameter, on each side of the brass frame, similar to those on Deleuil's balance, to which glass covers are fitted. There is no stuffing-box, but when the Standard weights to be compared are placed in the pans, and the balance case exhausted, contrivances are arranged for putting the balance in action and arresting it, for adding any balance weights to either pan and removing them, and for interchanging the pans and weights by transferring them to the other end of the beam, without any disturbance of the vacuum, or necessity of opening the case.

These arrangements enable the weighings to be made by Gauss's method of alternation. The balance case is firmly placed upon a strong mahogany stand. Two iron tubes are fixed underneath and opening into the balance case. They rest in iron cups containing a sufficient quantity of mercury. Within each tube is a steel rod rising to the required height inside the balance case, and having at the top an arm of convenient form. By means of a simple lever handle outside the tube, either rod can be lifted about an inch, and it can also be turned round. By this rotary motion, when the left-hand rod is in its normal position, it acts upon two bevelled wheels, and thus lowers the supporting frame of the beam and puts the balance in action; and by reversing the motion, the action is stopped. By raising either rod to nearly its full height, it can be made to take up one of several small balance weights riding on a little rail fixed to the pillar of the balance, and transfer it to a similar rail at the top of the pan, or to transfer it back again. Again by raising either steel rod to an intermediate height, and turning its arm under the arched rods of one of the pans, and then raising it a little, the pan and weight can be lifted off the hook of the beam and transposed to a small carriage standing upon a railroad near and parallel to the front of the balance-case. In a similar way the other pan and weight can be transferred to a second carriage at the back of the case. By means of a cord and pulleys, one of which is upon the right-hand steel rod and can thus be turned round with the hand, the two carriages can be moved to the other ends of the case, and then each pan with its weight can be attached to the hook at the other end of the beam. The desired results are all thus attained, and the whole action of the balance is open to view.

The construction of this new vacuum balance may be seen from Fig. 19.

The balance itself is similar in construction to the other Standard balances made by Mr. Oertling. It is constructed to weigh a kilogram in each pan. There are two Standard thermometers inside the case, one fixed to each pillar, and adjustible as to height, so that its bulb may be on the same level as the centre of gravity of the weight. A mercurial gauge is fixed between the pillars, and there is the same arrangement of three tubes and stopcocks communicating with air-pumps and with a mano-barometer, as in Deleuil's vacuum balance. Two glass vessels containing chloride of calcium, are also introduced for absorbing any moisture in the balance case.

There are two ways of comparing and verifying standard measures of capacity. The first and most accurate, as well as scientific method, is by weighing their contents of distilled water; the second method, which is simpler and more ordinarily used, consists in comparing the measure of water contained in them, with the contents of a verified standard measure.

In weighing the contents of distilled water contained in a standard measure, when quite full to the brim, and with the surface of the water made accurately level by a disc of plate glass slid over it, Borda's method of weighing is employed. The measure with its disc is placed empty in one of the pans of the balance, and is accurately counterpoised. A verified standard weight equal to the legal weight of water contained in the measure is then added to the pan containing the measure and disc, and is accurately counterpoised, and a sufficient number of weighings is taken until the mean resting-point of the balance is determined and noted. The standard weight is then removed. The measure is exactly filled with distilled water, and its temperature, together with the reading of the barometer noted. Any difference in the actual temperature and barometric pressure from the normal temperature and pressure is to be compensated by equivalent weights placed either in the measure pan or weight pan as required. If an equipoise is not now obtained, additional weights are placed in the pan until an equilibrium is produced, and any difference from the normal correcting weight for temperature and barometric pressure

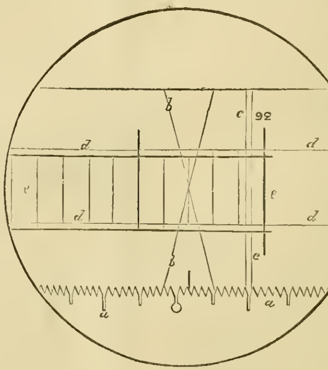


FIG. 20.—Field of Micrometer of Microscope.

either plus or minus, shows the error of the measure in relation to its legal weight of water at the standard temperature and barometric pressure.

For ascertaining the exact amount of the proper corrections for temperature and barometric pressure, authoritative tables are computed both for Imperial and for Metric Measures. Such tables will be found in the Papers appended to the Fifth Report of the Standards Commission, published in 1871 (pp. 81, 193, and 196), and to the Sixth Annual Report of the Warden of the Standards, published in 1872 (pp. 49 and 51).

With regard to comparing instruments for standard measures of length, their construction has necessarily varied according to the form of the standard measure. As has been already stated, the earlier scientific standards of length were defined by two points, and all comparisons were made by means of a beam compass.

The introduction by Mr. Troughton of the use of the micrometer microscope was a great step in advance towards the attainment of scientific accuracy in the comparison of our standard measures of length. It enabled optical observations to be made without injurious contact to the defining points or lines, and thus without interference with the permanence of the

measures. Several descriptions of comparing apparatus with micrometer microscopes have been constructed at various times, but all are made upon the same principle. The microscope is fixed in a vertical position, and is provided with a spirit level and with screws for accurate levelling and focal adjustment. The defining marks of the two standard measures to be compared are brought successively under it, their height being adjusted to the focal distance of the microscope. Any difference of length between the defining marks of the two measures is read off from the graduated head of the micrometer. This part of the apparatus consists of an endless screw with the very finest threads, having a large head divided into 100 parts. The screw is placed in a horizontal position, and when turned carries with it a nut moving in horizontal guides, together with an open frame, which has cobweb lines stretched across it. Two of these lines (*b b* Fig. 20) cross each other at equal angles to the axis of the screw, and so that a line bisecting them is normal to its axis. Two other lines (*c c*) are placed nearly close, and parallel to each other and normal to the axis of the screw; and there are two longitudinal lines (*d d*) parallel to the axis of the screw, by means of which this axis is made parallel to the axis of the measure under observation. When turning the screw, the number of revolutions is read off by the aid of a pointer from a rack (*a*) placed at the edge of the open frame and parallel to the screw, whilst the number of divisions in one revolution is read off on the graduated head of the screw, from a fixed line marked on the upper surface of the microscope. Looking through the eye-piece of the microscope at the magnified first ten hundredths of the inch 36—37 marked on the subdivided standard yard of the Standards' Department (here inverted), the field of the microscope is seen as represented in Fig. 20.

In this figure the cross lines are used for observation, and are seen adjusted to the 0·03 in. line. The pointer at the rack shows the screw to be turned between one and two revolutions from the middle of the field.

All micrometer microscopes used for the comparison of standard measures of length are constructed upon the principle thus described. But there are various kinds of arrangements for supporting the standard measures in a proper position, and for more conveniently bringing their defining marks under the microscopes. Under one of the arrangements, a single micrometer microscope is used, and fixed over the supporting apparatus, which, for the purpose of comparison, has both a transversal and a longitudinal displacement.

The two standard measures (denoted as A and B) being placed with their axes exactly parallel, and their defining marks as nearly as possible in the same line normal to the axes, the left-hand defining mark of A is brought under the microscope, and the position of the micrometer read off on the index scale and noted. By the transversal displacement, the left-hand defining mark of B is next brought under the microscope, and the reading of the index scale noted. The two measuring bars are then moved their whole length by longitudinal displacement, and the right-hand defining marks of A and B successively read off and noted, thus affording the means of ascertaining the difference of length of the two standard measures. The temperature of the bars at the beginning and end of the observations must be determined by thermometers, and the mean temperature noted, and allowance must be made by computation for any difference of length arising from unequal expansion or contraction of the two bars, when this temperature differs from the standard temperature. For this purpose it is absolutely necessary that the coefficient of expansion of each standard bar must be previously determined.

This method of comparing with a single microscope is used in France, but not in England, where the risk of error arising from the longitudinal movement of the bars is avoided by using two microscopes, and only a transversal displacement of the bars during the observations, although there are also means of longitudinal displacement for the purposes of adjustment. The objection raised against the use of two microscopes, that the distance between them may vary during the period of observation by the expansion or contraction from alteration of temperature of the material which unites them, is obviated by fixing them firmly and independently upon a solid stone support.

Placing measuring bars directly upon a plane support is objectionable. It has been proved that there is a risk of discordances in comparisons being caused by almost undiscoverable inequalities in planed surfaces, as well as by a difference of temperature in the plane surface and the under surface of the measuring bar, when thus placed. To guard against this risk, the bars are supported upon rollers, and the measuring bars ought to be stiff enough to bear to be supported upon a few points at which rollers can be conveniently applied. For a short bar two rollers are sufficient; for a longer bar more supports are required. The standard yard bars are supported upon eight rollers, and it is always requisite that each support should exert the same vertical pressure upwards, in order that the interval between two points upon the surface of the bar may not be altered by the flexure. This object is attained by a proper arrangement of levers; and it is easily seen that an arrangement of levers by which equal pressure upwards may be exerted at four or eight points is very simple. Each bar rests upon two brass lever-frames.

It has been shown by the Astronomer Royal, in his paper printed in the Royal Astronomical Society's Memoirs, vol. xv., that the value of the intervals (supposed equal) which ought to exist between different supports of a bar, each support exerting the same vertical pressure upwards, is as follows: n being the number of supports, the resulting intervals of supports is:—

$$\frac{\text{length of bar}}{\sqrt{(n^2 - 1)}}.$$

In order to ascertain with scientific precision how far the results of comparisons of standards obtained by the use of weighing and measuring instruments are to be depended upon for their accuracy, a calculation is to be made of the probable error of every such result, whether it be the result of a single comparison, or the mean result of any number of comparisons. And when other elements are to be taken into account, it is necessary that the probable error of each computation should be determined and allowed for before the final results of comparison can be determined and allowed for.

The mode generally adopted for calculating the probable error is based upon the method of least squares, and is fully stated by the Astronomer Royal, in his "Theory of Errors of Observation," pp. 44-7.

H. W. Chisholm

EARTH-SCULPTURE *

II.

YOU are aware that the revival of the half-forgotten doctrines of the early Scottish School of Geology has not been without vehement protest on the part of the older geologists, who have been inclined to treat them rather as novelties and departures from the older and purer faith. No one resisted them more determinedly than my much-missed friend and benefactor, the late Sir Roderick Murchison. He looked with regret, and even, perhaps, sometimes with a little alarm, upon their advance, and to the last he battled against them. He was, indeed, in this country the leader of his party, which has been called the "Convulsionist School," and his death

* Opening Address to the Edinburgh Geological Society, by Prof. Geikie F.R.S. (continued from p. 52).

has, doubtless, been a severe blow to that school, as it has been a loss to all who admired a straightforward, courteous, and undaunted antagonist.

Other members of the party have, however, in more or less direct ways, lifted up their voices of protest. I select this evening one of these antagonists, partly because he has spoken more and more energetically than any other, and partly because a good deal of his speaking has been directed against myself. And here I am sorry that I must begin by a reference to a matter of personal history. In the summer of 1865 I published a little volume, now out of print, on "The Scenery of Scotland, viewed in connection with its Physical Geology." The object of that work was to show how completely the Huttonian doctrine of earth-sculpture was borne out by the mountains and valleys of the northern part of this island. I distinctly disclaimed any novelty or originality on my own part in the broad doctrine which I tried to enforce. My veneration for Hutton and Playfair had been from boyhood profound; again and again in the pages of my book I quoted them, and spoke of them as the founders of the school to which I professed myself a loyal adherent, and in which I could boast such friends and colleagues as Jukes and Ramsay.

I was well aware, and stated in the preface, that the views to which I had been led "ran counter to what are still the prevailing impressions on this subject," and that I was prepared to find them disputed, or thrown aside. Convinced, however, of their essential truth, I looked forward to a time when what might then be regarded as mere dreaming would be established as a recognised part of the groundwork of geology. The views put forward in the volume met, indeed, with an amount of general acceptance which I could hardly have anticipated. But at length the expected opposition made its appearance.

On February 3, 1868, his Grace the Duke of Argyll read to the Geological Society of London a paper, entitled "On the Physical Geography of Argyleshire, in connection with its geological structure." Although that title was chosen, the paper proved really to be from beginning to end a criticism of my little book, which, indeed, the author candidly acknowledged to have served him as "the best text he could find."

To that paper I made no reply. It seemed to me that the noble author had failed to perceive the bearing of the whole argument from geological waste, as proved by geological structure. His objections being already, in my opinion, anticipated in the book which had called them forth, I did not see how I could make my case plainer by any amount of additional argument. But further, his Grace had begun his communication with a sentence in which he stated that the views set forth by me "seemed to be gaining ground with the younger school of geologists,"—fatal admission, as it occurred to me, for I felt that what was called the younger school must eventually take the place of that which styled itself the older, and that if it remained true to its belief, the views which were now called in question would carry the day without any battling of mine. Every month shows more fully the justice of this anticipation.

I was content to let the matter rest; nor would I recur to it now, but for the following reasons. Since that time the Duke of Argyll has become President of the Geological Society of London. In his recent address, and in a separate communication to the Society, he has returned to the subject of the origin of the present features of the land, referring to his former paper as "an argument which had not been met by any answer in detail," and adhering, therefore, to the views there expressed. As to the non-appearance of any "answer in detail" from myself, I can give no other explanation than that I considered my little book sufficiently detailed for its purpose, and believed that it already anticipated and answered the argument of my opponent. That is still my belief.

But a broad challenge addressed to the general body of geologists by the President in the official Address which he annually gives to the Society and the world, is not the same thing as a criticism from one member of the Society upon the work of another member. In the interests of science, therefore, it seems to me that some protest is now called for against doctrines promulgated at this late date in the century from so high and honourable position as the Chair of the Geological Society of London; and as I have been especially singled out for attack, it appears to me to be only an act of duty to vindicate, not my own position merely, but the reputation of that "younger school" which is accused of seeking to pervert the geological mind from the ancient and true creed. If these doctrines maintained by the President were to become generally diffused, which, happily, is now impossible, they would suffice to paralyse research in one important branch of the science; for, as far as relates to the history of the configuration of the land, they would assuredly bring down upon us again the pre-Huttonian darkness.

No one whom the Geological Society of London has chosen as its President can fail to command the respectful attention of geologists all over the world. And while I gladly acknowledge this right, I would also express the gratification which is widespread among the brethren of the hammer in this country that the Duke of Argyll, in the midst of so many and so onerous, as well as honourable duties, should find time to take a lively and active interest in the progress of geology. I admire, too, the vigour with which he wields his pen, and the boldness with which he gives his judgment among disputed questions. He has once more thrown down his geological gauntlet, and if I venture to take it up, and accept his battle, it is in the full consciousness of the presence of an adversary who, while dealing hard blows himself, will take in good part such buffets as the fortunes of war may bring to him.

I have already alluded to the natural impression that when we look at a region of rough mountains formed out of hardened and contorted rocks, we behold in the external outlines the direct results of the subterranean force by which the rocks were altered and crumpled. This obvious inference is far older than the days of geological inquiry. But surely its mere obviousness is no argument for its truth, any more than the rising and setting of the sun prove the earth to be the centre of the universe. In the volume already referred to I spoke of it as "dealing with that dreamland of conjecture and speculation lying far beyond the pathways of science, where one has no need of facts for either the foundation or superstructure of his theory. It thus requires no scientific knowledge or training; it can be appreciated by all, and may be applied to the history of a mountain chain by one to whom the very name of geology is unknown." But to recognise that this common and instinctive notion is yet a misleading one, requires an acquaintance with geological structure which comparatively few have an opportunity of obtaining, and which appears to be not always readily acquired at second-hand. I have watched the current geological literature on this question during the last decennium, and the result has been to convince me that the notion, or rather the prejudice which I am combating, is in some minds so deeply rooted that it cannot be got rid of by the reading of any number of books or treatises, and, of course, still less by the writing of them. Simple as may be the statement of the leading principles and facts relative to that waste of the earth's surface to which the term Denudation is applied, there is yet, I firmly believe, no part of geology more difficult adequately to realise. So striking are the difference and contrast between the magnitude of the results adduced and the apparent insignificance and impotence of the forces which are alleged to have produced them, that the mind not unnaturally hesitates to associate the one with the other in the rela-

tion of cause and effect. And yet it is only in proportion as one is enabled to master this subject that he is prepared to understand, far less to discuss the origin of the present contours of the land.

In the volume which the Duke of Argyll has singled out to bear the brunt of his attack, I carefully stated at the commencement that I proposed to consider the problem only "in so far as it relates to the history of the scenery of Scotland." I laid down no universal law or dogma by which the hills and valleys of every other part of the world were to be explained. I knew the mountains and glens of Scotland; I had wandered over them and studied them from boyhood; trained in the severe and laborious school of the Geological Survey, I had mapped many hundreds of square miles of their surface, across some of the most complicated pieces of geological structure in the kingdom. It was not, therefore, in any spirit of rashness, or novelty, or dogmatism, but with the growing convictions of many years of experience and in the belief that a service to the cause of geological inquiry in this country could be done, that I ventured to launch my little book upon the world. I was well aware that other regions exhibited features not seen here, and that for these other explanations might require to be found. But it was then no part of my subject to travel beyond my own domain. When the principles for which, in common with my able colleagues in the Survey, I contended were firmly established in relation to the scenery of this country, it would then be time to consider how far they were applicable elsewhere. That they would be found to be not merely of local but of wide general import I then held to be probable, and I now know to be profoundly true.

One main object of my chapters was to show how the present hills and valleys of Scotland had come into existence gradually, one by one, during an enormously protracted period of geological waste in the manner to which I have already referred this evening. I adduced copious proofs from all parts of the kingdom in support of this view, similar proofs having been already triumphantly accumulated by Mr. Jukes in Ireland, and by Prof. Ramsay and others in England.

Far from ignoring the influence of geological structure upon external form, I might even have been charged with having brought forward a needlessly ample accumulation of evidence to show how constantly the resulting contours of the country have been determined by the arrangement of the rocks. I showed how ancient, in a geological sense, the denudation of the country had been, and how thoroughly it had done its work upon the surface, no matter whether the rocks had been originally formed as mere soft mud or had been once in actual fusion. I dwelt on the remarkable fact that as a rule the valleys do not run along lines of fracture, and quoted in support of this assertion the published maps of the Geological Survey of the three kingdoms. To these and similar statements of sober fact which are now part of the common stock of geological knowledge, his Grace opposes such phrases as these: "The facts assumed are, in my opinion, to a large extent purely hypothetical," "This assertion is erroneous," "extravagant demands," "inventions and imaginations," and so on.

(To be continued.)

NOTES

THE annual meeting of the Fellows of the Royal Society was held on Tuesday at Burlington House. The retiring President, Sir George Biddell Airy, K.C.B., delivered the inaugural address. The presentation of the medals followed. The Copley Medal was awarded to Professor Helmholtz, the distinguished physiologist, physicist, and mathematician, of Berlin, "whose memoirs have ranged through nervous physiology, hydrodynamical theory, instruments (as the ophthalmometer and the ophthalmoscope) for exact measurement and for medical examination of the eye, and other important subjects, and have been generally recognised as giving real additions to our knowledge." A Royal Medal was awarded to Prof. Allman, F.R.S., "for his numerous zoological investigations, and more especially for his work upon the Tubularian Hydroids. The subject of these labours is one upon which few persons are qualified to enter; and the Council are impressed with the delicacy of the work and the value of the scientific results." A Royal medal was awardep to Professor H. E. Roscoe, F.R.S., of Owens College, Manchester, "for his various Chemical Researches, more especially for his investigations of the Chemical Action of Light, and of the Combinations of Vanadium." Dr. Joseph Dalton Hooker, C.B., was elected President of the Society.

THE alleged reply of the Government on the subject of an Arctic Expedition as reported in the daily papers (*Daily Telegraph* and *Pall Mall Gazette*) is calculated to convey a very erroneous impression. Mr. Gladstone has requested that he may be furnished, in writing, with the reasons for the despatch of an Arctic Expedition, before receiving a deputation on the subject. Those reasons, which we believe to be quite conclusive as showing the propriety of despatching an expedition next year, will at once be furnished to the Prime Minister.

PROF. A. W. WILLIAMSON has been elected a Correspondent of the French Academy.

THE Duke of Northumberland has been unanimously elected President of the Royal Institution, in succession to the late Sir Henry Holland.

THE probable arrangements for the Friday Evening Meetings of the Royal Institution before Easter 1874, are as follows:—Jan. 16: The Acoustic Transparency and Opacity of the Atmosphere, by Prof. Tyndall, F.R.S. Jan. 23: Recent Discoveries in Mechanical Conversion of Motion, by Prof. Sylvester, F.R.S. Jan. 30: Weber and his Times, by Sir Julius Benedict. Feb. 6: The Heart and the Sphygmograph, by Alfred H. Garrod, Fellow of St. John's College, Cambridge. Feb. 13: The Opponents of Shakespeare, by Dr. Doran, F.S.A. Feb. 20: The Autotype and other Photographic Processes and Discoveries, by Vernon Heath. Feb. 27: Men of Science, their Nature and Nurture, by Francis Galton, F.R.S. March 6: Venus's Fly-trap, by Dr. J. S. Burdon-Sanderson, F.R.S. March 13: Graphic Representations of Musical Sounds, by M. Cornu. March 20: The Temperature of the Atlantic, by Dr. W. B. Carpenter, F.R.S., Registrar Univ. Lond. March 27: The Physical History of the Rhine, by Prof. A. C. Ramsay, F.R.S., Director of the Geological Survey of Great Britain.

SIR SAMUEL BAKER has quite recovered from his recent indisposition, and will on Monday next address the Royal Geographical Society upon his adventures in Africa.

WE regret to announce the death of M. De La Rive at Marseilles on Nov. 27, on his way to Cannes. He had had an apoplectic fit about a fortnight previously, from which he seemed to be slowly recovering, though greatly shattered in intellect.

WE rejoice to learn that at a convocation held at Oxford on November 27, the grant alluded to in NATURE a fortnight ago in connection with Dr. De La Rue's gift of astronomical apparatus to the University, was acceded to in a manner creditable and gratifying to all concerned. Thus the University has, we believe, established the foundation of what ought to become a very useful Observatory for Astronomical Physics One immediate result, we hope, will be to excite Cambridge into vigorous action. Oxford deserves great credit for the efforts she has made during the

past few years to encourage the study of physical science; we hope the results will lead her to do so to a still greater extent.

THE fund being raised for the purpose of providing a suitable memorial to the late Prof. Sedgwick, of Cambridge University, reaches nearly 10,000*l*. The form of the testimonial will be some new and suitable buildings for the schools of geology, and a full-length statue of the late professor.

THE Cape mail brings word that the *Challenger* has arrived at Simon's Bay. On her voyage from Bahia she touched at Tristan d'Acunha, and made a survey of the groups of islands to which it belongs. Two Germans were found who had lived there for a couple of years, and who gladly availed themselves of the opportunity of leaving.

THE annual course of lectures of the Brown Institution, under the Government of the University of London, will be delivered in the theatre of the University by Dr. Burdon-Sanderson, F.R.S., on successive Tuesdays and Fridays during the present month, at 5 o'clock in the afternoon. The first lecture will be given on Tuesday next the 9th inst.

PROFESSOR E. WEISS, of the Vienna Observatory, we learn from the *Bulletin International* of the Paris Observatory, has identified the comet recently discovered by Coggia, with the first comet of 1818, discovered by Pons at Marseilles.

WE understand that the Lords of the Privy Council on Education have decided to unite the Professorships of General and Applied Chemistry in the Royal College of Science, Dublin, and that this joint professorship will be conferred on Mr. Galloway, for many years the Professor of Applied Chemistry to the College. The only vacancy to be now filled up in the college staff is therefore that of the Professorship of Zoology.

PROF. N. L. SHALER, Geologist of the State of Kentucky, in a recent letter to the *Frankfort Yeoman*, makes a rather novel suggestion for improving the navigation of the Ohio River, and at the same time preventing the enormous destruction of property which its floods now occasion at intervals, by washing away its banks. In what has hitherto proved a vain endeavour to accomplish the former object, a large amount of money has been already spent under appropriations of the United States Congress, for wing-dams and other structures to concentrate the flow during the season of slack water; and schemes have been considered with more or less favour that involved the expenditure of from ten to forty million dollars. The waste by floods, of property bordering the river, is estimated by Prof. Shaler at 400,000 dols. per annum. He thinks that both objects could be accomplished by simply planting willows upon the banks, as he finds that wherever such a plantation has been effected, the resulting growth not only holds the soil in which it is rooted, but accumulates that which is brought down by the river. When the banks have been sufficiently strengthened and extended by means of such plantations, a deepening of the channel must result, which will improve navigation. The entire cost of planting the banks of the river from Pittsburgh to its mouth is estimated by Prof. Shaler at 100,000 dols.

ON Monday, Nov. 24, a meeting of the Royal Geographical Society was held in the theatre of the University of London, Burlington Gardens; Sir Bartle Frere in the chair. Two papers were read—one by Capt. J. Moresby, R.N., "On recent discoveries at the eastern end of New Guinea," and the other by the Rev. W. Wyatt Gill, on three visits to New Guinea. Capt. Moresby's paper entered at much length into the configuration and aspect of the country, which the author described as not unlike that of Australia. From all he saw of the people, the old idea that they were the most savage of all races must be abandoned. Capt. Moresby's paper described the utensils used by the natives, and looked forward to a better future for them in consequence of their connection with England. The Rev. Mr. Gill then related his experience, which in general confirmed that of Capt. Moresby.

THE late Mr. Robert M'Andrew, F.R.S., of Isleworth House, Middlesex, has bequeathed to the University of Cambridge a very large and valuable collection of recent shells. The collection is one of great scientific interest, and is well known to persons engaged in the study of this branch of natural history. Mr. M'Andrew also bequeaths to the University "such of the purely conchological works in my library as the Vice-Chancellor or any Professor or other official nominated by him shall select, provided they are works which the said University does not already possess (otherwise than in the Public Library of the said University), and such works are to be placed in the Natural History Museum or some library connected with it."

A CORRESPONDENT asks whether any of our readers can inform him if there exists any description of a fine section of Rhætic beds which is to be found about half a mile outside the town of Newark-upon-Trent?

WE have received copies of the *New York Tribune* for October 29, 30, 31, containing full reports of the recent meeting of the American Academy of Sciences, in New York. The reports are very detailed, and have evidently been prepared with great care for the *Tribune*, which, moreover, to judge from the numbers referred to, seems to devote something like one-third of its space to matters more or less connected with Science, not to mention literature. We fear this would not pay in this country; it evidently does in America. The American Academy, appears to be a kind of select upper Association for the Promotion of Science. It started with fifty members, and adds only five new members each year; there seems to be but little prearrangement as to the meetings.

THE earthquake on the 9th November, in Western Asia Minor, was rather remarkable. It was felt at 10 A.M. at the Dardanelles and Broossa. It reached to Ak Hissar, Phocæa, and the islands of Samos and Nisyros, in fact from N. to S. At Smyrna a first shock was felt at 9.49 P.M., and another at 3.20 A.M. [of the next day?]. After the first shock a strong smell of sulphur pervaded the atmosphere and entered the houses. A thick mist which had hung about for days dispersed, and the night was clear. Nisyros was supposed to be the centre. At the Dardanelles the shock was preceded by a rumbling noise. At Broossa there was a second shock at 1 P.M. An earthquake was felt on October 10, at 4.45 A.M., at San Salvador, in Central America. It was slight.

THE naturalists connected with the U.S. Yellowstone Expedition of the summer of 1873 have all returned from the field, and are at present engaged in preparing reports for transmission to the Secretary of War. The opportunities furnished by the occasion were not so good as had been hoped for, the region proving to be much more destitute of animal and vegetable life than anticipated. Everything was done, however, by them that the circumstances would allow. The collections embrace a full series of everything met with in the form of animal and vegetable life. The collections of butterflies and of plants were especially rich; of fossils not many were obtained, but among them will doubtless be found some new species. Among these was a large ammonite, 3 ft. in diameter, presented to the party by Lieut. P. H. Ray. A few uncharacteristic bones of fossil vertebrates were picked up, but the expedition failed to reach any of the great bone deposits of the Mauvaises Terres, as they had hoped to do.

We have recently had occasion to notice the fact that the plans of the new observatory at Cincinnati, U.S., had been approved, and were about being carried into execution. It gives us pleasure to record the rapid progress that has been made in this work, as evinced by the fact that on the 28th of August the corner-stone of the new building now in process of erection on Mount Lookout was laid with becoming ceremonies. The site chosen for the new observatory is about four miles north-east of that on Mount Adams, where the original observatory, founded by Prof. O. M. Mitchell, was established. The corner-stone that was laid in 1843 on that elevation by John Quincy Adams has been carefully removed to the new site, and appropriately forms the corner-stone of the new equatorial pier. The observatory has, by means of a tripartite agreement with the city and the heirs of Nicholas Longworth, now passed into the hands of the Cincinnati University. The proceeds, amounting to 50,000 dols., realised on the sale of the property on Mount Adams have been invested for the support of the art department of the university. The city, however, has pledged itself to maintain the observatory when once established, and the establishment has itself been hastened by the liberality of Mr. John Kilgour, who has given four acres of ground as a site for the new building, and added 10,000 dols. for the latter. The site is admirably adapted for the purpose of the institution. It is one of the highest points in the county, commanding a beautiful and extended view, and it is not likely that the difficulty experienced at the old site from the smoke and vapours of the city will for a long time if ever, trouble the astronomers on Mount Lookout. The new edifice faces south, having a width of about sixty feet, a depth of ninety feet, and two wings, making the breadth through the wings about one hundred feet. One of the wings will be used for the meridian instruments; and in the centre of the building, on a brick pier thirty-six feet high and seventeen feet in diameter, will rest the big telescope. The building will be two stories high, except in the centre, where the revolving turret of iron for the equatorial will add half a story. The structure is to be of pressed brick, with freestone trimmings.

The additions to the Zoological Society's collection during the last week include an Arabian Baboon (*Cynocephalus hamadryas*) from Arabia, presented by Miss Sandon; a Wild Cat (*Felis catus*) from Scotland, presented by Sir T. Riddell, Bart.; three Gray's Terrapins (*Clemmys grayi*), and some Moorish Tortoises (*Testudo mauritanica*) from Persa, presented by Hon. E. Ellis; an African Goat (*Capra hircus*) from Bedah, presented by Mr. J. A. Croft; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Lady Stirling; two Blue-throated Parrots (*Pionus sordidus*) from Venezuela; an Active Amazon (*Chrysotis agilis*) from Jamaica, and a Blackish Sternothere (*Sternothoerus subniger*) from Madagascar, purchased.

SCIENTIFIC SERIALS

The *Journal of Mental Science*, October 1873. This journal is still occupied with only medico-psychological subjects. The Morisonian Lectures on Insanity for 1873 begun in this number are of great interest, and mark the advance of Science in this painfully important branch of knowledge. Nothing, we think, can be more evident than that Dr. Skae proceeds on a scientific principle when he attempts to classify the various forms of insanity according to the bodily disease or condition, as far as it can be ascertained, which proceeds or accompanies the insanity. And it is surprising that even Dr. Maudsley should be found among those who cavil at Dr. Skae's classification, instead of adopting his principle and making the most of it. With insanity Science has made a beginning, but that is all.—In an article by Dr. J. T. Dickson on "The Functions of Brain and Muscle Considered in Relation to Epilepsy" we have a rather singular hypothesis concerning the functional relation of the brain to the muscular system. We cannot afford to indicate this curious theory; we doubt if we quite understand it; but we can inform the scientific world generally, on the authority of Dr. Dickson, that what they have been in the habit of believing on this subject "is not only improbable, but impossible." Dr. Hughlings Jackson has, it seems, been at the pains to quote against Dr. Dickson some passages from Herbert Spencer's Psychology; but he could have little known with whom he had to deal. Dr. Dickson quietly remarks—"From this it would seem that Spencer holds somewhat the same, though the untenable view." Was there ever a finer example of how completely original ideas can free a mind from the degrading thraldom of authority? Does Spencer differ from me? why then that is the worse for Spencer.—The article of most general interest is "The Morbid Psychology of Criminals," by Dr. D. Nicolson, continued from last number, and still unfinished. It abounds in valuable observations, and good practical common sense. When in prison criminals offer good opportunities for observation, but we do not perceive that their "emotional displays" can with strictness be said to mark anything specially morbid. From all that is said, we cannot gather more than that criminals are like the much larger class to which they generally belong, namely people of a low type of mind. The unfortunates that find their way into our prisons are, we regret to think, far from the only people who cannot help insanely acccusing others of wicked designs against them; whose minds are lawless and undisciplined; who must have their "breakings out;" and for whom, when they become intolerably insolent and violent, "a good drubbing on the spot" would be the most appropriate medicine. People, when inclined to what they ought not to do will not be deterred by the fear of punishments that are not painful, or which are too distant to act on their dull imaginations. This leads to large considerations, but we can only say that it would be a great matter for social progress if our tender-hearted philanthropists—those who busy themselves with theories of home, school, and prison discipline, distributing gratis wonderful receipts for the painless cure of all bad habits—could be brought to understand a little better than they do the real nature of the material on which they have to work. The review of the Lunacy Blue Books will be found interesting; also "Antiquarian Scraps relating to Insanity," by Dr. T. W. McDowall.

Journal of the Royal Geological Society of Ireland, vol. xiii., Part 3, for the session 1872–73, contains E. T. Hardman on the occurrence of gypsum in the Keuper Marls, near Coagh, Co. Tyrone.—Prof. T. Rupert Jones, on some Foraminifera from the chalk of the North of Ireland.—P. S. Abraham, notes on the geology of the Hartz.—Prof. Macalister, a description of two Veddah skulls, and Presidential address (which latter gives an able summary of the work done by German petrologists with the object of determining the mineral constitution and structure of plutonic, metamorphic, volcanic and other rocks by the aid of the microscope).—Prof. E. Hull, on the microscopical structure of the Limerick carboniferous Trap Rocks, and on the microscopical structure of Irish granites.—Col. Meadows Taylor, the Coal fields of Central India.—R. J. Cruise, Analysis of the Leitrim coal, remarks on the coal area of the district.—Dr. Studdert, on the Lough Allen coal from the Arigna District, Co. Leitrim.—G. H. Kinahan, on the carboniferous ingenite rocks of the County Limerick.—E. T. Hardman, on the occurrence of siliceous nodular brown Hæmatite (Göthite) in the carboniferous limestone beds near Cookstown, Co. Tyrone, &c., and on an analysis of white chalk from the County of Tyrone, with notes on the occurrence of zinc therein.—Rev. Dr. Macloskie, on the silicified wood of Lough Neagh.—Dr. Tichborne, on the formation of crystalline minerals having the spherical form.

The 2nd and 3rd numbers of the 7th volume of the *Canadian Naturalist* commence with a paper by Dr. Dawson on impressions and footprints of aquatic animals and imitative markings on carboniferous rocks, those considered being invertebrate. The paper originally appeared in *Silliman's Journal*.—Mr. G. F. Mathew continues a description of his impressions of Cuba, and enters into detail respecting the botany of the island.—Mr. Whiteaves gives an account of a deep-sea dredging expedition round the island of Anticosti, in the Gulf of St. Lawrence, in which upwards of 100 species of marine invertebrata new to the Gulf of St. Lawrence were added to the previously recorded fauna.—Dr. Dawson also contributes a paper on the geological relations of the iron ores of Nova Scotia, considering first the bedded ores of the Lower Helderberg series, and of Nictaux and Moose River; next the veins of iron ore of the East River of Pictou, Shubenacadie, and other parts.—Dr. Nicholson, of Toronto, describes some new fossils from the Devonian rocks of

Western Ontario, including *Zaphrentis fenestrata* (n.s.) *Blothrophyllum approximatum* (n.s.); *Heliophyllum colbornensis* (n.s.); *Petraia logani* (n.s.); and *Alecto canadensis* (n.s.).—A detailed report is given of the meeting of the American Association for the Advancement of Science, of which an abstract has already appeared in our pages.

Journal of the Franklin Institute, Oct. 1873.—We have here the second portion of Prof. Thurston's valuable paper on the molecular changes produced in iron by variations of temperature. He comes to the conclusion that at temperatures above 600° and below 70° F., iron conforms to the general law for solid bodies, that increase of temperature diminishes tenacity but increases ductility and resilience, while decrease of temperature has the opposite effect. Below 70° the tenacity increases with diminishing temperature at the rate of 0·02 to 0·03 per cent. for each degree F., while the resilience decreases in much higher ratio. Between ordinary temperatures and a point somewhere between 500° and 600°, on the other hand, iron shows marked deviation from the law, the strength increasing to the extent of about fifteen per cent. with good iron. The practical result is, that as iron does not lose its power of sustaining "dead" loads at low temperature, but greatly loses its power of resisting shocks, the factor of safety in structures need not be increased in the former case, where exposure to severe cold is apprehended; but that machinery, rails, and other structures which have to resist shocks should have large factors of safety, and be protected, if possible, from extremes of temperature.—Mr. Lowe communicates "something new concerning the physical properties of steam," viz., that the external work given out by steam in expanding from the temperature (t') to the temperature (t), bears a constant ratio to the difference; that is, to ($t' - t$). He considers the latent heat performs the internal work, while the sensible heat only is available for external work; in which case that vapour whose latent heat is the smallest, other things equal, would be the best agent for converting heat into work.—A paper on statistics of coal, is compiled from Mr. James McFarlane's "Coal Regions of America."—Mr. Bilgram furnishes an "Elementary treatment of Zeuner's slide-valve;" and Mr. Murphy has a paper on "Bridge building considered normally."—There are descriptions of machinery for utilisation of coal waste, a stone-cutting machine, and a machine for making paper boxes. The latter produces match-boxes at the rate of 3,000 in an hour. Paste is dispensed with, the slips of wrapper being fastened by delicate staples of iron wire.

American Journal of Science and Arts, November, 1873. In this number we find two contributions in chemistry from the Massachusetts Institute of Technology, in one of which it is shown that by solution of cast-iron in an acid, there may be obtained, besides gaseous bodies, which escape with the hydrogen, volatile hydrocarbons, boiling between 93° and 155° C., and probably belonging partly to the saturated, partly to the non-saturated series. Of the latter, considerable quantities may be condensed by combination with bromine, after having passed through a freezing mixture.—Prof. H. L. Smith gives a series of investigations made in the Queen's Chamber of the Great Pyramid, as supporting the view that a high degree of geometrical and astronomical knowledge must have been possessed by the builders, but without superhuman accuracy. In a paper on rocks of the Helderberg era, in the Connecticut Valley, Prof. Dana endeavours to show that Staurolitic slate, hornblendic rocks, gneiss, mica schist, &c., are extensively developed in a *formation of Helderberg age*, and probably the Upper Helderberg or Lower Devonian. There is a letter from Dr. B. A. Gould, Director of the Cordoba Observatory (date Aug. 5), giving an account of work recently done there. Zone observations had been begun in September last year, and were nearly half completed, some 50,000 stars having been observed. From a note on the hypsometric work of the U.S. Geological and Geographical Survey of the Territories, we learn that four stations were established: at Denver, 5,000 feet above the sea; Cañon City, 6,000 feet; Fair Play (in the South Park), 10,000 feet; and Mount Lincoln, 14,000 feet; the observations at each being taken three times daily. The U.S. Signal Service have recently established a permanent meteorological station on the summit of Pike's Peak, about 14,000 feet high; the observations will be published daily by telegraph, and will doubtless be of high scientific and popular interest.—Of the remaining matter we may note suggested improvements in filter pumps, and in the arrangement of shutters in a dome for an equatorial telescope.

Poggendorff's Annalen der Physik und Chemie. No. 7. 1873. In this number, M. Quincke continues his "Optische Untersuchungen," investigating at some length the behaviour of polarised light on its passage through gratings.—M. Riess enunciates thus a new kind of reaction of currents: a wire circuit, part of which is traversed by a given (Leyden) battery current, remaining unaltered, various secondary currents, produced in it successively, react on the primary, so that the weaker secondary corresponds to the stronger primary.—Dr. Voller has examined the influence of temperature on electromotive force of galvanic combinations, and finds that with salt solutions in contact with copper or zinc, the force is diminished by rise of temperature, whereas with acids it is increased.—An interesting paper by Prof. Villari treats of the time flint glass takes to be magnetised, demagnetised, and to turn the plane of polarisation. He rotated a glass cylinder between the poles of an electro-magnet, where it acted like a cylindrical lens to polarised light passing through the poles. When not magnetised, the cylinder, whether in motion or at rest, was neutral to the light; but when magnetised, its plane-rotating power considerably diminished with increasing velocity of rotation; the reason being that, in such quick revolution, each diameter remained too short a time in the axial direction to acquire all the magnetism it would otherwise have. To give flint glass such diamagnetic intensity, as became observable by rotation of the plane, required at the least 0·″001244, while to give it all the diamagnetism it is capable of taking under a strong magnet, at least 0·″00241 was necessary.—"A contribution to the theory of thermal currents," by M. Avenarius, appears to be an appropriation of results published by Prof. Tait in 1870, and which are incorporated in the professor's Rede Lecture for this year. A similar remark will apply to M. Topler's application of air-friction to the deadening of galvanometer needles, &c., which is simply Sir W. Thomson's dead-beat principle.—M. Raye criticises unfavourably M. Zöllner's theory of sun-spots and protuberances; his own theory represents, in the sun, something like what occurs in our cyclones, in which there is an *upward* air-current carrying with it aqueous vapour, which forms above into a cloud. He thus differs from Faye, who supposes a *descending* current, in the solar cyclones.—M. Hennig describes an apparatus for quantitative spectrum analysis, and M. Schneider continues his account of salts of sulphur. We find also notes on galvanic reduction of iron under the influence of an electromagnetic solenoid, and on the reflection and refraction of sound; from the St. Petersburg and Vienna academies respectively.—An abstract of an instructive paper by M. Vogel on the spectra of comets we hope to give shortly.

SOCIETIES AND ACADEMIES

London

Geological Society, Nov. 19.—Prof. Ramsay, F.R.S., vice-president, in the chair.—The following communications were read:—"Supplemental Note on the Anatomy of *Hypsilophodon Foxii*," by Mr. J. W. Hulke, F.R.S. The material for this note was a slab from Cowleaze Chine, containing portions of two individuals of *Hypsilophodon Foxii*, one consisting of a skull with a great part of the vertebral column, the other of a portion of the vertebral column. The author described some details of the structure of the skull, and especially the palatal apparatus. In connection with the question of the generic rank of *Hypsilophodon*, the author stated that in *Hypsilophodon* the centra of the sacral vertebræ are cylindroid and rounded below, whilst in *Iguanodon* they are compressed laterally and angulated below.—"The Drift-beds of the North-west of England, Part 1, Shells of the Lancashire and Cheshire Low-level Clay and Sands," by Mr. T. Mellard Reade. The author gave a list of the localities in which shells were found, and stated that in all forty-six species had been met with distributed through the clay-beds, those found in the sand-seams being rare and generally fragmentary and rolled. He contended that the admixture of shells in the boulder-clay was due to the tendency of the sea to throw up its contents on the beach, whence changing currents and floating ice might again remove them, and to the oscillations of the land bringing all the beds at one time or another within reach of marine erosive action. He maintained that it is in the distribution of land and sea at the period of deposition of the Lancashire deposits, and not in astronomical causes, that we must seek the explanation of the climate of that

period, the conditions of which he endeavoured to explain by a consideration of the proportions of the species and the natural habitats of the shells found in the drifts.—"Note on a deposit of Middle Pleistocene Gravel near Leyland, Lancashire," by Mr. R. D. Darbishire. The bed of gravel, about forty feet thick, and about 240 feet above the level of the sea, is covered by yellow brick clay, and overlies an untried bed of fine sea-sand. The shells and fragments occur chiefly at the base of the gravel. The author considered the Leyland deposit, like those on the west of the Derbyshire hills, to be more probably littoral and truly climatic than that of the Liverpool clays, the subject of Mr. Reade's paper, and hazarded the conjecture that the latter were sea-bottom beds, into which, during some process of degradation and redistribution, the specimens found and enumerated by Mr. Reade had been carried down from the former more ancient retreating coast-lines.

Geologists' Association, Nov. 7.—Mr. Henry Woodward, F.R.S., president, in the chair.—At this, the first meeting of the session 1873–74, the president delivered the opening address of the new session, in which he gave a review of the progress of geological science during the past year. Mr. Woodward referred to the progress made in the acceptance by botanists and zoologists of the doctrine of evolution. "Darwin's theory has already passed through the fire like crude ore, it has been roasted, crushed, sifted, washed, and after all the pure metal remains. Our speculations, however, bring us no nearer to the discovery of the origin of life itself."

Meteorological Society, Nov. 19.—Dr. R. J. Mann, president, in the chair.—The following papers were read:—The thunderstorm at Brighton on Oct. 8, 1873, and its effects, by F. E. Sawyer, and some considerations suggested by the depressions which passed over the British Islands during September 1873, by F. Gaster.—A discussion took place on the best form of thermometer stand. It was resolved that the following conditions should be fulfilled:—(1) The contained thermometers must at all times be shielded from the direct rays of the sun; (2) The stand must be so arranged that even when its own external temperature is raised, the thermometers shall not be thereby affected; (3) As reflected heat must diminish the accuracy with which thermometers indicate air or shade temperature, these disturbing causes should be excluded; (4) The temperature of the air alone being desired, it is necessary that the readings of the thermometers be not affected by radiation to the sky; (5) It being desirable that one pattern of stand be used in all localities, it follows that it should be absolutely independent of all surrounding objects; (6) There must be free access of air round the thermometers; (7) No rain should ever reach the dry-bulb thermometers, for if it does, it improperly lowers their temperature, making them read even lower than the wet bulb; (8) The stand must also be unaffected by snow, both as a direct fall or from obstructed circulation of air; (9) It is very desirable that the stand require no attention between the hours of observation; (10) It is desirable, but not absolutely necessary, that room be provided for a duplicate set of instruments; (11) The stand should not be costly; (12) It should be capable of easy transmission by rail or otherwise. Mr. Prince gave an account of some experiments he had made, and was of opinion that the true temperature of the air could be obtained without a stand. Mr. Symons thought that a stand constructed on the Kew and Stevenson pattern combined, but smaller than the former and larger than the latter would be the best form of stand to adopt. The meeting not having the results of the comparison of the observations made with the different stands at Strathfield Tungiss, the discussion was adjourned till after these are published.

Anthropological Institute, Nov. 25.—Prof. Busk, F.R.S., president, in the chair.—Mr. F. W. Rudler read a report on Anthropology at the meeting of the British Association at Bradford.—Dr. G. W. Leitner, Principal of the Government College of Lahore, gave an account of the Siah Posh Kafirs, a race of people inhabiting Kafiristan, on the south-eastern slope on the Hindu Kush. Kafiristan may be said to form a triangular tract of country lying between 35° and 36° N. lat., and 70° and 72° E. long., and is bounded on its sides by Kábul, Badakshan, and Kashmir. The name of Siah Posh Kafirs was given to them by the Mahommedans, "Siah" meaning "black," "Posh" clothing, and "Kafir" infidel; for in fact a Kafir, according to the Mahommedans, was any one who did not follow the teaching of Mahomet. The Kafirs claimed to be a sort of country cousins of the British. Slavery existed within their own country, and also within five miles of Peshawur, where the Kafirs were sold in the open market. The consequence was that the Kafirs in retaliation, kept the roads leading to Central Asia in a state of insecurity, and murdered all travellers coming within their reach. Dr. Leitner, referring to the asserted Macedonian origin of the Kafirs, said that that supposition was founded on very loose and vague data, and that they themselves knew nothing of Alexander. The Tunganis, another of those races, claimed direct descent from Alexander's soldiers. Another theory was that the Siah Posh Kafirs were Zoroastrians, who were supposed to have been forced into the hills by the Arabs, and the existing customs among the Kafirs certainly seemed to support the idea that they were ethnologically connected with the Pursees. He inclined to the opinion that they were Aborigines; and if they were not descended from the same stock as the "Aryan" race, they were certainly, as far as language was concerned, equally related to the Sanscrit.

Entomological Society, Nov. 17.—Prof. Westwood, president, in the chair.—Mr. Higgins exhibited *Deilephila euphorbiæ* and *Sphinx pinastri*, bred from larvæ taken in June 1872, near Harwich.—Mr. Champion exhibited several rare Coleoptera taken at Braemar and other places during the past season.—Mr. Boyd exhibited a Trichopterous insect, *Brachycentrus subnubilus*, a species which constructs quadrangular cases, which had been reared from the egg state.—Mr. Müller remarked on some galls found by Dr. Masters on the roots of *Deodara*, which he considered identical with the galls of *Biorhiza aptera*, Fab., usually occurring on the roots of oak.—Mr. Bird exhibited *Chilo gigantellus* from Horning Fen, and Mr. Vaughan *Pempelia davisellus* reared from Furze.—Mr. Stevens exhibited some rare Lepidoptera taken on the South Coast.—A paper was read, entitled "Notes on the Habits of *Papilio merope* Auct., with a Description of its Larva and Pupa," by J. P. Mansel Weale, B.A. Also a paper entitled "Observations on *Papilio merope* Auct., with an account of the various known Forms of that Butterfly," by Roland Trimen, F.L.S., &c.—Some remarks were communicated by Mr. Miskin, of Brisbane in Queensland, respecting *Mynes guerini* of Wallace, which he considered identical with *M. geoffroyi* Guerin, and directing attention to the singular habit of the pupæ, which were suspended in groups of three or four individuals, united at the tails.

Royal Horticultural Society, Nov. 12.—Scientific Committee.—A. Grote, F.R.S., in the chair.—The Rev. M. J. Berkeley sent a Capsicum from Transylvania with two small fruits produced from the placenta.—Mr. Anderson Henry sent fruit of *Tacsonia quitensis*, produced in a cool greenhouse.—Mr. Wheble sent wood and bark of *Sequoia sempervirens*, the latter being extremely similar to that of the large tree exhibited at the Crystal Palace.—Prof. Thiselton Dyer exhibited preparations of the buds upon the leaves of *Malaxis*, prepared by Prof. Dickie.

General Meeting.—H. Little in the chair.—Prof. Thiselton Dyer called the attention of the meeting to the fine plant of *Vanda cærulea* with four panicles; a plant of the recently introduced *Batemania Burtii* from Costa Rica; specimens of a species of *Stylidium* (probably *S. ciliatum*), an Australian genus with the radical leaves in a Crassula-like tuft; flowering specimens of *Cunonia capensis* from Syon House; and a "grape-rail," a contrivance by which grapes could be preserved through the winter. The pieces of cane to which the grapes were attached were inserted into holes in long zinc rod-like boxes which contained a mixture of fuller's earth, starch, sugar, charcoal, and water. It was remarked by Mr. Jennings that *Vanda cærulea* was fast disappearing from its native localities. At the present rate the ruthless removal of the plant must determine its extermination at any rate in the Khasia hills.

Anthropological Society, Nov. 18.—Dr. R. S. Charnock, president, in the chair. Extracts from letters from foreign correspondents were read, one of which announced an alleged discovery of a Phœnician inscription of the 4th century, B.C., near Rio de Janeiro, and one from Captain Burton, mentioning the discovery at Maeshowe, in Orkney, of Scandinavian inscriptions, in Arabic letters.—Personal observations of the Sae-lies or Flathead Indians of North America, by J. Simms, M.D., of New York The discourse treated of the manner of fashioning or deforming the head, the customs, dress, diet, disposition of the dead, &c. Dr. Simms also gave a brief description of the Quatsino Indians who inhabit the north-western coast of Vancouver Island, the mode of fashioning their peculiar, sugar-loaf form of heads, their superstitions, food, &c. He also gave a very interesting account of the Digger Indians of California, the ircolour, form,

dress, manner of living, general habits, including badges of mourning, food, &c. The Snakes, Utes, Pintes, Foxes, Siouxs, and other tribes were briefly described.

CAMBRIDGE

Philosophical Society, Nov. 17.—"On a suspected forgery in the Vatican Manuscript Record of the Trial of Galileo before the Inquisition," by Mr. Sedley Taylor, late Fellow of Trinity College. The object of the paper was to show, in accordance with the views of recent German and Italian authorities, that the sentence pronounced against Galileo in 1633 was based on a spurious document fabricated for the express purpose of securing his condemnation. The evidence adduced to support this conclusion was taken partly from the works and letters of Galileo, and partly from the contemporary records of the trial preserved in the Archives of the Inquisition, portions of which have been lately published for the first time. The result of the paper was to exonerate Galileo completely from the charge of contumacy which all his biographers have hitherto either advanced or tacitly admitted.

MANCHESTER

Literary and Philosophical Society, Nov. 4.—R. Angus Smith, F.R.S., vice-president, in the chair.—"On the Bursting of Trees and Objects struck by Lightning," by Prof. Osborne Reynolds, M.A. The results of the experiments referred to in this paper were exhibited to the meeting. The suggestion thrown out by Mr. Baxendell at the last meeting—that the explosive effect of lightning is due to the conversion of moisture into steam—seemed to him to be so very probable, that he was induced to try if he could not produce a similar effect experimentally. He tried various experiments by sending a discharge through pieces of damped wood, and through glass tubes with and without water. The pieces of wood, which varied in size, yielded various results, and the glass tubes, which also were of various sizes, were shivered to pieces.—The Rev. W. N. Molesworth, M.A., brought under the notice of the Society some Roman and Celtic antiquities, to which he thought that sufficient attention had not been given in this country.

Nov. 18.—E. W. Binney, F.R.S., vice-president, in the chair.—"On the Bursting of Trees and Objects struck by Lightning," by Prof. Osborne Reynolds, M.A. In a paper on this subject read at the last meeting I stated that the tube which was burst by a discharge from a jar would probably withstand an internal pressure of from 2 to 5 tons on the square inch; and I made use of the expression the tube might be fired like a gun without bursting. These statements were based on the calculated strength of the tube, and with a view to show that there was no mistake, I have since tried it in the following manner.—I made 3 guns of the same tube. No. 1, which was 6 inches long, had its end stopped with a brass plug containing the fuze hole. No. 2 and No. 3 were 5 inches long and had their breeches drawn down so as only to leave a fuse hole. These tubes were loaded with gunpowder and shotted with slugs of wire which fitted them, and which were all $\frac{3}{4}$ inch long. No. 1 was first fired with $\frac{1}{2}$ inch of powder, the shot penetrated $\frac{1}{4}$ inch into a deal board, and the gun was uninjured. No. 2 was then fired with $1\frac{1}{2}$ inches of powder, and the shot went through the 1-inch deal board and $\frac{1}{2}$ inch into some mahogany behind, thus penetrating altogether $1\frac{1}{2}$ inches; the tube, however, was burst to fragments. Some of these were recovered, and although they were small they did not show cracks and signs of crushing like those from the electrical fracture. No. 3 was then fired with $\frac{3}{4}$ inch of powder, and the shot penetrated $\frac{1}{2}$ inch into the deal board. It was again fired with 1 inch of powder, and the shot penetrated 1 inch into the deal. Again it was a third time fired with $1\frac{1}{4}$ inches of powder, when it burst, and the shot only just dented the wood. These experiments seem to me to prove conclusively the great strength of the tube and the enormous bursting force of the electrical discharge.—On the colour of Nankin cotton by Edward Schunck, Ph.D., F.R.S.—An improved method for preparing Marsh Gas, by C. Schorlemmer, F.R.S. The author found that by heating an intimate mixture of anhydrous sodium acetate with more than twice its weight of lime and sodium carbonate, a very regular and quiet evolution of marsh gas took place. The gas thus obtained always contains some acetone, which is easily removed by shaking it with water, or, better still, with a solution of acid sodium sulphite.

DUBLIN

Royal Geological Society of Ireland, Nov. 12.—Prof. E. Hull, F.R.S., president, in the chair.—Mr. J. E. Gore, C.E., read a note on a bed of fossiliferous kunkar in the Punjab—The president read a series of notes on the Microscopic Structure of Irish Granites:—1, Granite of Aillemore, Co. Mayo; 2, Granitoid Quartz Porphyry of Attithomasreagh, Co. Galway; 3, Granite of Ballynockan, Co. Wicklow.—Prof. Reynolds exhibited specimens of the new minerals Uranotine and Walpurgine.—Prof. Traquair exhibited specimens for the Rev. J. Emerson, of some coal fossils from the Jarrow Colliery, Co. Kilkenny, among which were noticed portions of the skeletons of *Urocordylus wandesfordii* and *Ichthyerpeton bradleyi* described some time since as from a neighbouring colliery, by Huxley and Wright; also the palate tooth of *Ctenodon cristatus*, patches of scales of *Megalichthys hibberti*, and some vertebræ and scales of a Rhizodopsis.

Royal Irish Academy, Nov. 10.—Rev. Prof. Jellett, president, in the chair.—A paper was read by Messrs. Draper and Moss on some forms of Selenium, and on the influence of light on the electrical conductivity of this element.—Prof. Macalister read a paper on the anatomy of a species of Aonyx from the Upper Indus. The species had been sent by the late Earl of Mayo to the Royal Zoological Society of Ireland, but differed in no marked degree from the one described by Horsfield as *A. leptonyx*.—Mr. H. W. Macintosh read a paper on the myology of *Arctopithecus blainvillii*.

EDINBURGH

Royal Society of Edinburgh, Dec. 1.—Sir Robert Christison, vice-president, in the chair.

The following communications were read:—

1. Laboratory Notes, by Prof. Tait.—(1) First Approximation to a Thermo-electric Diagram. (2) On the Flow of Water through Fine Tubes.

2. Note on the use of ∇ in Curvilinear Co-ordinates, and on the Transformation of Double and Triple Integrals, by Prof. Tait.

2. On the Physiological Action of Ozone, by James Dewar and Dr. M'Kendrick.

4. On a Compound formed by the addition of Bromacetic Acid to Sulphide of Methyl, and on some of its Derivatives, by Prof. Crum Brown.

5. Note on the Expression for the Action of one Current-element on another, by Prof. Tait.

GLASGOW

Geological Society, Nov. 13.—Mr. E. A. Wünsch, vice-president, in the chair. A paper on the Post-tertiary Beds (Kyles of Bute), by the Rev. H. W. Crosskey and David Robertson, was read to the meeting. The succession of beds, as found at various parts of the Kyles, in proceeding from high to low water mark, is as follows:—(1) Boulder-clay, hard, compact, unfossiliferous, and red in colour; (2) A highly laminated clay, precisely similar to that which occupies the same position at Paisley and many other localities, has been found to contain the remains of some species of Foraminifera; (3) A bed of clay and sand, exceedingly rich in characteristic Arctic shells; (4) The *Pecten maximus* bed, has been found cropping out in various localities.—Mr. Jas. Armstrong read a paper on the Fossils found in the Carboniferous Shales of Gare and Westerhouse, illustrated by a series of finely-preserved specimens collected from these localities, about three miles to the north-east of Carluke.—The Chairman exhibited some interesting specimens of the junction of granite and slate from the island of Arran, and made some remarks on the various theories which had been propounded regarding its origin.

CONTENTS

THURSDAY, DECEMBER 11, 1873

THE ARCTIC EXPEDITION

WE were able to announce, in our last number, that the version of the reply of the Government with regard to the despatch of an Arctic Expedition, which had appeared in the daily newspapers, was inaccurate, and that the subject was still under consideration. But the grounds for abandoning Arctic discovery, which were attributed to the Government, have no doubt occurred to the official mind; and they involve fallacies which would be so fatal to the best interests of this country, that we cannot allow them to pass without remark.

It was said that the Government hold that survey operations have a stronger claim than those of discovery; and that if Ministers were inclined to augment charges for such purposes, they would incline to do so for survey, rather than for a new voyage of discovery.

We have here an attempt to separate scientific expeditions into two branches, survey and discovery. The originator of this fallacy does not appear to be aware that all surveying voyages are voyages of discovery in the strictest sense. Their operations are intended to explore, and accurately lay down, unknown or little known coasts or harbours. Captain Cook's voyages were surveying operations, and it will scarcely be denied that they were also voyages of discovery. The Arctic voyages of Ross and Parry included surveys which have been of the utmost value to the whaling fleets ever since.

Arctic discovery is now advocated by naval and scientific men for the very reason that it will include marine surveys and hydrographical investigations of the most undoubted importance. Few operations have "benefited commerce and promoted international intercourse" more than Arctic voyages of discovery. One of our earliest Arctic expeditions discovered the White Sea route to Russia, and opened a flourishing trade. The Spitzbergen voyages led to the establishment of a fishery which added millions to the wealth of these islands. The discovery of Davis's Straits did the same. Ross's first voyage showed the way for the whalers into Baffin's Bay. Parry's voyages pointed out new ground in Prince Regent's Inlet. The handling of steamers by Osborn and Cator, as Capt. Penny declared at the time, caused a revolution in the system of ice navigation by whalers. Arctic voyages are surveying operations, and they have benefited commerce as much as any other surveying work whatever. As to promoting international intercourse, Arctic achievements have always excited friendly sympathy and interest throughout the civilised world.

We must also notice the shocking insincerity of the reply that is imputed to the Government. An Arctic Expedition cannot be undertaken, we are told, because Ministers are anxious to provide funds for ordinary surveys. Now it is a fact that no Government has ever more persistently neglected the surveying branch of the service; which has been so starved and pared down as to cause anxiety to those acquainted with the subject. If the Hydrographer's official position did not seal his lips, he could give an account of the way in which the surveying department has been treated of late years, which would excite indignation throughout the country. Some idea may, however, be obtained of the way in which surveys are neglected, from the following figures. From the year 1849 to 1853, the proportion of each 1000*l.* of naval expenditure spent on surveying averaged 15*l.* 5*s.* It is now 9*l.* In 1871–72 the total effective naval expenditure was 7,807,946*l.*, and the expenditure on the surveying branch was 70,456*l.* The total tonnage of the British mercantile marine in 1871–72, was 7,142,894, so that the total naval expenditure per ton of British naval shipping, was 1*l.* 1*s.* 11*d.*; and the proportion of expenditure for surveying and discovery, by far the most useful and important work of the navy in time of peace, was 2*d.* Not only has surveying and Arctic work been rendered inefficient by extreme parsimony, or wholly neglected; but, while the wealth of the country has enormously increased, the expenditure on the best work of the navy has been cut down to a third less than it was twenty years ago.

It may be that the official notion of surveying is confined to the revision of work on comparatively well-known coasts. Even such work is done inefficiently; and its renewed efficiency would be no argument for the neglect of Arctic exploration. At the time when Arctic expeditions of discovery were despatched, the more ordinary surveying operations were not neglected Officers were surveying the coasts of these islands, Capt. Graves was at work in the Mediterranean, Collinson in China, Kellett in the Pacific, and their vessels were properly equipped. Assuredly the Government are bound to restore the Surveying Department to efficiency; and such a reformation would include the despatch of a thoroughly well-equipped Arctic Expedition for survey and discovery. We understand that a further most able and carefully-considered letter has been addressed to Mr. Gladstone on this subject; and we earnestly trust that, after further consideration, the Prime Minister will see that his plain duty points in the same direction as political expediency. The country feels strongly on the subject; and the resolution to despatch an Arctic Expedition of discovery in 1874, will meet with the hearty approval of all classes of the community.

LOCAL SCIENTIFIC SOCIETIES *

III.

IN the ten years succeeding 1860 the number of local scientific societies formed throughout the country was more than double that of the previous decade, amounting altogether to fifty-six, of which no less than forty-five are field-clubs. Many of these are well known for producing excellent work, but we must refer our readers to the list at p. 521 of vol. viii. for details. The Quekett Club of London was formed during this period, as were also a number of clubs in the Severn Valley, the Eastbourne Natural History Society, and others which have done good work, but which are far too numerous to mention. Two or three very excellent societies were formed in North Britain during this decade, including the Perthshire Society of Natural History, which, at any rate as represented by a few of its members, is one of the hardest-

* Continued from p. 40.

working societies in the kingdom. Under its auspices the *Scottish Naturalist* is published, and a *Flora* and *Fauna* of the extensive and varied county of Perthshire is being brought out; recently we noticed a proposal issuing from one of the members for the establishment of a British Naturalists' Agency. A very laudable though somewhat Scotch appendage has just been added to the Society, in the shape of a "Perthshire Mountain Club" for the exploration of the Perthshire mountains, more especially those that have been neglected by naturalists, with the following office-bearers:—A cairn-master, a scribe and naturalist, a geometer, a bard, and, to crown all, a quaigh-bearer, a quaigh being a two-eared drinking-cup from which to quaff the "mountain-dew" withal.

Another Scottish club that we deem worthy of special mention is the Alva Society of Natural Science and Archæology, whose history has been one of continued success. There can be no doubt, the secretary informs us, that this Society has tended to foster a taste for natural history in the neighbourhood, and encouraged the observation of local phenomena. It was founded in 1862, and now numbers 110 members belonging to all classes of society; the patron being the Earl of Kellie, the president the sheriff-substitute of the county, the vice-presidents a medical practitioner, a grocer, and a wine-merchant; the councillors a clergyman, a bank agent, a hairdresser, an architect, and an ironmonger; the treasurer a druggist, the secretary a medical practitioner, the curator a blacksmith, and the librarian the governor of the prison. The object of the Society is the study of natural science and archæology by the exhibition and preservation of specimens, the reading of communications, by lectures, excursions, and the formation of a library and museum. The number of members has become so large, and the collections of the Society have so accumulated, that their present place of meeting has become too small, and the Society has therefore contracted to have a special building erected for its own use, at a cost of about 1,600*l*., raised by subscription from among the members and the noblemen and gentlemen of the neighbourhood. The papers read at the monthly meeting are printed in one of the local papers, the type being afterwards broken into pages, and a small volume of transactions thus published for each year. One of these volumes we have before us, and its contents are varied and exceedingly creditable, though we miss a list of the fauna and flora of the small county of Clackmannan, in the county town of which the Society has its head-quarters. We hope this excellent Society will make the compilation of such lists part of its work in the future.

Our space only permits us to name the Largo Field Naturalists' Society, on the north shore of the Frith of Forth, a society founded in 1863, and which, to judge from the papers read and the secretary's report to us, is doing excellent service in connection with the natural history of the county of Fife; it appears to have a valuable collection of specimens. We mention these three societies because, in some respects, they are worthy of imitation by other similar associations, and because, we regret to say, Scotland is not represented in the list of field-clubs in anything like the proportion, even considering its size, that England is; very large districts, which we are sure would yield abundant fruit of a rare and interesting kind, being entirely unworked by any club. We hope in the course of a very few years to see this defect remedied.

In the three years 1871-2-3, at least twenty-seven new societies have been formed; there may have been more of which we have not heard. Fourteen of these have had their origin during the present year; and if field-clubs continue to multiply during the remaining years of the decade in the same proportion, we may expect to see very few districts in England and Scotland at least, without its local field-club. We had hoped that the inquiries of the British Association Committee on this subject might have given an additional impetus to the spread, as well as to the usefulness, of such societies; but we fear that hitherto this committee has done absolutely nothing.

We cannot conclude this part of the subject without referring to the field-clubs of Lancashire and the west of Yorkshire. In Lancashire there are a number of field-clubs * composed almost exclusively of working-men, some of which have been in existence for many years, and all of them, we believe, in excellent working condition. In Lancashire there are at least eleven of such clubs, one of which is among the most efficient field-clubs in the kingdom. This is the Todmorden Botanical Society, which may be taken as a specimen of these Lancashire clubs, and of which Sir Walter Elliot thus speaks:—

"One of the most successful of the above is the Todmorden Botanical Society, established in 1852, principally through the exertions of Mr. Stansfield, who has always been its president. The bulk of the 185 members are working-men, who pay a subscription of 6*s*. a year, meet on the first Monday of every month, and in the winter, on the intermediate fortnights, for lectures and papers; and make six field excursions, four within ten miles, and two longer ones, extending into neighbouring counties, and even as far as Scotland. They have a good herbarium, and have prepared a flora embracing a space of six miles round Todmorden. They have also acquired a library of 600 volumes, chiefly botanical."

We can only briefly refer to the West Riding Consolidated Naturalists' Society, which at present, as will be seen from our list, consists of an amalgamation of twelve local clubs, belonging to various towns in the West Riding, and all of them, like the Lancashire Societies, composed mainly of working-men. Each of these societies has, we understand, its own district in which to carry on its field-work, and the united societies have stated meetings, but so far as we have ascertained, they have not yet decided upon a satisfactory *modus operandi*. The amalgamated societies have, however, a journal in common, "The Yorkshire Naturalists' Recorder," in which their proceedings are published, we believe monthly. There is no doubt that if their united societies could devise a satisfactory organisation in which to carry on their work in co-operation, great good would be the result. Their example might, we think, be followed with advantage by other contiguous small societies, which we fear are often apt to get disheartened from the paucity of working members, and a feeling of isolation. This is

* We regret that these were omitted from our list, as we got no information from them, and Sir W. Elliot does not give them in his list, only referring to them for some reason in his address.

the only instance, so far as we know, in which a number of contiguous societies have united into a connected group, though other societies occasionally have excursions in common.

We regret to say that since our list was published, we have ascertained that two of the Yorkshire Societies named therein, are now defunct, viz. the Halifax Naturalists' Society, once a member of the West Riding Union, and the Leeds Natural History Society. We have been told that the Wigan Field Naturalists' Scientific Society, given in Sir Walter Elliot's list, with 150 members, is also dead. We hope that in reality these are not dead, but only sleeping; and that means may soon be taken to rouse them again into activity.

Altogether, then, including the Lancashire Societies not in our list, and others of which we have heard since our list was published, one of which was founded at Ballymena, County Antrim, the result, we believe, of some lectures there last winter, there are at the present time in Great Britain and Ireland at least 169 associations established solely or partly for the pursuit of science in one form or another. Of these 104 are professedly field-clubs, while a considerable number of the remainder do field-club work in so far as the publication of lists of the natural productions of their surrounding districts are concerned. Only 22 of these 169 societies were founded previous to 1830, while all the field-clubs were formed after that year, and by far the greater number of them within the last twenty-three years. We do not reckon among these the scientific societies which have been formed in connection with our public schools, to which we shall refer afterwards.

Of these societies the English ones are mainly grouped in the North of England, along the Welsh border, and in the southern counties, the midland district being but sparsely represented, and Bedfordshire,* Derbyshire, Essex, Hertfordshire, Huntingdonshire, Lincolnshire, Rutlandshire, not at all, not to mention the Channel Islands and the Isle of Man, which would afford opportunities to field-clubs which cannot be attained in the main island at all. Glamorganshire is the only Welsh county represented by a society, while all but three of the Irish counties are unrepresented. Scotland, the birthplace of field-clubs, we have already referred to as being far behind England in this respect. Ireland, and even Wales, cannot perhaps at present be blamed for their backwardness in regard to associations of this kind, though each country, in its own way, offers a magnificent field of investigation to local naturalists. With regard to the unoccupied districts of England and Scotland, we can only hope that the scientific contagion may rapidly spread, as no doubt it will when all the conditions are present for its taking effect. Meanwhile, the rapid spread of scientific societies, and especially field-clubs, and the valuable results that have already followed from the labours of a number of them, must be exceedingly gratifying to all who desire to see the triumph of science, and, indeed, to all who are earnestly seeking after the elevation of their fellow-men. Is it not one more sign that "the old order changeth, yielding place to new?"

* By a misprint in our last article the Woolhope was said to be in Bedfordshire instead of Herefordshire.

MARSHALL'S TODAS OF SOUTH INDIA

A Phrenologist amongst the Todas; or, the Study of a Primitive Tribe in South India. By William E. Marshall, Lieut.-Col. of H.M. Bengal Staff Corps. (Longmans, 1873.)

THE Todas are a pastoral hill-tribe in the Nilagiri region of Southern India, whose singularly interesting social condition fairly entitled them to be described in a volume by themselves. Colonel Marshall succeeds in communicating to his readers the lively interest he felt in his work, and several points of ethnology will be perceptibly advanced by it, notwithstanding much of the theoretical part of the book which will hardly meet with acceptance.

Especially from the moralist's point of view, the condition of these secluded herdsmen deserved to be put on record while still little changed under influences from without. They show perfectly how the milder virtues naturally prevail among men in an intellectually childlike state, if only society is undisturbed from without, and finds its equilibrium within. "The general type of the Toda character is most unvarying; singularly frank, affable, and self-possessed, cheerful yet staid;" theft and violence are almost absent among them; their quiet domestic life is "undisturbed by the wrongs of grasping, vindictive, overbearing natures;" their engagements to support their wives and children, though resting on mere promises, are kept through utter guilelessness and want of talent to plot. Toda society is simply held together by the strength of family affection. "It is a quiet, undemonstrative, bu intensely domestic people; domestic in the wider sense of viewing the entire family, to the last cousin, much as one household, in which everyone is everywhere entirely at home; each one assisting, with the steadiness of a caterpillar, in the easy, progressive task of emptying his neighbour's larder; no one exerting himself by one fraction to raise the family. The great feature in Toda organisation, is the all-absorbing power of his domestic attachments, which, like Pharaoh's lean kine, swallow up all other qualities." The points where the moral code of these easy-going folk differs from that of modern intuitive moralists, are especially polyandry and infanticide. Their marriage-relations within the family have perhaps more nearly approached than those of any other known tribe that promiscuity which several modern ethnologists have supposed to belong to a primitive state of society; "it was formerly their almost universal custom—in the days when women were more scarce than they are now—for *a family of near relations to live together in one mand, having wife, children, and cattle all in common.*" Here, indeed, is socialism of an extreme order, prevailing among a low race, in whose general condition its evi and good are alike visible. As need hardly be said, to the Toda mind polyandry seems part of the natural order of things. So it was with infanticide, till about fifty years ago an English officer, Mr. Sullivan, mounted the Nilagiri plateau and visited the homes of the Todas. Since then all the events of Toda history have been dated from the visit of "Sullivan Dore," as we date from the Christian era, and thenceforward the Government put down infanticide, and its former prevalence is now only to be traced in the census, and learnt from the memory of old people.

An aged Toda gave his account of the practice :—"I don't know whether it was wrong or not to kill them, but we were very poor, and could not support our children. Now every one has a mantle ('putkuli'), but formerly there was only one for the whole family, and he who had to go out took the mantle, the rest remaining naked at home, naked all but the loin-cloth ('kuvn'). We did not kill them to please any god, but because it was our custom. The mother never nursed the child—no, never! and the parents did not kill it. How could we do so? Do you think we could kill it ourselves? . . . Boys were never killed, only girls; not those who were sickly and deformed—that would be a sin ('papum'); but when we had one girl, or in some families two girls, those that followed were killed."

Perhaps the ablest part of Colonel Marshall's work is his tracing out of the social forces which brought about this condition of society, the enforced equilibrium between population and means of subsistence, leading a tender-hearted people to systematic female infanticide, and then causing a huddling together of the endogamous polyandrous clans to keep themselves alive. It is no doubt true that the entrance of new conditions, such as a state of war or an advance in the arts, would have altered not only the relation of the sexes but also the moral laws of the people. Colonel Marshall's researches were especially suggested and guided by Mr. M'Lennan's "Primitive Marriage," and if a new edition is brought out of that important treatise (now out of print and scarce), the Todas will supply some items of valuable evidence to it, bearing on ancient social conditions of mankind.

Care must be taken, however, to interpret with proper reservation the word "primitive," as used in these inquiries. Colonel Marshall calls the Todas a "primitive tribe," and argues from their customs to the condition of "primitive races," nor is this objectionable if the word be meant only to signify a comparatively early stage of society. But the Todas are by no means primitive as representing the earliest known grades of civilisation: they are not savages, but a pastoral tribe in a condition much above savagery, belonging to the great Dravidian race of South India. Among them, moreover, may be noticed certain curious customs, to be accounted for on the principle of "survival in culture," and being apparently relics of a former condition of the race different from the present. The Todas are not now hunters, nor do they use bows and arrows. But, at a certain time after marriage, the Toda husband and wife go into the village wood, and kneeling before a lamp at the foot of a tree, the wife receives from the husband a bow and arrow made by him, which she salutes by lowering her forehead to them. Taking up the weapons, she asks, "What is the name of your bow?" each clan apparently having a different name for its bow; he tells her the name, and afterwards she deposits the bow and arrow at the foot of the tree. Colonel Marshall can hardly be wrong in his supposition that this custom has come down from a former period when the Todas actually carried such weapons. This is also confirmed by their funeral rites, where among the articles burnt for the dead man are a flute (an instrument they never use), and a toy bow and arrows, which they get made for the purpose by their neighbours the Kotas. When the author got a man to buy him one, the Kota who made it asked "Who is dead?" The inference is obvious, that the Todas were hunters before they took to their absolutely pastoral life. Nowadays, their cattle are all in all to them; not only their life but their religion turns on buffalo; the milkman is a divine personage too holy to be touched; the most sacred objects are certain ancient cow-bells, and the dignity of the sacred bell-cows is handed down from mother-cow to daughter-cow. The keeping up of this sacred heritage in the female line leads Col. Marshall to infer, at any rate ingeniously, that he has found here a relic of ancient days when the rule of kinship on the mother's side (which he considers with Mr. M'Lennan to characterise primitive society) still prevailed; it only now holds good of bulls and cows, while among men and women relationship is on the male side, thus following the rule which is considered to belong to a higher stage of society. It is not a new idea that the worship of the cow in Egypt and India had its origin not in myth but in practical expediency, being craftily devised to prevent the lives of such valuable creatures being wasted. But nowhere does this argument look so complete and rational as among those thoroughgoing devotees of the milk-can, the Todas.

It is to be feared that the title of Col. Marshall's volume may prevent its having all the popularity it deserves. Not that this title is misleading, for he accepts and uses confidently the now discredited phrenological system of bumps and organs, and tabulates his series of Toda skulls according to their Concentrativeness, Amativeness, Veneration, &c. On this classification by phrenological organs he founds a theory as to the relation between civilisation and the shape of the skull. It appears, from his description, that the Todas are a uniformly long-skulled race, though, among his dimensions, I fail to find anywhere the actual measurements of cranial length and breadth, and can only guess from the portraits (which, by the way, are beautiful autotypes), that the proportions of these two diameters may perhaps be something like 100 : 72 or 75. Now these dolichocephalic Todas being a kindly, harmless, indolent, unprogressive race, Col. Marshall proceeds to connect their narrowness of skull with their want of active energetic qualities, the phrenological organs of which are placed at the side of the head. Thus he comes to the conclusion that it is the brachycephalic tribes, with their skulls broadened by the fierce conquering and progressive organs, which come to the front in the march of civilisation. Well, no doubt there are various dolichocephalic tribes who have remained at low stages of culture, but how is it in the northern half of Asia, the abode of the broadest-headed tribes of man, whom nevertheless the comparatively long-headed Russians have for ages been beating with one hand and civilising with the other. Prof. Carl Vogt's treatment of the question is on a far broader basis, where in a few lines of one of his lectures he shows that both the extreme dolichocephalic and brachycephalic tribes are savages or barbarians, while the main work of civilisation has been done by people who are neither the one nor the other, the mesaticephalic or intermediate-headed races, such as ourselves. This is one of the points which make the reader regret that Col. Marshall did not keep his book waiting till he could bring his opinions under discussion at the Anthropological Institute or the Asiatic Society, which might have

led him to modify his views in several ways. As it is, his preface is dated from Faizabad, and in it he describes himself as "a solitary Indian, far away from contact with men of science, but fresh from the actual and impressive presence of 'Nature's children.'" These words account for the freshness and vigour of his style, but they must not be taken to imply that his examination was made without want of knowledge of anthropology. So far from this, one of the great excellencies of the volume lies in showing how much more deeply an observer sees into the life of an uncivilised people, when he is engaged in examining evidence for and against current ethnological theories, than when he goes as a mere traveller, setting down at random anything that takes his attention.

EDWARD B. TYLOR

OUR BOOK SHELF

An Elementary Treatise on Geometrical Conic Sections. By G. Richardson, M.A. (Rivington, 1873.)

THIS is one of the volumes of the publisher's Mathematical Series, is very well printed, and has, if we are not mistaken, only three trivial misprints. There is quite a run at the present time on this subject, if we may judge by the number of treatises which have recently made their appearance, and this we are not altogether surprised at, as it is one of great interest; its theorems have great intrinsic beauty and almost boundless applications. The ordinary propositions are discussed not altogether in the usual order of consecution from the locus-point of view (the last chapter of four pages being devoted to the cone); the demonstrations are neat, and two or three are exceedingly concise as well. The only or chief novelty is the simultaneous treatment of the ellipse and the hyperbola, the corresponding propositions facing one another on the even and odd pages respectively. The discussion of the asymptotic properties of the latter curve pairs off against a series of propositions on projections. The book is a good working one for beginners, and embraces sufficient for the preliminary examination for mathematical honours at Cambridge, without having too much for school use. There is an extensive selection of exercises. R. T.

Waste Products and Undeveloped Substances. A Synopsis of progress made in their economic utilisation during the last quarter of a century, at home and abroad. By P. L. Simmonds. (London: Hardwicke, 1873.)

MR. SIMMONDS'S book is seasonable in these days, when so much has been done in the utilisation of waste, as showing how very much yet remains to do.

In nearly 500 pages of close print he has drawn attention to a mass of matter almost bewildering in its vastness, and extending to nearly every kind of material in use in civilised communities. We cannot help noticing that Mr. Simmonds has been affected by the mass of subjects he has attempted, for the book very frequently displays a considerable lack of arrangement.

The author should look to this in a future edition, in which also the book might be easily and advantageously condensed to a considerable extent.

We must, however, thank the author for the service he does in calling the attention of civilisation to the extravagant, and we might say, "riotous" living with which its substance is wasted.

La Botanique de la Bible. Étude scientifique, historique, litteraire et exégétique des plantes mentionnées dans la Sainte-Ecriture. Par Frédéric Hamilton. 8vo. pp. 220, 25 photographs. (Nice: Eugène Fleurdelys, 1871.)

THIS interesting volume will possibly be unknown to the majority of our readers, and yet we venture to think that, from the beauty of its illustrations and the pleasantness of its style, it may to some of them prove a welcome addition to their knowledge of the subject on which it treats. Not stopping to discuss the nature of those mysterious trees said to have existed in the Garden of Eden, the author divides his subject into two parts. The first treating of the genera and species of which there can be little doubt, such as the pomegranate, almond, cedar, fig, &c.; and the second of those plants or portions of plants about which it is difficult to decide to what genus even they may belong, such as shittim-wood, hyssop, &c. In the first portion of the volume not only are the scientific characters of the plants given, but there is also added a series of references to them from the classics. The photographs are taken from living specimens growing chiefly in the neighbourhood of Nice and Mentone.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Effects of Temperature on Reflex Action

I DO not know if I quite understand Mr. Lewes's objections to my little article in the *Journal of Anatomy and Physiology*. He attributes the absence of movements in the case in question to a loss of sensibility *to temperature*. At first his statement reads as if the loss of sensibility to temperature were due to the removal of the brain. But he cannot mean this, because the whole of my paper starts from the fact that when the toes alone are exposed to gradually heated water, the leg is withdrawn. If he means that the sensibility to temperature alone is destroyed or depressed by the exposure of the whole body to the gradually heated water, and the other "sensibilities" left intact, I do not see how my argument touching the difference between the entire and the brainless frog is affected at all by a limitation of the stimulus to one particular kind. Moreover, in the last observation recorded in my paper it is expressly stated that in the later stages of heating the absence or diminution of reaction towards chemical as well as thermal stimuli was observed. Gradually heated water acts as a very slight stimulus, sulphuric acid (even dilute) is a very strong stimulus; and that the latter suddenly applied, as in the experiment of Goltz referred to by Mr. Lewes, should call forth a reflex action at a time when the former is unable to do so, in no way contradicts my explanation of the absence of movements. A red-hot iron might have been substituted for the sulphuric acid with identical results.

The paper in question had for its object simply the solution of the difficulty why the brainless frog allowed himself to be boiled without moving. In it I carefully avoided entering upon any discussion concerning Sensation (or Consciousness) in the spinal cord. The words "movement of volition, *that is*, a *movement carried out by the encephalon*,"—"ordinary reflex action, that is, a movement *carried out by the spinal cord alone*," were purposely chosen. I went so far as to speak of an "intelligent frog" and an "unintelligent reflex action," because we have means of measuring intelligence, and we can speak of a body as being conscious and yet not intelligent. I imagine that if Mr. Lewes and myself were to talk over the matter quietly, he would find that I am not so much at variance with him as he imagines. I feel with him the difficulty of refusing to the protoplasm of a white blood corpuscle, a something which may be evolved into (not out of) consciousness. That and like difficulties are not a little increased if, as Mr. Darwin seems to suggest, we regard inherited voluntary acts as the chief instead of the occasional source of reflex actions. Without entering into any long discussion, perhaps I may be permitted to say that in such matters as the movements of a brainless frog, it seems to me there are two things which ought to be kept separate: the investigation into the laws according to which those movements take place, *i.e.*, the study of the various nervous mechanisms of the spinal cord, and the question whether those movements, whether the working of those mechanisms, is or is not accompanied by consciousness. As a physiologist I am prepared to busy myself with the first, as I see prospects of success. With regard to the second, I am not prepared to say anything until we have ob-

tained some better tokens of consciousness than the greater or less resemblance of the movements in question to such movements as our conscious selves are in the habit of executing.

M. FOSTER

Meyer's Exploration of New Guinea

FEW persons can have read Dr. Meyer's account of his recent adventurous and very successful journey with more interest than myself; but I confess I was surprised to find that the translator of my book should have misunderstood what I had stated, and so create a difference between us where none exists. He says (speaking of Dorey) that I "have not given a correct impression of the natives of the surrounding hills and mountains, separating them in some way from the inhabitants of the coast, as smaller, uglier, not mop-headed," &c.; and that he finds on the other hand, that "there is no generic difference at all between the Papooas of the mountain and the Papooas of the coast, except such differences as we find everywhere between the highlanders and coast inhabitants of the same race." Now I say exactly the same thing: "From these (sketches) and the captain's description, it appeared that the people of Arfak were similar to those of Dorey." ("Malay Archipelago," 3rd Ed. p. 505.) Dr. Meyer however, probably refers to what I say of the people of one hill village, close to Dorey: "The inhabitants seemed rather uglier than those at Dorey village. They are, no doubt, the true indigenes of this part of New Guinea, living in the interior, and subsisting by cultivation and hunting. The Dorey-men, on the other hand, are shore dwellers, fishers, and traders in a small way, and have thus the character of a colony who have migrated from another district. These hillmen, or Arfaks, differed much in physical features. They were generally black, but some were brown like Malays. Their hair, though always more or less frizzly, was sometimes short and matted," &c. (p. 499). I can only suppose that the word "differed" in the above passage was taken to mean "differed from the Dorey people," whereas the context shows that it means "differed among themselves," or varied, which would have been a better word. In the preceding page I have stated of the inhabitants of Dorey: "The majority have short woolly hair;" so that there is no difference from them in that respect. In all I have written about the Papuans I have maintained that the people of New Guinea and of all the immediately surrounding islands are of one race, with very unimportant local differences; and I do not think my remark, that the people of one village were "*rather* uglier" than those of another, three miles off, justifies the idea that I supposed there was any "difference," in an ethnological sense, between them. I cannot find that I have said a word about difference of stature.

The great success of both Messrs. D'Albertis and Meyer in penetrating inland in New Guinea will, it is to be hoped, induce other travellers to attempt the exploration of the far larger and less known southern portion. Two Europeans, with a small steam launch and a Malay crew, would, no doubt, be able to penetrate a long way up some of the larger rivers, and establish a station from which exploration of the central mountains might be effected. There is now no portion of the globe so completely unknown as this, or which promises such great results for every branch of Natural History.

ALFRED R. WALLACE

Deep-sea Sounding and Deep-sea Thermometers

WITH reference to the discussion which has recently been carried on in NATURE as to the deep-sea thermometers, I hope that perhaps the following statement may tend to put the matter at rest.

One of Negretti's thermometers was exhibited at the Royal United Service Institution at a lecture, March 11, 1859, by Admiral FitzRoy, who then spoke of them "as thermometers peculiarly constructed, self-registering," &c. The construction of these thermometers had been fully described in the "First number of Meteorological Papers, 1857," and was subsequently given in a "Treatise on Meteorological Instruments," published by Negretti and Zambra in 1864. The peculiarity of these thermometers was mentioned in the Hydrographic Instructions to Captain Dayman of the *Cyclops* Sounding Expedition, dated May 29, 1857. These facts are sufficient to show the ample publication of the device in question for protecting the bulbs against pressure.

I know from Dr. Miller himself that he did not know of Negretti's plan. In his paper in the Royal Society Proceedings, he calls the one which he describes a "simple expedient." I am not aware of any just claim on the part of Mr. Casella to the principle of the invention.

I consider that the practice of instrument makers designating by their names instruments which they have not *invented*, is most reprehensible.

ROBERT H. SCOTT

London, Dec. 9

[We have received a letter on this subject also from Mr. Casella, but as there is nothing in it bearing on the real point at issue, we do not print it. The above letter from Mr. Scott renders it clear to us, and it will doubtless be also clear to our readers, that the whole credit of the double bulb belongs to Messrs. Negretti and Zambra. We quite agree also with Mr. Scott's closing remarks. This correspondence must now cease. —ED.]

The Dutch Photographs of the Eclipse of 1871

ABOUT a year ago Dr. Schellen kindly sent me two paper copies of the Java photograph, one of them was stated to be of the size of the original negative and the other was an enlargement of about ten and a half diameters, with a delicately soft outline and much detail in the corona. On comparing this with the Indian photographs I found that though the outline of the corona corresponded depression for depression with the two Indian series, yet there was great difference in the detail of the lower parts. The question therefore arose, Was such difference to be regarded as proof of enormous change in the corona in the course of about an hour, during the passage of the totality shadow from India to Java?

I had carefully compared and catalogued the details visible upon the original negatives of the two Indian series, and had found no structure in the one that could not be traced in the other, but the details of the new Java photograph were quite of a different character, lumpy, and in more definite masses. On mentioning this to Lord Lindsay he informed me that he had other copies of the Java negatives which he had received directly from Prof. Oudemans and which were almost structureless. Mr. Davis undertook a critical comparison of the two Java photographs, and pointed out that in spite of the striking dissimilarity of the paper prints, they were evidently both taken from the same original, for they each showed a faint scratch and three minute photographic flaws in the same relative positions. It was impossible to assert that the one was a good print and the other a very bad one, for in the photograph with the delicate corona the moon's limb was soft and hazy, while with the poor corona the limb was perfectly sharp and definite. We had only one course left, and that was to infer that the softening and details had been produced artificially. Having detected manipulation in the corona, we naturally suspected it in the moon's limb, and thus arose my remark at the meeting of the Astronomical Society, that the sharp edges of the irradiation under the prominences might have been artificially produced by stopping out the moon, or rather by stopping out the hazy irradiation which presents so marked a feature, especially under the prominences in the Indian photographs, as well as in those taken in 1870.

There is still a little mystery which requires clearing up about the hazy irradiation. No trace of it is to be found in the copies of the Shelbyville photograph taken by Mr. Whipple in 1869, nor (as we now learn) in the Java photographs, although the action of the light has been greater in these than in some of the Indian and 1870 negatives, which show it as a very marked feature. We know that under ordinary circumstances hazy irradiation is produced by reflection at the hinder surface of the glass on which the photograph is taken, and that its amount may be greatly reduced by backing the plate, during its exposure, with wet paper, so as to produce a film of water instead of a film of air immediately behind the plate, thus causing nearly all the light to be transmitted instead of reflected at its back surface. Yet the Baikul photographs (and I understand also the Cadiz photograph of 1870) were backed with wet paper, and still show the irradiation very markedly.

The cause of the ellipticity of the dark moon touched upon by Prof. Oudemans seems to me to involve some very interesting questions. It is remarkable that the ellipticity does not occur in all eclipse photographs. After making allowance for the moon's motion during 40 seconds in the enlargement from the Cadiz negative, I may say that I have not been able to detect any difference between the polar and equatorial diameters in *any* of the 1870 photographs.

In No. 2 of the glass copies from the Ottumwa photographs, 1869, the moon is also apparently quite circular; but in No. 4, where the bright depths of the chromosphere are just appearing, the polar diameter is distinctly the longest. I have been led to conclude that the ellipticity is caused by an unequal eating over or irradiation at the polar and equatorial portions of the limb, and that in this lies proof that at the sun's equatorial regions the brighter layers of the chromosphere extend to a greater height than near the poles. We know from other sources that the corona generally, and probably also its lower portions, were not so bright in 1870 as in 1869 and 1871; hence the eating over between the prominences has been comparatively slight, and no detectable difference has been caused between the polar and equatorial diameters.

A. Cowper Ranyard

The British Museum

It is strange that such a statement as that advanced by Mr. W. Stanley Jevons in Nature, Nov. 13, has so long remained unchallenged, viz. "that the British Museum exists not so much for the momentary amusement of gaping crowds of country people, who do not understand a single object on which they gaze, as for the promotion of scientific discovery, and the advancement of literary and historical inquiry." No one will dispute the truth of these statements, but substitute the word "instruction" for "momentary amusement," and I very much doubt if his views would meet with public approval. I have always looked upon the British Museum as the National Museum, and *pre eminently* the Museum of the people, and, as such, the arrangement and labelling of the specimens should be of the most simple and instructive nature: nor is such an object opposed to, but perfectly coincident with, the highest interests of science. No wonder the Museum is filled with "gaping crowds" when nothing is done to instruct them as to the nature of objects of which Mr. Stanley Jevons himself admits they are ignorant, nor to provide them with a suitable and educational guide-book, without which they are as sheep without a shepherd When the Trustees of this Museum can spare time, they may, perhaps, be able to direct attention to the fuller development of its scientific and educational functions; as regards the former, by the establishment of one exclusively British Department; and, as regards the latter, by carrying out the very obvious suggestions which I have advanced. The view that science, or rather scientific men, should have a monopoly of the benefits to be derived from this Institution is astoundingly selfish and narrow-minded. If such are the views of the Trustees, the British Museum had better be closed to the public.

S. G. P.

Moraines

I have recently been visiting some of those spots which, according to Prof. Ramsay and other geologists, are marked by moraines of the ancient glaciers of North Wales, and several of which are supposed to form the retaining walls of lakes or tarns: and a question has arisen in my mind to which neither my own consideration nor any of the few books here at my command has afforded any answer.

A glacier which has retreated from its terminal moraine, is always the source of a stream of water, and this stream always cuts through the terminal moraine, and makes in it a gap often wide, and always reaching down to the level of the original soil. A terminal moraine from which a glacier has retreated is the rim of a saucer with a cleft in it, extending to the bottom of the saucer. It consequently cannot and does not act as a retaining wall, and the water from the glacier does not form a lake, but flows out as a stream. No better illustration of this fact occurs to me than the Rhone glacier, with its long series of terminal moraines, all intersected and cut through to the ground by the infant Rhone. How then can a terminal moraine ever form a lake? But if a terminal moraine alone cannot form a lake, a terminal moraine with a stopper put into its hole might. But how is the stopper to get there? Why should *débris* or stones or any other stopper stay in the one place in the whole line where there is no resistance?

Where the basin of the lake is supposed to be constituted by a rock basin and a moraine on its rim, what I have said has, of course, no application to the rock basin, but seems to me to apply to show that the moraine cannot constitute any part of the retaining barrier.

And again, where the retaining barrier is supposed to be constituted by a marine terminal moraine, *i.e.* by a moraine deposited under the sea, the observations I have made seem not to apply.

My questions apply to ordinary terrestrial terminal moraines. They are so simple and go so to the root of the whole notion that such moraines can form lakes that I presume they have been answered long ago by geologists. Can any of your readers tell me where such answers are given or what they ought to be?

Bryn Gwyn, Penmaenmawr, Oct. 13 Edw. Fry

The Elevation of Mountains and the Internal Condition of the Earth

I have just read in Nature, vol. ix. p. 62, Captain Hutton's letter to the Rev. Osmond Fisher on the "Elevation of Mountains and Volcanic Theories." I was also indebted some time since to the courtesy of Captain Hutton for a copy of his lecture on the Formation of Mountains, delivered at Wellington, New Zealand, November, 1872. Without entering at present into a discussion upon the particular theory which finds favour with him, I may be permitted to call attention to the fact that Sir William Thomson's views as to the rigidity of the earth have been distinctly called in question in a former number of this journal, which has probably not reached Captain Hutton. I refer to my communication entitled "The Rigidity of the Earth," printed in Nature, vol. vii. p. 288. Captain Hutton expresses his belief that the theory of internal rigidity has probably a weak point somewhere. I venture to think that its weak points are so many as to make it a theory too brittle to form a support to any geological superstructure.

Dublin, November 28. H. Hennessy

METEOROLOGIC SECTIONS OF THE ATMOSPHERE

THE primary object of meteorology is to record the pressure, the temperature, the moisture, the electricity, and the movements of the atmosphere. It is desirable, however, that observations on these subjects should be combined with the elements of time and distance. At the general meeting of the Scottish Meteorological Society on June 26, 1867, I proposed the method, since generally adopted, of reducing the intensity of storms to a numerical value by the calculation of barometric-gradients, or in other words by dividing the difference of reading of any two barometers by the distances between the stations where such barometers are placed, thus introducing a nomenclature of universal application, by which the movements of any aërial current, and particularly the wind force of storms, may in every part of the world be reduced to one standard of comparison; and the calculation of thermometric, hygrometric, and electric gradients was subsequently proposed. Since then I suggested to the same society the extension of this system by the establishment of a series of barometers placed at short distances from each other in one or more than one direction in azimuth, so as to give horizontal atmospheric sections for pressure. By means of such lines of section the maximum gradient during storms might, from the nearness of the stations to each other, be ascertained, and thus the phenomena of local storms and other local atmospheric disturbances investigated with some hope of success; and since then a horizontal section extending landwards from the sea-shore has been proposed for temperature and moisture, chiefly with the view of determining the extension inland of the influence of the sea on climate.

It would be important were the system of meteorological sections extended to the vertical as well as the horizontal plane. If a string of stations were placed at short horizontal distances from each other and extending from the bottom to the top of a high hill or mountain, the section thus obtained would show the relative distribution at different times, of pressure, temperature, humidity, &c., in the vertical plane. In Scotland, the existing station of Drumlanrig is 191 feet, and that at Wanlockhead 1,334 feet above the sea, so that the difference in elevation is 1,143 feet. The horizontal distance between them is 9 miles, and in all probability the necessary number of intermediate stations could be established. In Hong Kong the town of Victoria is 1,666 feet below that of Blockhouse Victoria Peak, while in Switzerland

and other mountainous districts many other suitable places might no doubt be found.

Would it not be possible to secure funds for establishing at least one such atmospheric section on the slope of some steep hill or mountain in connection with a station or two on an adjoining level district of country?

THOMAS STEVENSON

ON THE PHYSIOLOGICAL ACTION OF OZONE

AT a meeting of the Royal Society of Edinburgh on the 1st inst., a communication was read from Mr. Dewar and Dr. M'Kendrick on the physiological action of ozone. The authors, in the first place, pointed out that little was known regarding the action of this substance, except its peculiar smell and the irritating effect it had on the mucous membrane of the respiratory tract. Schönbein had shown that a mouse died in five minutes in an atmosphere highly charged with ozone; and it was this distinguished investigator who asserted that there was a relation between the quantity of ozone in the air and the prevalence of epidemic diseases. The action of ozone was therefore a subject to be elucidated; and having occasion to employ ozone in another experimental inquiry, the authors resolved to investigate the matter. The ozone was made by passing a current of dry air or oxygen from a gasometer through a narrow glass tube, bent for convenience like the letter U, about 3 ft. in length, and containing a platinum wire 2 ft. in length, which had been inserted into the interior of the tube, and one end of which communicated with the outside through the wall of the tube. Round the whole external surface of this U-shaped tube, a spiral of copper wire was coiled, and the induction current from a coil giving half-inch sparks was passed between the external copper to the internal platinum wire, so as to have the platinum wire as the negative pole in the interior of the tube. After the stream of gas was ozonised by the transmission of the induction current, it was washed by passing through a bulb-tube containing caustic potash, when air was employed, or water when pure oxygen was used, in order to eliminate any traces of nitrous and nitric acids that might have been formed. By means of the gasometer, the volume of gas passing through the tube could be ascertained.

The action of ozone was determined (1) on the living animal enclosed in an atmosphere of ozonised air or of ozonised oxygen; and (2) on many of the individual living tissues of the body. Numerous experiments were made on frogs, birds, mice, white rats, rabbits, and on the authors themselves. Two experiments may be given here as illustrating the action of ozone on (1) a cold, and on (2) a warm-blooded animal.

1. *On a Frog.*—A large, healthy male frog was introduced into the air chamber, through which a current of air was passing sufficient to fill a litre jar in three minutes. At the end of two minutes, the respirations were ninety-six per minute. The induction machine was then set to work so as to ozonise the air. In half a minute, the eyeballs were retracted, so as to appear deeply sunk in the orbits, and the eyelids were closed; the respirations were now eight per minute. At the end of six minutes, the animal was motionless, and there were no respiratory movements. Pure air was then introduced. In half a minute, there was a slight respiratory movement, and in eight minutes there were eighty-five respirations per minute. At the end of other twelve minutes, ozone was again turned on, with the same result. A frog will survive in a dormant condition in an atmosphere of ozonised air for several hours In one case, the animal died. The heart was found still pulsating. It was full of dark blood. The lungs were slightly congested. The blood was venous throughout the whole body. In ozonised oxygen the effects were, on the whole, the same as in ozonised air, with this difference, that in ozonised oxygen the respiratory movements were not affected so quickly, and were never completely arrested.

2. *On a White Mouse.*—A full grown and apparently healthy white mouse was introduced into a vessel through which a stream of air was passing at the rate of eight cubic inches per minute. Five minutes thereafter, the animal was evidently at ease, and the respirations were over 100 per minute. The air was then ozonised. One minute after, the respirations were slower, but the number could not be ascertained owing to the animal moving uneasily about. In four minutes from the time of the introduction of the ozone, the respirations were thirty-two in a minute. The mouse now rested quietly, occasionally yawned, and, when touched by a wire, moved,—but always so as to remove its nose from the stream of ozonised air. At the end of fifteen minutes, the animal had slight convulsive attacks, which increased in severity until it died—nineteen minutes after the introduction of the ozone. The post-mortem appearances were great venous congestion in all parts of the body. The heart pulsated for several minutes after systemic death. In ozonised oxygen, death was delayed for a much longer period. Instead of dying at the end of fifteen or twenty minutes, as happened to mice in ozonised air, they lived for forty or sixty minutes. It is noteworthy that even after death in ozonised oxygen, the blood was found to be in a venous condition.

On breathing an atmosphere of ozonised air themselves, the authors experienced the following effects:—a suffocating feeling in the chest; a tendency to breathe slowly; irritation of the fauces and glottis; a tingling of the skin of the face and conjunctivæ. The pulse became feebler. The inhalation was continued for eight minutes, when they were obliged to desist; and the experiment was followed by violent irritating cough and sneezing, and for five or six hours thereafter by a sensation of rawness in the throat and air-passages.

The general result of the inquiry may be briefly stated as follows:—

1. The inhalation of an atmosphere highly charged with ozone diminishes the number of respirations per minute.

2. The cardiac pulsations are reduced in strength and this organ is found beating feebly after systemic death.

3. The blood is found after death to be in a venous condition, both in those cases of death in an atmosphere of ozonised air and of ozonised oxygen.

4. The inhalation of an ozonised atmosphere is followed by a lowering of the temperature of the body to the extent of at least 3° to 5° C.

5. The inhalation of ozone does not exercise any appreciable action on the capillary circulation, as seen in the web of the frog's foot under the microscope (200 diameters).

6. In the bodies of frogs killed in an ozonised atmosphere, the reflex activity of the spinal cord is not appreciably affected.

7. By means of a myographion, the work done (in gramme-millimetres) by the gastronemius muscles of frogs subject to the action of ozone was noted. The muscles were stimulated by a single opening or closing induction shock produced by Du-Bois-Reymond's apparatus and a Daniell's cell. The result was that the contractility and work-power of the muscle were found to be unaffected.

8. Ozone has an action on the coloured and colourless corpuscles of human blood and of frog's blood resembling that produced by a weak acid; and in the case of the coloured corpuscles of the frog like that of a stream of carbonic acid. The corpuscles of animals killed in an ozonised atmosphere are normal in appearance.

9. Ciliary action is not affected by a stream of ozonised air or oxygen, provided there is a considerable amount of

fluid covering the cilia; but if the layer of fluid be very thin, the cilia are readily destroyed.

In conclusion, the authors stated that it would be premature, at this stage of the inquiry (which opened up many points of interest in the physiology of respiration), to generalise between physiological action and the physical and chemical properties of ozone; but they pointed out the fact that the density of ozone ($O_3 = 24$) is slightly greater than than that of carbonic acid ($CO_2 = 22$); and that although the chemical activity of the substance is much increased, yet, when inhaled into the lungs, it must retard greatly the rate of diffusion of carbonic acid from the blood, which accounts (from the accumulation of CO_2) for the venous character of that fluid after death. From this point of view, destruction of life by ozone (with the exception of its irritant action) resembles that caused by an atmosphere surcharged with carbonic acid. This has been found to be the case more especially as regards the diminished number of respirations per minute, and the appearance of the blood after death. If, however, the analogy were perfect, the inhalation of an atmosphere of ozonised oxygen would not have produced death, because it is now well known, as shown by Regnault and Reiset,* that animals can live in an atmosphere containing a large per-centage of carbonic acid, provided there is an excess of oxygen present. The amount of oxygen in these experiments converted into ozone certainly never exceeded ten per cent. But the authors have observed that an animal lives only a somewhat longer time in ozonised oxygen than in ozonised air; and they are thus induced to regard ozone as having some specific action on the blood that their future experiments may elucidate. They are now prosecuting a series of researches (*a*) on the action of smaller percentages of ozone; (*b*) on the action of ozone on noxious gases and effluvia; and (*c*) on any therapeutical or hygienic influences it may have on the origin and treatment of zymotic diseases.

THE ATMOSPHERIC TELEGRAPH †

II.

A VERY common question with visitors who witness the departure of a train is,—If the boxes stick on the road how do you manage to disengage them? To answer this question we shall notice in detail the various

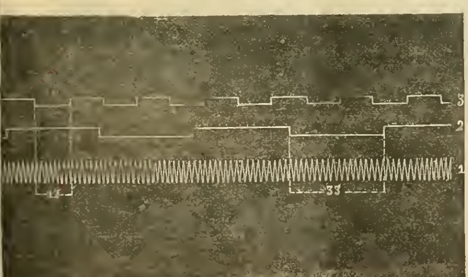


FIG. 3.—Diagram of the Chronograph. 1. Line of the electric *trembleur*. 2. Line of the seconds' pendulum. 3. Line of the membrane.

means employed in transmission, and thus we shall classify the derangements.

Let us commence with the tubes. These may cause an obstruction by a defect of the interior polish, by projecting joints, or by the escape of air through these joints. In the Paris system, however, precautions have been taken against these three sorts of danger. The degree of polish is sufficiently perfect, being obtained without hammering, by pushing the tube along a mandril before it becomes completely cooled. The joints represented in Fig. 2 (p. 66), give an almost mathematical continuity to the interior surface, and they are rendered air-tight by means of India-rubber fittings. In this direction, then, there is little risk of damage and the consequent stoppage of the trains. In fact, since 1866 there has not been a single accident caused by any defect in the tubes, and the experiment is made upon a length of twenty kilometres of pipes so constructed that joints occur every five metres.

The derangements arising from the machinery for compressing the air are not of a special character, and need not be particularised here. There remain the boxes. Numerous types were tried before the system of the two cases in tin and leather, which can be hermetically closed and are easily opened; from its simplicity this method has been adopted. Nevertheless it does sometimes happen that the boxes open during the journey; how this is caused is not easy to explain in each particular case. Sometimes the collarette of the piston is in a bad condition, and the air divides the train; the cases are separated, and the despatches are scattered in the tube. At other times wrinkles are formed in the envelope of leather, the effect of which is to wedge the train so firmly that it is impossible to make it move. Another form of derangement is when the piston breaks and the pieces are lodged between the boxes and the tube. It is scarcely possible to exhaust the series of accidents of this nature; the mean number of derangements in the working of the system during the year is eight, and it is rare to find the same cause occurring twice. When accidents do occur, it is necessary to make all haste to relieve the train.

Often alternate manœuvres with compressed and rarified air removes the obstruction; at Berlin, for the same purpose, M. Siemens employs water with which he forcibly inundates the tube. The great thing is to extricate the train without having to take the line to pieces. When such means fail it is necessary to have recourse to the operation of excavation; and the necessity will be evident of a preliminary and sufficiently exact determination of the place of derangement. The first means is indicated by the method on which the system is worked. There is at hand a reservoir of compressed air of a certain pressure; if this air is partly distributed in the section of the tube comprised between the reservoir and the obstacle, the new pressure is in a known ratio to the original pressure. In a word, Mariotte's law, which regulates the ratios of the pressures and volumes of the same mass of gas in two different circumstances, furnishes the means of finding *one* of the elements, volume, when we know the three others, two pressures and one volume.

M. Siemens prefers to measure the quantity of water which it is necessary to distribute in order to flood the line as far as the obstacle; the accuracy ought to be very great, but it must be acknowledged that the process, in spite of its apparent simplicity, has a somewhat primitive aspect. It is not difficult to understand how this great mass of water is introduced, but it is very difficult to conceive that it can easily remove the obstacle.

We may speak, finally, of an indirect means which is illustrated in Fig. 4. The reader knows that when a concussion is produced at the end of a tube filled with air, this concussion is propagated in the air of the tube at a speed of 330 metres per second. When the concussion encounters an obstacle, it is reflected and returns to the point of its origin at the same rate of 330 metres per second. If then the time is noted which elapses between the departure and the return, the period thus obtained corresponds to the passage of the concussion along a distance equal to double the distance of the obstacle; from an observation of the time, the distance can be easily calculated

* "Air and Rain," by Dr. Angus Smith, p. 182. (London, 1872.)

† Continued from p. 66.

For example:—The interval of time between the departure and return of the wave produced by the concussion is $\frac{1}{3}$ of a second; the double journey is represented by $\frac{330 \text{ m.}}{3} = 110$ m., and the distance of the obstacle is $\frac{110}{2} = 55$ metres.

The times of the departure and of the return of the wave are graphically registered on a chronograph, by the interruption of an electric circuit obtained by the motion of a-membrane of caoutchouc placed at the extremity of the tube.

It is known that an electric current magnetises a horseshoe magnet. The magnetisation of the magnet communicates to a palette placed above the poles, an attraction which ceases as soon as the current is broken. Without entering into further explanation of this well-known arrangement, which is the basis of nearly all telegraphic apparatus, it will be granted that with conveniently placed conductors it will be possible to make the armature of the magnet move like the elastic membrane; in other words, if the membrane is raised 2, 3, 4 times in a second, the armature will be connected 2, 3, 4 times, and the durations as well as the intervals of the contacts will be identical in the two apparatus.

Let us return to the chronograph. The time is marked by it, and is recorded by means of electro-magnets. The oscillations of a seconds pendulum are repeated electrically and registered on a line, No. 2 in Fig. 4, which is described by a point fixed to the electro-magnet, upon a smoke-blackened cylinder, to which is given a movement of continuous rotation. The electro-magnet whose point describes line No. 2, is moveable on a carriage that advances along the cylinder in the same time as the latter takes to turn. The carriage bears two other electro-magnets: one corresponds to a sub-divisor of the time which gives fractions less than a second. It is this which

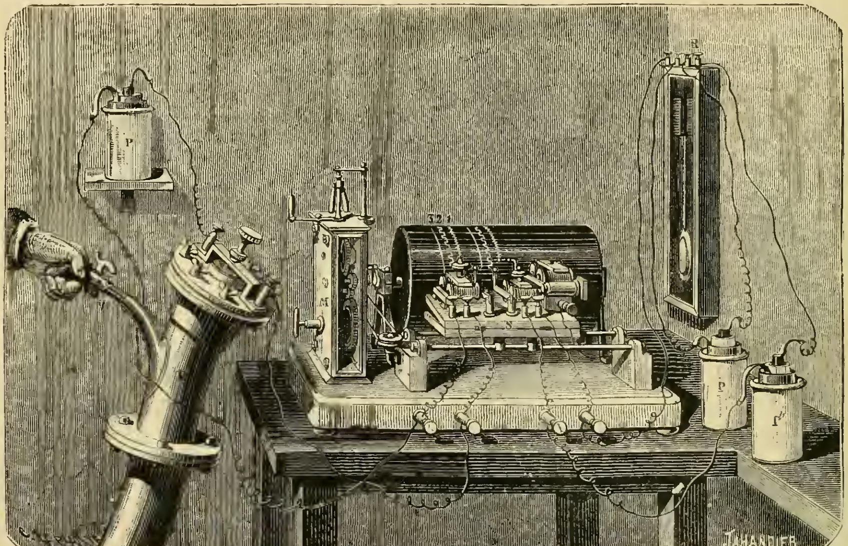


Fig. 4.—Chronograph for determining the point of stoppage of a train.

traces line No. 1, representing by its tracings sub-divisions equal to $\frac{1}{33}$rd of a second; this division into fractions corresponds to the oscillations of the palette of an electric *trembleur*, a contrivance in which the interruptions and re-establishment of the current take place at the rate of 33 per second in the model here represented.

The third electro-magnet, in connection with the membrane of caoutchouc, corresponds to the movement of the wave in the tube; it furnishes line No. 3 in the figure. It may be remarked that the same wave undergoes many successive reflexions.

It will be easily seen from the diagram how the result sought can be obtained from the experiment. Suppose the obstacle to be placed at 62 metres; the interval between two successive marks of the membrane is about 12 sub-divisions. A comparison of lines 1 and 2 shows that there are 33 sub-divisions in *one* second; the indications of line 3 then are equal to $\frac{12}{33}$ of a second. The double distance represents $\frac{12}{33} \times 330$ m, and the simple length given by the experiment is thus about $\frac{1}{2} \times \frac{12}{33} \times 330 = 60$ metres, the result sought to within 2 metres.

Fig. 4 shows the method adopted for producing the wave. On the left T is the tube in which a small pistol V is placed to produce the detonation which gives rise to the wave. On the table in the centre of the figure is the chronograph; M is the clock-work which turns the registering cylinder, on the surface of which are traced the lines 1, 2, 3; S is the carriage bearing the three electro-magnets, each of which traces its line. The electro-magnet on the right, line 1, is the *trembleur*, in connection with the pile P P''. The middle electro-magnet, line 2, is connected with the seconds pendulum R. Finally, the electro-magnet on the left, line 3, communicates electrically with the caoutchouc membrane that surmounts the tube T, and exactly fits the opening, on which it is stretched like a drum-skin.

THE COMMON FROG*

VI.

The Skeleton of the Frog

IT may cause surprise to speak of the skin of the common Frog as part of its skeleton, consisting as the skin does of soft membranous structures only.

FIG. 26.—*Dactylethra capensis.*

The term "skeleton," however, should properly include all the membranous and gristly, as well as the bony structures.* Moreover, more or less of the skin may attain to so solid a condition as fully to justify its comprehension under the name "skeleton," even in the popular signification of that term.

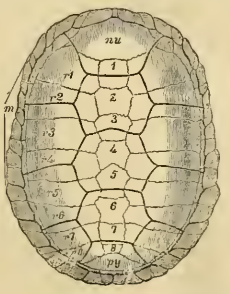


FIG. 27.—Dorsal surface of the Carapace of a Fresh-water Tortoise (Emys) 1—8, expanded neutral spines; r^1—r^8, expanded ribs; *nu*, first median (or nuchal) plate; *py*, last median (or pygal) plate; *m*, marginal scutes. The dark lines indicate the limits of the plates of the horny epidermal tortoise-shell; the thin sutures indicate the lines at the junction of the bony scutes.

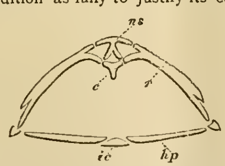


FIG. 28.—Diagram of a vertical section of both Carapace and Plastron of a Tortoise, made transversely to the long axis of the skeleton *c*, vertebral centrum; *ns*, neural spine which expands above into a median dorsal scute; *r*, rib which forms one mass with a lateral scute and terminates at a marginal plate; *ic*, inter-clavicular scute; *hy*, hyo-sternal scute.

* Continued from p. 69.
† See "Lessons in Elementary Anatomy," Lesson II., p. 22.

The skin of Vertebrate animals consists of two layers: an outer layer (the epidermis or *ecteron*), and an inner layer (the dermis or *enderon*). The *epidermis*, and any projections or processes developed from it when they take on a dense or hardened structure, become *horny*. Of such horny nature are hairs, feathers, nails, and scales, they are more or less dense *epidermal* appendages. The *dermis* when hardened becomes *bony*, and of such nature are the bony skin-plates or "scutes," and teeth. They are *dermal* appendages. Now both layers of the skin of the common Frog are entirely soft and utterly destitute of any of these appendages. Allied forms, however, present us with examples of some interesting epidermal conditions. Thus in old male Toads, in *Dactylethra* and in one of the Japanese efts, the epidermis of some of the finger-tips becomes hardened and horny, in other words we begin to meet with incipient "nails." "Incipient" because, in ascending from the lowest vertebrates, "nails" are first

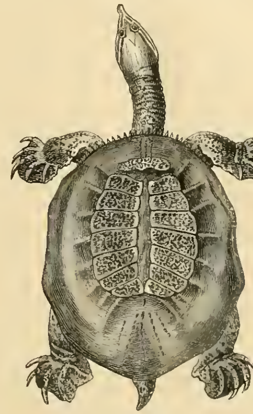


FIG. 29.—A Mud-tortoise (*Trionyx*), showing the dorsal plates.

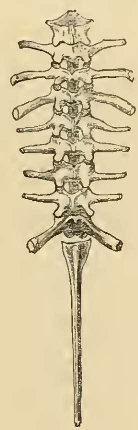


FIG. 30.

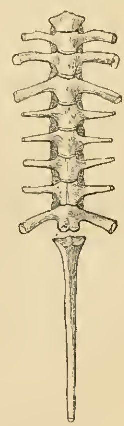


FIG. 31.

FIG. 30.—Backbone of the Frog (dorsal aspect). FIG. 31.—Backbone of the Frog (ventral aspect).

met with in the Frog's class, and these only very rarely and in an imperfectly developed condition.

As has been mentioned, in two kinds of Frog (*Ceratophrys* and *Ephippifer*) the skin of the back is furnished with bony plates. These are found in the deeper layer or dermis, and are therefore "scutes."

The remarkable circumstance, however, is that we have here a lower stage (as it were an *incipient* condition) of that more developed dermal skeleton which exists in tortoises and turtles. In most of these reptiles both the back and the belly are protected by bony plates which adjoin one another, and together form a solid box in which the body is enclosed. Moreover the bony plates of tortoises and turtles are invested by large horny epidermal scales ("tortoise-shell"), which scales do not agree in either size or number with the bony plates on which they are superimposed.

Again, the middle series of bony plates of the back are continuous with the subjacent joints of the backbones, and the lateral series of dorsal plates are continuous with the ribs beneath them.

There are certain Chelonians, however—"mud-tortoises"—(of the genus *Trionyx*), which have the dorsal plates

FIG. 32.

FIG. 33.

FIG. 32.—The Axis Vertebra. *c*, centrum : *s*, neural spine ; *d*, tubercular process ; *p*, capitular process ; *a*, anterior articular surface for atlas ; *z'*, postzygapophysis ; *o*, odontoid process ; *hy*, median vertical ridge beneath centrum. FIG. 33.—The Atlas Vertebra. *s*, rudiment of neural spine ; *d*, tubercular process ; *p*, capitular process ; *a*, articular surface for skull ; *hy*, plate of bone holding the place of a cranium, and articulating with the odontoid process of the axis vertebra.

much less developed and not connected with the ventral plates save by means of soft structures.

Here then we have in reptiles an interesting approximation to the condition we have seen to exist in those exceptional Anourans, *Ceratophrys* and *Ephippifer*. Moreover this resemblance is still further increased by the fact that in *Trionyx* the bony plates are not covered with any tortoise-shell, but are merely invested by soft skin as in the genera of dorsally-shielded Batrachians.

Have we then here a true sign of genetic affinity? Are these tortoises to be deemed the more specially modified descendants of shielded frogs or of some as yet unknown slightly-shielded animals which were the common ancestors both of frogs and tortoises?

Certainly tortoises cannot be the direct descendants of frogs, they agree with all reptiles in characters which are both too numerous and too important to allow such an opinion to be entertained for a moment.

The other opinion is hardly less untenable ; for if all the multitudinous species of frogs (together with a number of reptilian forms more closely allied to the tortoise than any frogs are) descended from slightly shielded animals, how comes it that all frogs and toads, save one or two species in no other way peculiar, have every one of them lost every trace of such shielded structure which nevertheless cannot easily be conceived to have been in any way *prejudicial* to their existence and survival?

On the other hand, it cannot but strike us with surprise that structures so similar—extending even to the continuity of the dorsal plates with the subjacent joints of the backbone—should have arisen twice in nature spontaneously. Here we seem to have a remarkable example of the independent origin of closely similar structures ; and if so, what caution is not necessary before concluding that *any* given similarity of structure are undoubted marks of genetic affinity!

The skin of the frog is also interesting from a physiological point of view. Our own skin is by no means popularly credited with the great importance really due to it. "Only the skin!" is an exclamation not unfrequently heard, and wonder is very often felt when death supervenes after a burn which has injured but a comparatively small surface of the body. Yet our skin is

FIG. 34.—Lateral, Dorsal, and Ventral view of first Vertebra of *Amphiuma*.

really one of our most important organs, and is able to supplement, and to a very slight extent even to replace, the respective actions of the kidneys, the liver, and the lungs.*

In the frog we have this cutaneous activity developed in a much higher degree. Not only does its *perspiratory* action take place to such an extreme degree that a frog tied where it cannot escape the rays of a summer's sun speedily dies—nay, more, is soon perfectly dried up—but its *respiratory* action is both constant and important. This has been experimentally demonstrated by the detection of the carbonic acid given out in water by a frog over the head of which a bladder had been so tightly tied as to prevent the possibility of the escape of any exhalation from the lungs. The fact of cutaneous respiration has also been proved by the experiment of confining frogs in cages under water for more than two months and a half, and by the cutting out of the lungs, the creature continuing to live without them for forty days. Indeed it is now certain that the skin is so important an agent in the frog's breathing that the lungs do not suffice for the maintenance of life without its aid.

It is no less true that in Batrachians which breathe by means of permanent gills—as, *e.g.* the Axolotl—such gills are not necessary to life, as the late M. Aug. Duméril and Dr. Günther have established by cutting them away without inducing any apparent injurious effects. In the whole class of Batrachians skin respiration seems, then, to be of very great importance.

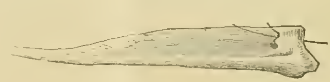


FIG. 35.

FIG. 36.

FIG. 35.—Coccyx of Frog, lateral view, a black line indicates the course of the sciatic nerve. FIG. 36.—Anterior aspect of Coccyx, showing the double articular concavities placed side by side beneath the neural arch.

The *internal* skeleton (or the skeleton commonly so called) of the frog presents some points of considerable interest, especially as exhibiting its intermediate position between fishes on the one hand, and higher vertebrates on the other. First, as regards the *backbone*, it may be remembered that it is made up of distinct bony joints (or *vertebræ*), in which it agrees with all animals above fishes and with bony fishes ; its hinder termination, however, is essentially fish-like. It is fish-like, because the terminal piece, as it is called, or "*coccyx*" (unlike the coccyx in man or in birds) is not formed of rudimentary vertebræ which subsequently blend and anchylose together, but is formed by the ossification continuously of the membrane investing (or *sheath* of) the hindermost part of that primitive continuous rod, or notochord, which, as has been said,

* See "Elementary Physiology," Lesson V., § 19.
† From Νῶτος, back, and Χορδὴ, chord.

precedes, in all vertebrate animals, the development of the backbone, making its appearance beneath the primitive groove.

The vertebræ are shaped like rings, and enclose within their circuit the spinal marrow upon which, as it were, these rings are strung. From the side of each ring (except at the two ends of the backbone) there juts out a bony prominence called a "transverse process," and to a certain number of these a bony "rib" is in most vertebrate animals attached (though there are none in the frog), often extending round to join the breast-bone in front, and being capable of more or less motion, so as (by their simultaneous movement) to be able to enlarge or to contract the cavity of the chest, which they thus enclose and protect.

That part of each vertebra which is placed next the body cavity is generally the thickest part, and is called the "body," or "centrum." The series of bodies (or centra) occupy the position which was at first filled by the primitive notochord, the rest of the vertebral rings having been formed in the sides and roof of the canal formed by the upgrowth and union of the two sides of the primitive groove of the embryo.

The frog order is distinguished amongst veteb rates as that which has the absolutely smallest number of joints in the backbone. In the frog there are but nine in the front of the coccyx. In the Pipa toad there are but seven, the eighth vertebra (to the transverse processes of which the haunch bones are attached) having become solidly joined in one bone with the coccyx.

In all higher vertebrates, *i.e.* in all beasts, birds, and reptiles, the head is supported on an especially ring-like vertebra which—because it so supports—is called the *atlas*, and this (in almost all) can turn upon a peculiar vertebra termed (from this circumstance) the *axis*. and provided with a toothlike (*odontoid*)* process, round which, as round a pivot, the "atlas" works. Nothing of the kind exists in any fish.

In the frog (and in all its class) we find but a single vertebra representing these two, but in some allied forms, *e.g.* in *Amphiuma*, this vertebra develops a median process, reminding us of the odontoid process of the axis.

The frog, as has been said, has no ribs, in spite of the long "transverse processes" which project out on each side of the backbone. Ribs are not necessary to it, for it could apply them to none of the purposes to which ribs are ever applied.

In all beasts ribs aid importantly in respiration, serving by their motions alternately to inflate or empty the lungs by enlarging or contracting the cavity of the chest in the way before mentioned. The frog, however, breathes exclusively, as regards the lungs, by *swallowing* air by a mechanism which will be described shortly.

In serpents the ribs are the organs of locomotion, as also in the Flying Dragon before referred to; but in frogs locomotion is effected exclusively by the limbs. In the very aberrant species, *Pipa* and *Dactylethra* there are on each side of the anterior parts of the body two enormously long transverse processes, each process bearing at its extremity a short flattened, straight osseous or cartilaginous rib. These little ribs can, however, take no part in such functions as those just referred to.

Ribs, moreover, are found in the other existing orders of the frog's class, *i.e.* both in the *Urodela* and *Ophiomorpha*. In none, however, do they join a breast-bone, or sternum, another character in which *Batrachians* agree with fishes, though they differ from fishes in that they have a sternum at all. In ascending from fishes through the vertebrate sub-kingdom, a sternum first appears in the class *Bratrachia*.

In a certain North African Salamander named *Pleurodeles* the ribs are not only elongated, but their apices, if they do not actually perforate the skin, are so prominent as to seem to do so when the finger is drawn from behind forwards along the side of the animal's body.

* From ὀδούς, a tooth, and εἶδος, form.

The several joints of the backbone are connected together by surfaces which are not the same on both the anterior and posterior sides of the centrum, or body, of the same vertebra. Each of the first seven vertebræ is furnished with a round prominence, or head, on the hinder side of its centrum, and each of the præcoccygeal vertebræ, except the first and last, has the anterior surface of its centrum excavated as a cup for the reception of the ball of the hinder surface of the vertebra next in front. The first vertebra has in front two concavities, side by side, to articulate with the skull. The eighth vertebra has a concavity at each end of its "body." The ninth vertebra has a body provided with a single convexity in front and a double convexity behind, to articulate with the concavities placed side by side on the front end of the coccyx.

These arrangements are not constant in the frog's order, still less in its class. In *Bombinater* and *Pipa* the vertebræ are concave behind each centrum, instead of in front: and the same is the case in *Salamandra*. In many tailed Batrachians the vertebræ are biconcave, as *e.g.* in *Spelerpes*, *Amphiuma*, *Proteus* and *Siren*.

The biconcave shape is an approximation towards the condition which is almost universal in bony fishes, though not quite universal, since the bony pike (*Lepidosteus*) has a ball at one end of each vertebra and a cup at the other. Moreover, even in some reptiles (*e.g.* the lizards called *Geckoes*) the vertebræ are biconcave, and the same was the case with the majority of those species of crocodiles the remains of which are found in strata older than the chalk, and even in existing crocodiles the first vertebra of the tail is biconcave.

Vertebræ with a cavity in front of the centrum and a ball behind it are found in the crocodiles now living as well as in the frog, while vertebræ with a ball in front and a concavity behind are found even amongst beasts, as in the joints of the neck of Ruminants, *e.g.* the sheep. Thus though the vertebræ of the frog's class exhibit no very decided signs of affinity, they show more resemblance to those of fishes than to those of any other non-batrachian class.

The transverse processes of the ninth or last vertebra in front of the coccyx, articulate with the haunch bones, but are not very remarkable in shape. In some frogs and toads the transverse processes of this vertebra become enormously expanded, and the expanded or non-expanded condition of this part is a character made use of in zoological classification. The coccyx is made up mainly, as has been said, of a continuous ossification of the sheath of the notochord, and never consists of distinct vertebra. Nevertheless, the small bony arches which are at first distinct coalesce with it. These arches are called "neural" because they arch over the hinder part of the spinal marrow. The great nerve of the leg (the sciatic nerve) proceeds outwards on each side through a foramen situated at the anterior end of the coccyx from the spinal marrow—the spinal marrow being that structure which gives origin to the great mass of the nerves pervading the entire frame.

ST. GEORGE MIVART

(*To be continued.*)

[The author sincerely regrets, that by an inadvertence for which he is exclusively answerable, two cuts introduced into the second of these articles, namely, the figures representing *Rana esculenta* and *Bufo vulgaris*, were copied, without sanction, from two illustrations in Professor Bell's "History of British Reptiles," published by Mr. Van Voorst, to whom, therefore, this apology is due.]

EARTH-SCULPTURE *

III.

I DO not consider it necessary to defend my facts. They are familiar enough to the geologists of this country, as displayed more or less plainly in every district of our island. I am at present concerned with the counter-statements which the Duke of Argyll would put in their place.

He states his belief that the Highland mountains have had their contour mainly given to them by "upheavals, subsidences, and lateral pressures, which have folded them and broken them into their present shapes." A belief of any kind must be founded on evidence of some sort, and that evidence must be produced if the owner of the belief desires that it should be accepted by others besides himself. What evidence, then, does his Grace furnish as the basis on which he expects that his "belief" is to supersede what he is pleased to term "the extravagant theories of the younger glacialists"? Having shown "the antecedent improbabilities involved in the extreme theories of erosion," he states that he "proceeds to test them on the field of fact." We follow him anxiously to the field in question, and find that his so-called facts are stated in such words as these: "Loch Fyne . . . occupies, as I believe, the bed (*sic*) of an immense fault." "The transverse valley of Loch Eck lies across a steep anticlinal, and is due, in my opinion, to the extreme tension to which the crystalline rocks have been subjected." "The Pass of Awe is a rupture and chasm." These, and other similar assertions regarding various parts of the Highlands are confidently expressed, but they are accompanied by no evidence by which their accuracy may be tested. In truth, the "facts" which his Grace adduces in support of his "belief" are only other "beliefs" and "opinions" of his own. They may be correct or the reverse, but they cannot legitimately be adduced as evidence in a scientific argument. But they are very far from correct. I utterly deny, for example, the assertion that Loch Fyne lies along the bed of an immense fault, and I ask the Duke of Argyll to try to prove that it does so. Nay more, I challenge him to produce a geological section which would bear a moment's examination on the ground, in which he can show the coincidence of a valley with a line of fault in any part of his own county of Argyll. That cases of this coincidence may be found I do not doubt, but the search for them will be useful in teaching his Grace how exceptional they are.

The Duke of Argyll does indeed offer some explanatory statements regarding some of his assertions of fact. For instance, with regard to Loch Awe, he dwells on the inclinations of the slates and the intrusion of the porphyries among them as evidence that the present contour has been directly the result of subterranean convulsion, and he triumphantly adduces these and similar appearances "ignored" by myself as a demonstration of the truth of his "belief." But any one who knows the Highland rocks at all may well smile when he is told that a geologist who had ever been over the ground, even in the most cursory way, requires to have these phenomena pointed out to him. In reality I had already granted the existence of these, and far more wonderful evidences of underground movements, for I knew the Highland rocks well, and had mapped their structure over leagues of ground from the mountains of Sutherland to the moors of Forfar, and the headlands of Islay. I was therefore perfectly familiar with the phenomena to which the Duke of Argyll so confidently refers. But I had learned more about them than merely their tale of subterranean turmoil. I had found that they did not bear directly on the origin of hill and valley at all. I had traced everywhere evidence that what we now see of intruded granite or curved slate has been laid bare only after the removal of hundreds and thousands of feet of rock under which they once lay. His Grace, it would seem, has still this lesson to learn, and until he has mastered it, and, apart from any theory but simply as a matter of demonstrable fact, has realised what it involves and how vain is the attempt to connect the contorting and hardening of the rocks with the *present* surface features of the country, argument with him on this question seems hardly possible.

Again, I had quoted the mountain Ben Lawers, with its flanking hollow in Loch Tay, as a typical example of the kind of evidence which could be abundantly adduced from all parts of the Highlands to show the relation between geological structure and external form, and to prove from under what an enormous mass of removed rock the present surface of the Highlands has appeared. I gave a section to show at a glance the broad facts of the case—a section from which no conclusion is possible but that which I drew. But here, once more, the Duke of Argyll's belief in the all-powerful efficacy of granite and igneous rocks, or his thraldom to what he calls "the influence of a preconceived theory," brings out in well-marked prominence that obliquity of vision which prevents him from seeing anything but convulsion and fracture. He scents intrusive rocks of some sort along the south bank of Loch Tay. It would be vain to remonstrate that this alleged influence of the igneous rocks is, to say the least, as pure "invention and imagination" as anything which the "younger school" could readily supply, or that the denudation of that region is a momentous fact to be looked in the face and explained, not to be dismissed or denied, no matter what our "theory" or "belief" may be regarding the origin of granite. Without further ceremony, the proofs of enormous denudation at Ben Lawers and Loch Tay, together with their luckless advocate, are all bundled off with the summary judgment, so happily appropriate to its own author, "I attach no value whatever to a theory which passes over and ignores this class of facts altogether."

The dogmatic assertions which the Duke of Argyll makes regarding the influence of granite and other rocks upon the surface, and as to the existence of fractures and depressions along the line of valley and glen, are really most flagrant examples of the *petitio principii*. In effect, his Grace tells us, "The 'inventions and imaginations' of these younger men are based upon 'assumed facts' which 'are, in my opinion, to a large extent purely hypothetical.' I am 'suspicious of the influence which a preconceived theory has had on their estimate of evidence.' I therefore 'attach no value whatever' to their statements, and do not consider it necessary to lose time in weighing what they actually mean by this denudation of theirs, and all which, as they contend, must flow from it. My belief is that valleys are due to fractures and depressions. The Highlands abound in valleys, and therefore it must be evident to everyone capable of forming an opinion on the subject, that they abound also in proofs of fracture and depression."

In the foregoing remarks I have been dealing only with the Duke of Argyll's paper of February 1868, which in his recent vigorously-worded address he cites as still unanswered, and which, therefore, we may suppose still to express his views. And yet no one can peruse that address without perceiving that it betokens a considerable change of opinion. Especially gratifying must it be to that "younger school" of geologists against which the Duke has so vehemently lifted up his protest, to observe that the lapse of time which he would not allow to have had much denuding effect upon the rocks, has yet been able to strip off from himself some of that crust of preconceived "theory" against which no argument or adverse fact could once make any impression. It is true

* Opening Address to the Edinburgh Geological Society, by Prof. Geikie, F.R.S. (continued from p. [illegible])

that his Grace formerly thought it necessary to assure us that Time could do nothing by itself, "nothing except by the aid of its great ally Force—Force working in Time." Well, we shall not quarrel about the use of words, but cheerfully admit that the change which has become perceptible in the opinions of the Duke of Argyll is wholly the result of "Force working in Time," and not a very long time, for it cannot be stretched out beyond five years. Surely if the lapse of so brief a space, with all the amount of Force which we can crowd into it, can have modified geological opinions which certainly seemed as solidly and unalterably fixed as his own Ben More itself, it can hardly be too much to hold that by the end of another *lustrum* still further modification may justify the confident belief that his Grace may still come to join the "younger school" heart and hand. We can assure him a jubilant welcome.

But it may be asked what is the nature of this present alteration of view? In brief, it may be put thus: the Duke of Argyll finds that, after all, denudation is one of those disagreeable facts which will insist on being prominent—"chiels that winna ding." He has discovered that it really has had some share in the shaping of the present outlines of the land. He now admits in words "that the forms of hill and valley which preceded the coming-on of glacial conditions [during the Ice age] had been themselves determined in a large degree by previous denudations." And even though this general admission is neutralised by statements which follow it, it is most welcome as an indication doubtless of the effect of those "more extended opportunities of observation" which his Grace tells us he has since enjoyed, and on the continuance of which our hopes of his secession to the ranks of the "younger school" are mainly based.

The Duke of Argyll appeals once more to the details of geological structure. Most gladly do we accede to the appeal. He points to the contorted condition of the older rocks as evidence of the extent to which they have been affected by subterranean movements. But no geologists are more familiar with these facts than his maligned "younger school." He conceives that it was after such movements that the forces of denudation began to work. Most assuredly; this has been explained over and over again. He affirms that "so long as such hills and mountains last at all, and wherever they are exposed to view, they bear upon them the unmistakeable impress of their origin and of the mighty subterranean forces to which their structure is due." This sentence is rather ambiguous. If it means that contorted rocks retain evidence of contortion, such an obvious truism was hardly worth a sentence to itself. If it means that a mountain made of contorted rocks has had its form determined at the time of contortion, the statement is mere assertion and a begging of the very question to be proved.

In the same address the noble president declares that "denudation has done its work along the lines determined by upheaval, by fracture, and by unequal subsidence." This has never been denied by anyone. A main object of my book was to show how, by means of denudation along such lines, much of the present contour of Scotland has been produced. Again we are told—"All sedimentary beds must have had an edge somewhere; and if they are lifted into a vertical position and the edges come to be exposed, the removal of a small amount of material may result in a horizontal surface, or in surfaces cutting across the lines of structure at every variety of angle." If the Duke intends this explanation to apply not to a mere hand specimen, but to any district of convoluted and vertical rocks, such as the hills of Wales or the Southern Uplands or Highlands of Scotland, he cannot have noticed the string of physical absurdities which it involves. The rocks are often vertical, or nearly so, for miles at a stretch. Could we put them into something like their original horizontal or gently inclined position their present edges would end off in a cliff many miles high. Can his Grace expect anyone to believe that the beds, which certainly "must have had an edge somewhere," ever ended off in that fashion? But this would be only a part of the feat. In actual fact the rocks have been violently contorted, so that a series several hundreds or even thousands of feet in thickness is folded again and again upon itself. The present surface has been cut across these foldings, and in great part has its inequalities independent of them. If we could flatten these curved rocks out again from their present condition they would show a series of deep sharp troughs separated by steep pyramidal ridges of flat strata. And from the Duke of Argyll's teaching we should learn that this wonderful arrangement was the normal plan in old times of laying down sediment which, instead of always going to the bottom and filling up the hollows as it does nowadays, contrived then to ascend, layer after layer, like the tiers of the Great Pyramid, as if it were under the impulse not of mere gravity or of the play of ocean currents, but of the methodical action of organisms like the coral polyps. We should further learn that these neatly-shaped sand and mud ridges and troughs were so accurately laid down that when subterranean forces came into action and crumpled the whole up, every ridge popped conveniently into a trough below, as if a trap-door had been opened for its reception, and with such nice adjustment as to bring its top to the same general level as the bottom of the former troughs!

The truth is, and, in common fairness I am bound frankly to state it, that such assertions as these with which I am dealing, could never be made if geological structure were really understood and kept in view. This is a matter of science, and is only to be mastered by the same patient toil which is required in other scientific inquiries. Moreover, it is by no means so easily mastered as it seems to be. The first absolute requisite for overcoming our ignorance, is to reduce our facts to the test of ocular proof and measurement. Let us construct a section across the tract of which we would master the structure, and to avoid risks of error from exaggeration of proportion, let us begin by making the section as nearly as possible on a true scale, that is, giving the same value to length as to height. With the outline of the ground accurately traced we may then, section in hand, insert upon it at the proper places, and with the true angle of dip, such rocks as we be able to see exposed. Having fixed these data in this patient way, we may expect with some confidence to understand and fill in the geological structure of the ground for ourselves, and to make it intelligible and credible to others. Until we have gone through such a training ourselves, or have learnt adequately to appreciate what it is from the labours of others, we have no right to utter an opinion on the relations between geological structure and external form, for we are destitute of one of the necessary qualifications for dealing with the problem.

The greater part of the recent address of the president of the Geological Society deals with the traces of ice-action in this country, and the manner in which they are to be accounted for. In his remarks upon this subject, the Duke again places himself in opposition to the views of the "younger school," and expresses opinions from which every member of that school would, I am sure, emphatically dissent. It is no part of my present purpose to enter upon these. I cannot, however, pass by one statement in the address. His Grace asserts that these restless "younger geologists" have recently made a most complete change of front. He therefore directs his attack against this new position. He says that they no longer maintain the existing systems of hill and valley to have been cut out of the solid by an enormous glacier, but admit the general contour of the country to have been very much the same before the Ice age as after it, all the

work of the ice having been to deepen valleys, degrade hills a little, and fill up the plains and hollows with clay and sand. "Such as I understand it," says the Duke, "is the new glacial theory." But surely he can have paid but scant attention to the subject if he imagines that this idea is in any sense new. I really cannot recall that the geologists of the "younger school" have for many years past held any other view than that which they are now said to have adopted only recently. If, for example, his Grace will turn to the little volume which he abused so heartily in the spring of 1868, he will find the "new view" stated as plainly there as words can express it (see page 150). And yet in this address he thinks it needful to adduce evidence to disprove that valleys have been gouged out by an universal ice-sheet—a notion which, according to his own showing, the "younger school" does not hold.

These remarks have been extended this evening beyond the length to which I had originally proposed to confine them. My excuse must lie partly in what to myself is the ever fresh charm of the subject, and partly in the desire to vindicate the fair fame of the modern Huttonian school of geology from attacks which had been in some measure called forth by writings of my own. I have again to express my regret that it was impossible to avoid an appearance of personal conflict, and I am conscious that a man who does his best to give as good as he gets in such conflict is apt to do more than he meant. I can only hope that this consciousness has kept me far within the bounds of legitimate reply.

Of one thing I feel securely confident. When the din of strife has ceased and men come to weigh opinions in the dispassionate light of history, the profound influence of the Huttonian doctrines of the present time on the future course of geology will be abundantly recognised. By their guidance it will be possible to reconstruct the physical geography of the continents, in successive ages back, perhaps into some of the earliest periods of geological history. This work indeed is already in part accomplished. But much more remains to be done before the history of the land on which we live has been wholly unravelled. This is the task to which we have set ourselves, in which we have found ample scope for enthusiasm and hard work, and out of which we trust that there will eventually come a story of permanent interest to all whose range of vision extends beyond the present condition of things, and who would fain understand what now is by the light of what once has been.

EXTERMINATION OF MARINE MAMMALIA

THROUGH the kindness of a friend, there has been placed in my hands a little book—one of the few copies in England—which though not much bigger than a pamphlet, seems to me more deserving of notice than I fear it is likely to obtain. Of its author, I may say, I know nothing. Its title is "Mammalia, Recent and Extinct; an Elementary Treatise for the use of the Public Schools of New South Wales. By A. W. Scott, M.A." It is published at Sydney by Thomas Richards, Government Printer, and bears date 1873. One's first wish on looking at it was that such a book might be wanted "for the use of the Public Schools of" the old country; but it is not my object now to enlarge on this theme or even to call attention to, or pass judgment upon it from a scientific point of view—though some of the author's opinions are, if not novel, such as have not been generally received. Mr. Scott's treatise is confined to the "*Pinnata*, Seals, Dugongs, Whales," &c. and he tells us in his preface why he has so limited it:—

"Whatever information we possess upon the natural history of the finned mammals, particularly in a popular, yet scientific form, has been so scantily and unequally distributed, that in this direction a comparatively new field may be said to be open to the teacher as well as to the youthful inquirer.

"Influenced, also, by the great commercial value of several species of the pinnata, I have felt anxiously desirous to direct, without further delay, the attention, and thus possibly secure the sympathy, of readers, other than students, to the necessity of prompt legislative interference, in order to protect the oil and fur producing animals of our hemisphere against the wanton and unseasonable acts committed by unrestrained traders; and thus not only to prevent the inevitable extermination of this valuable group, but to utilise their eminently beneficial qualities into a methodical and profitable industry.

"Keeping steadily in view these two objects, whose importance, I trust, will bear me out in deviating from my original intention in the order of the issue of publication, I have endeavoured . . . by devoting as much space as my limits would permit to the consideration of the animals whose products are of such commercial value to man, and whose extinction would so seriously affect his interests, to point out the pressing necessity that exists for devising the means of protection for the Fur Seals and the Sperm and Right Whales of the Southern Ocean.

"To evidence what great results may be effected by considerate forethought, I refer the reader to pages 8 to 13 of this treatise [containing extracts from the excellent paper on *Otariidæ* by Messrs. Allen and Bryant (Bulletin Harvard College, ii. pp. 1–108)], where he will see that, under the fostering care of the United States Government, the Northern Fur Seals of commerce, which but a few years ago were nearly extinct, have already, by their rapid increase and mild disposition, developed themselves into a permanent source of national wealth.

"The islands of the Southern Seas, now lying barren and waste, are not only numerous, but admirably suited for the production and management of these valuable animals, and need only the simple regulations enforced by the American Legislature to resuscitate the present state of decay of a once remunerative trade, and to bring into full vigour another important export to the many we already possess."

Mr. Scott's design appears to me eminently praiseworthy; and the question it raises is, without doubt, one which must imperatively demand (and will, I trust, in time) the attention not only of the naturalist, but of everyone who is interested in the commercial prosperity of this country and its colonies. Though to some extent their place has been supplied by mineral and vegetable oils, for certain purposes it is, I believe, admitted that animal oils are absolutely required, and the demand for these oils increases with the increase of civilization. Now no one who has at all closely investigated the subject of the extermination of animals by man can come to any other conclusion than that unless, by some legislative restriction (which from the nature of the case will probably have to be *international*) it is prevented, all the Marine Mammalia are inevitably doomed to early extinction. Who can read of the butcheries which are yearly perpetrated on the breeding Seals of the ice-floes in the North Atlantic, and as yearly recorded with more or less zest in the newspapers, without feeling certain that the same fate awaits them as has overtaken, or is overtaking, so many of their fellow-denizens of the deep? Where is the *Rhytina* of Behring's Island? Absolutely abolished from the face of the earth! Where are the Manatees that played in the waters of the Antilles, when those "isles of the sun" were first visited by Europeans? Limited to some three or four muddy creeks in as many of the larger islands! Where is the Right Whale that used to throng the Greenland seas, the Walrus that haunted the Gulf of St. Lawrence? Driven so far to the northward that ships in the pursuit of either are now led to encounter the greatest perils! Where is that smaller Whale which furnished employment for all the navies of Biscayan ports? You have to seek its remains in the museum at

Copenhagen! Where are the Dugongs of Rodriguez so charmingly described by Leguat? Vanished! Where are the Sea-elephants of Ascension, Tristran d'Acunha and the Crozettes? So hunted down that it is not worth a skipper's while to seek them! Where are the countless and mighty Otaries that Péron found in Bass's Straits? Not there assuredly!* The list of questions might be extended indefinitely. Surely it is time to stop such wanton, such short-sighted destruction. Let me not be misunderstood, however. No one believes more firmly than I do in the right which man has to turn animals to his *use*. It is the *abuse* of which I complain. It is an abuse of power to slaughter these creatures in such places and at such times of the year as must lead to their utter extinction; and I know there are many naturalists, some of high standing, who think with me, though perhaps their acquaintance with the facts has not been sufficient to make them see so clearly as I do that interference with the abuse must speedily be adopted or it will be too late. Naturalists, as a rule, are rare in the legislature of this country, but is there not one, at least, to call upon the Government to take the necessary steps? Granted that these steps are beset with difficulties—so much the more honour to him who surmounts them. The Russians and the Americans have been before us, and through their wise measures there is now every chance that the Seals of the Northern Pacific will continue to exist for many a long year to the great profit of all concerned.

In this matter, as in similar cases, the present generation will deservedly be reproached by posterity if we steadily shut our eyes to what has taken place and to what is going on now. ALFRED NEWTON

* See Mr. Charles Gould's remarks in the Monthly Notices, &c., of the Royal Society of Tasmania for 1871, pp. 61—67.

NOTES

SIGNOR SCHIAPARELLI, Director of the Milan Observatory, has been appointed Director of the Florence Observatory in place of the late Signor Donati. The Florentine Observatory, which stands near Galileo's Tower at Arcetri, is in every way superior to that of Milan, and we may look for considerable results from an astronomer who has already done much with small opportunities.

ON Monday evening Sir Samuel Baker met with an enthusiastic reception at the meeting of the Geographical Society, from a large, distinguished, and brilliant audience, which included the Prince of Wales and the Duke of Edinburgh. Sir Samuel spoke mainly of what he had done to suppress the slave-trade, and of the almost overwhelming difficulties he and his brave wife had to face in bringing the lawless African tribes to reason. After Sir Samuel sat down, the Prince of Wales said a few words, and testified to the sincerity of the Khedive.

IN his address at the opening meeting of the Newcastle-on-Tyne Chemical Society, the president, Dr. Lunge, spoke of his visit to the Vienna Exhibition, and of the rapid progress which the Continent is making in the manufacture of the finer chemicals. The reason, he says, is not far to seek. "You find in every chemical works on the Continent, I may say, without exception, one, sometimes several, chemists of thoroughly scientific training, who have acquired their theoretical basis by three or four years' studying at a University or a Polytechnical Institution. One "works," to which I have already alluded, certainly one of the largest in Germany, keeps something like half-a-dozen such chemists (not practical managers), with salaries varying from 300*l*. to 400*l*., and it retains the services of an accomplished chemist, of scientific reputation, at a salary of nearly 2,000*l*. per annum, exclusively for theoretical work in the laboratory, without any trouble or responsibility connected with the manufacturing work outside. But then, they *do* constantly invent new things there, and make them in tons, or hundreds of tons, when the chemical world outside has, perhaps, barely heard of the discovery of a new compound, with a barbarous name, apparently only obtainable at the rate of a few grains in a sealed tube after many weeks' patient work. What I maintain, after a visit to the Vienna Exhibition, and at a few German and Austrian chemical works, is, that foreign countries are taking the wind out of our sails very fast in this line, and that both their rate of progress and the means of attaining it are very much superior to ours."

A PRELIMINARY meeting was held on November 29 in the Physical Laboratory of the Science Schools, South Kensington, to consider the formation of a Physical Society. The chair was taken by Dr. J. H. Gladstone, F.R.S. Thirty-six gentlemen were present, including most of the physicists of London. It was resolved that the following gentlemen be requested to serve as an organising committee:—W. G. Adams, E. Atkinson, W. Crookes, A. Dupré, G. C. Foster, J. H. Gladstone, T. M. Goodeve, F. Guthrie, O. Henrici, B. Loewy, Dr. Mills, A. W. Reinold, and H. Sprengel. A letter was read from the Lords of the Committee of Council on Education, granting the use of the Physical Laboratory and apparatus at the Science Schools, South Kensington, for the purposes of the Society.

THE *Photographic News* says that a curious and important discovery has been made by Dr. Vogel during the last few weeks. It consists, as he describes it in a private letter, in making the non-actinic rays under certain circumstances actinic. "I have found," he says, "that bodies which absorb the yellow ray of the spectrum make bromide of silver sensitive to the yellow rays. In like manner I find bodies which absorb the red ray of the spectrum make bromide of silver sensitive to the red rays. For example, by the addition of *corallin*—which absorbs the yellow ray—to a bromide of silver film it becomes as sensitive to the yellow ray as to the blue ray." This is one of the most important and interesting observations in connection with actino-chemistry which has been made for several years.

AN examination will be held at Queen's College, Oxford, on April 14, 1874, and following days, for the purpose of filling up four open scholarships of the yearly value of 90*l*. tenable for five years. Candidates must not have attained the age of 20 years. One of the open scholarships will be awarded for mathematics and one for natural science in case competent candidates offer themselves. Candidates offering in natural science should be proficient in either physics, chemistry, or physiology, and possess some acquaintance with a second physical science. These candidates are requested to signify by letter to the Provost, as early as may be in March, their intention of standing, and to state at the same time the subjects they propose to offer, in order that the necessary arrangements may be made for their examination. Candidates are to call on the Provost in the College-hall at 9 P.M. on Monday, April 13, bringing with them satisfactory evidence of date and (where necessary) place of birth, and testimonials of good conduct from their schoolmasters or tutors.

THE following alterations have been made in the programme of lectures at the Royal Institution:—In consequence of Prof. Tyndall's desire to give six lectures on the Physical Properties of Gases and Liquids on Tuesdays before Easter, Prof. Rutherford will give five lectures on Respiration before Easter, and six lectures on the Nervous System after Easter. At the Friday evening meeting, March 6, Sir Samuel Baker will lecture on the Suppression of the Slave Trade of the White Nile. Dr. Burdon-Sanderson will lecture after Easter.

MR. HENRY LEE reports the development of a new calcareous sponge in the Brighton Aquarium. In its early condition it

closely resembles, in its mode of growth, *Leucosolenia botryoides*, but afterwards, in some instances, becomes massive and semi-globose. It has been submitted for examination to Dr. Bowerbank, who describes it as follows :—"In the young state, a congeries of thin fistulæ, like a *Leucosolenia*; when adult massive; furnished with numerous thin conical or cylindrical cloacal organs, very variable in size and length. Surface of the mass mooth and even; small cloacæ furnished with numerous long, slender, acerate, external defensive spicula, projected ascendingly at small angles to the surface; large cloacæ nearly destitute of external defensive spicula, furnished with a few long, slender, acerate, procumbent spicula; internal defensive spicula of cloacæ spiculated, equi-angular, tri-radiate; spicular ray, slender and attenuated. Oscula minute, distributed on the inner surfaces of the cloacæ. Pores unknown. Dermal membrane pellucid aspiculous. Skeleton spicula, equi-angulated and rectangulated, triradiate; radii slender and unequal in length, distorted; colour, cream white. Habitat, Brighton Aquarium, Henry Lee. Examined in the dried state." This sponge will be figured in three several conditions of its development, in the forthcoming third volume of Dr. Bowerbank's valuable monograph of the British *Spongiadæ*, published by the Ray Society, and will be known as *Leuconia Somesii*; Dr. Bowerbank having named it after Mr. Somes, the chairman of the Brighton Aquarium Company.

A CORRESPONDENT of the *Scotsman* points out how desirable a thing it is that a marine aquarium should be erected in Edinburgh. "The city," he rightly says, "abounds in educational establishments, to which such an institution would be an invaluable accessory. Great local facilities exist for the creation of an aquarium, and were a scheme for that purpose but set on foot, many willing hands would aid in its realisation. The cost would not be great, considering the advantages to be obtained; and it is certain the establishment would be self-supporting." We hope to see the matter earnestly taken up by proper hands.

THE fifth part of the illustrated work on Lepidoptera, domestic and foreign, by Mr. Herman Strecker, of Reading, Pennsylvania, has made its appearance. In the present part the illustrations relate entirely to the genus *Catocala*, of which one supposed new species is presented under the name of *C. perplexa*, from the vicinity of Brooklyn. Mr. Strecker merits particular commendation from the fact that this work is prepared exclusively by his own hand, the illustrations being drawn on stone, printed, and coloured by himself—and, if we mistake not, the type of the text is set up by him likewise—all done in the intervals of his daily labour as a mechanic. The expense of the work—fifty cents per number— is such a mere trifle that we trust he will be encouraged by a sufficient subscription list to continue it to completion, increasing the number of plates, as he promises to do, without any change in the price, should he receive the desired patronage.

THE London Association of Correctors of the Press held a *conversazione* on Saturday last under the presidency of Mr. B. H. Cowper, editor of the *Queen*. We are glad to notice that the principal items of the programme were of a scientific character. Mr. E. R. Johnson, Chairman of the Association, read a paper on the past work of the Association, enumerating some of the papers and discussions on philological topics which had engaged its attention, and while commending the study of philology, the advantage of an acquaintance with one or other of the exact sciences was set forth. Mr. G. Chaloner, late Secretary of the Association, and lecturer on Chemistry at the Birkbeck Institution, enlightened the meeting as to some of the properties of hydrogen, accompanying his remarks with appropriate experiments. Mr. J. T. Young discoursed on the glacial period, and exhibited some fossils illustrative thereof. The wonders of the microscope and stereoscope also contributed to the enjoyment of the evening.

THE two scientific papers in the last number of the *Quarterly Journal of the Meteorological Society* are :—"On some Results of Temperature Observations at Durham," by Mr. J. J. Plummer; and "Notes on the Connection between Colliery Explosions and Weather in the year 1871," by Messrs. R. H. Scott, F.R.S., and W. Galloway. The subject of the latter article is of the greatest importance to miners, and, in connection with it, we would call attention to a letter in yesterday's *Times* warning colliery managers of the present high reading of the barometer. We are glad to see from the Report of the Council that the Society has attained an exceedingly prosperous and altogether satisfactory condition.

NO. XI. of Petermann's *Mittheilungen*, contains a brief letter from Dr. Richard v. Drasche, concerning his geological voyage to Spitzbergen in July and August last. The letter contains a few very valuable details as to the physical and geological characteristics of the west coast of the island.

SIR GEORGE ROSE, F.R.S., died at Brighton on the 3rd inst. in the 92nd year of his age.

DR. SPEIER, of Fulda, has been appointed by the Japanese Government as Professor of Natural Sciences at Yeddo. A very handsome salary has been guaranteed to him by the Japanese Embassy at Berlin. Other appointments are expected to follow in the departments of Experimental Physics and Medicine.

Apropos of the letter in this week's number on the British Museum, we take the following from an article in a recent number of *Iron* on "Our National Museums :"—As at present constituted, Museums may be broadly divided into three types: first, that of the South Kensington, Jermyn Street, and Bethnal Green Museums in London, and the Albert Museum in Exeter,—a type of the actually useful museum, where the artisan may see illustrations of manufacturing operations, and the artist may find examples of the masterpieces of old. Here everything is neat, orderly, and simple; no object is without a label, which explains clearly what it is; and spectators need not wander about among collections of incomprehensible curiosities, which excite in their minds wonder but no interest. The second type is that of the British Museum, which is purely scientific. Museums like this are scattered over the country, containing vast numbers of useful specimens buried in drawers and cases, adorned with Latin labels; museums wherein the populace rove about with awe, partly at the monstrous objects displayed to their gaze and partly at the tremendous names which they bear. These museums are only fitted for scientific persons; they are next to useless to others, unless, as has been lately done in the British and Ipswich Museums, superintendents and curators are willing to descend from their high level and escort bodies of the simpler folk through the collections, giving as they go some plain account of the more prominent objects. A third type of museum is scarcely to be found in any national collection. It is usually seen in small country towns, where dusty cases are arranged in ill-lighted rooms, and are made the receptacle of rubbish brought by resident gentlemen from all parts of the world—one giving a collection of minerals for which he has not room; another a few drawers of butterflies of which he has grown tired. South Sea islanders' weapons, elephants' tusks, and other spoils of the chase are scattered about in corners and on walls, and the collection of oddments is dubbed a "museum." Our readers can draw on their own experience for other details on this subject, and we are much mistaken if they do not agree with us that the energy that is expended with but little useful result on our local and national museums is almost or entirely thrown away.

THE little town of Massa Marritima (Tuscany), says the *Journal of the Society of Arts*, sets an example which would be well to be followed by many larger and better known towns, both in Italy and this country. In 1867 the municipality of Massa purchased the interesting collection of minerals, models of mining machinery, and specimens of tools used in mines in various countries from Signor Teodoro Haupt, a well-known mining engineer of Florence, together with a complete series of maps and plans of most of the mines in Tuscany. This forms the nucleus of the museum, which has since been enriched by a collection of the birds and animals found in the province, the donation of a medical man residing in the town, and their value is considerably enhanced by being well arranged and tabled with both common and scientific names. The library now contains about 6,000 volumes, some of which are of great value, as being extremely rare, and relating to the history of the republic of which Massa was once the capital. The archæological department contains a very beautiful Etruscan funeral urn.

THE additions to the Zoological Society's Gardens during the past week include four Bull Frogs (*Rana mugiens*) from Nova Scotia, presented by Dr. B. Sanderson, F.R.S.; two white-handed Gibbons (*Hylobates lar*) from the Malay Peninsula, presented by Sir H. Ord, C.B.; two Griffin Vultures (*Gyps fulvus*) and a Golden Eagle (*Aquila chrysaetos*), European, presented by Mr. A. J. White; two Rough-legged Buzzards (*Archibuteo lagopus*), European, presented by Mr. A. B. Hepburn; a Green Monkey (*Cercopithecus callitrichus*) from India; and a Bonnet Monkey (*Macacus radiatus*) from India, presented by Miss Bradshaw; a Barasingha Deer (*Cervus duvaucelii*) from the Himalayas, received in exchange; and a Hairy Armadillo (*Dasypus villosus*) from La Plata, deposited.

SCIENTIFIC SERIALS

Der Naturforscher, Oct. 1873.—Among the abstracted matter in this number we find an account of recent experiments by M. Exner, to determine the "reaction time" of the sensorium. Some part of the body having been stimulated, the person immediately made a signal by pressing a key with the right hand. Marks were produced on a blackened cylinder, both at stimulation and at signalling, and the interval was noted. The reaction time (which ranged between 0·1295 and 0·3576 sec. in 7 persons) seems independent of age, and is shortest in those who have the habit of concentration. The tables also show it to have been shortest in stimulation of the eye with an induction shock; then follow, in order, electric shock to finger of left hand, sudden sound, electric shock to forehead, shock to right-hand finger, sight of an electric spark; and lastly, shock to toes of left foot. M. Exner analyses the reaction time into 7 "moments."—In chemistry we have some important observations on the non-luminous flame of the Bunsen burner, by M. Blochmann, and on vinegar-ferment and its cause, by MM. Mayer and Knierim, who think the action of mycoderma aceti probably physiological, and that it is a kind of bacterium which shows a mobile and an immobile state; the latter producing rapid acetification. Further, the vinegar-production occurs without the presence of nitrogenous substances, though less slowly than where they are present.—An interesting question in plant-geography is that as to the transport of seeds by ocean-currents, and in other ways independent of human agency. M. Thuret has been experimenting on this in Antibes. Having tried 251 different species, he knows of only two kinds of bare seed which are capable of floating, Maurandia and Phormium. A long immersion in sea-water does not always destroy the vitality of seeds. Out of 24 species immersed more than a year, at least 3 germinated afterwards as vigorously as seeds kept quite dry.—We find astronomical notes on the spectra of the two new comets, III. and IV., of 1873, and on the connection of solar protuberances with auroras (Tacchini); and in meteorology there is a notice of Dr. Koppen's valuable researches on an eleven years' period of temperature.—In physics, the subjects are: short galvanic currents and electrical discharges (Edlund), armatures of magnetic bundles (Jamin), and molecular rotatory power of vinous acid and its salts (Landolt).—A review of Häckel's *Die Kalkschwämme*, by M. v. Martens, is worthy of notice.

SOCIETIES AND ACADEMIES

LONDON

Zoological Society, Dec. 2.—Dr. A. Günther, F.R.S. vice-president, in the chair. A communication was read from Dr. James Hector, containing an account of the complete skeleton of *Cnemiornis calcitrans*, Owen, and showing its affinity to the Natatores.—Prof. Owen, F.R.S., read a paper containing a restoration of the skeleton of *Cnemiornis calcitrans*, Owen, with remarks on its affinities to the Lamellirostral group, and forming the twentieth part of his series of memoirs of extinct birds of the genus *Dinornis* and its allies.—A communication was read from Mr. W. H. Hudson, containing an account of the habits of the Pipit (*Anthus correndera*) of the Argentine Republic.—A communication was read from Mr. A. G. Butler, containing a revision of the species of the genus *Protogonius*.—A communication was read from Dr. J. E. Gray, F.R.S., on the skulls of some seals from Japan, with description of a new species, proposed to be called *Eumetopias elongata*.—Mr. P. L. Sclater read a paper on some birds collected in Peru by Mr. H. Whitely, being the seventh of the series of articles upon this subject.—A communication was read from Mr. Henry Whitely, containing additional notes on humming-birds collected in High Peru.—A communication was read from Mr. R. Swinhoe, containing remarks on the Black Albatross with flesh-coloured bill, of the China Seas.—Mr. Garrod read a paper on the visceral anatomy of the Ground Rat (*Aulacodus swinderianus*).

Linnean Society, Dec. 4.—Mr. G. Bentham, president, in the chair.—Revision of the genera and species of Tulipeæ, by Mr. J. G. Baker. In this tribe of Liliaceæ the author includes the caulescent capsular genera with distinct perianth-segments and leafy stems bulbous at the base, viz., Fritillaria, Tulipa, Lilium, Calochortus, Erythronium, and Lloydia. The characters presented by the different orders were described *seriatim* in the paper. In the structure of the underground stems there are four leading types, viz., (1) a squamose perennial bulb, consisting, when mature, of a large number of thin flat scales tightly pressed against one another, and arranged spirally round a central axis which is not produced either vertically or horizontally, as exemplified in all the Old-world species of Lilium; (2) in most of the species of *Fritillaria* we have a pair only of hemispherical scales, half as thick as broad, pressed against the base of the flower-stem, these scales being the bases of single leaves which die down before the flower-stem is produced; (3) an annual laminated truncated bulb occurs generally in *Tulipa*, *Calochortus*, and *Eu-Lloydia*; (4) in the section *Gageopsis* of *Lloydia* we have a truncated corm. The leaves are very uniform throughout the tribe, with the exception of a section of *Lilium*, *Cardiocrinum*, with long clasping petioles. The perianth leaves are all coloured except in *Calochortus*, when the three outer segments are sepaloid and lengthened into points. The stamens are always six in number and nearly equal in length, hypogynous, and the dehiscence of the anther never properly introrse, but lateral, exactly as in *Colchicum*. In the capsule, *Calochortus* differs from the other genera in its septicidal dehiscence. As regards the connection between Liliaciæ and Colchicaceæ Mr. Baker is disposed to lay less stress than before on the evidence of any sharp line of demarcation between the orders, all the characters usually ascribed to the latter order being found in some of the genera of Liliaceæ. In its Geographical Distribution the tribe is spread throughout the north temperate zone; only one species, *Lloydia serotina*, is really boreal and Alpine; the southern limits are Mexico, the Philippines, South China, the Neilgherries, and the southern borders of the Mediterranean; the principal concentration of species is in California and Japan; nearly all are hardy in this climate. Lilium with 46, and Fritillaria with 55 species, have the distribution of the tribe; the latter stopping eastwards at the Rocky Mountains, while the former reaches the Atlantic sea-board; Tulipa, with 48 species, is restricted to the Old World, reaching from Spain, Britain, and Scandinavia to Japan and the Himalayas; Calochortus, with 21 species, is confined to Mexico and the west side of the Rocky Mountains; of the 5 species of Erythronium, 1 is confined to the Old World and 4 to the New; the 3 species of Gageopsis are Oriental and Siberian; while *Lloydia serotina* is the most widely spread of all the Liliaceæ, and a unique instance of a petaloid Monocotyledon of the North Temperate Zone with almost universal high mountains and Arctic distribution.

Chemical Society, Dec. 4.—Dr. Frankland, F.R.S., vice-president, in the chair.—A paper entitled Mineralogical Notices,

by Prof. Story-Maskelyne and Dr. W. Flight, was read by the former, treating of the composition of caledonite and lanarkite.—Mr. John Williams then exhibited some fine specimens of crystallised phosphorous acid and metallic phosphites, and gave a short account of their reactions.—Prof. Church made a communication to the society on the composition of the mineral autunite.—Prof. Lawrence Smith of the United States, whilst describing a modification of the Bunsen gas burner employed by him for heating the crucible in determinations of the alkalis in silicious minerals, gave a short sketch of the process he had devised for that purpose.—In the course of the evening a gas burner by Mr. Fletcher of Warrington was also exhibited.

Royal Microscopical Society, Dec. 3.—Chas. Brooke, F.R.S., president, in the chair.—The list of donations to the society included a valuable binocular microscope with apparatus complete, from Mr. Charles Woodward, for which the special thanks of the meeting were returned.—A paper in continuance of the one read at the November meeting, was read by the secretary.—On some further researches into the life history of the Monads, by Rev. W. H. Dallinger and Dr. Drysdale, in which the complete process of fission was described in all its stages, and also the conjunction of two or more bodies, the whole course of internal division, of final rupture of the containing envelope and escape of minute free organisms.—Mr. Charles Stewart exhibited a section of *Ficus elastica* showing cystoliths, described the method of preparation and mounting, and stated it to be his belief that they were rather deposits of a gum-like substance, than actual concretions.

Society of Biblical Archæology, Dec. 2.—Dr. Birch, F.S.A., president. The following papers were read:—Future Punishment of the Wicked, a Doctrine of the Assyrian Religion, by H. Fox Talbot, F.R.S.—Notes from Borneo, illustrative of Passages in Genesis, by A. M. Cameron. In this paper the author cited a Dyak tradition, that at an archaic general inundation, the ancestors of the Chinese, Malay, and Dyak had to swim for their lives; and (possibly foisted on this tradition) the Dyak preserved his weapons, and the Chinaman his books. A second tradition stated that an ancestral Dyak made a ladder to go up to heaven; unhappily one night a worm ate into the foot of the ladder and brought all down. Mr. Cameron further stated that one of the two Dyak names for the Supreme Being is Yaouah: the author refers to the similar sounding Jehovah and Yahveh of the Bible.

PHILADELPHIA

Academy of Natural Sciences, June 17.—The president, Dr Ruschenberger, in the chair.—*Laws of Sex in Juglans nigra*.—Mr. Thomas Meehan said he had at various times during the past few years called the attention of the Academy to specimens of numerous plants which illustrated the principle that sex in plants was the result of grades of vitality; or, as it had been suggested, viability; and that this power of life was a mere matter of nutrition; the highest grades of vitality only producing the female sex. He now exhibited specimens of the common black walnut, *Juglans nigra*, which furnished excellent illustrations of what had been said on other occasions. Examining the tree at the flowering season, it would be plainly seen, by even a superficial observer, that there were grades of growing buds. The largest buds made the most vigorous shoots. These seemed to be wholly devoted to the increase of the woody system of the tree. Lower down the strong last year shoots, were buds not quite so large. These made shoots less vigorous than the other class, and bore the female flowers on their apices. Below these were numerous small weak buds, which either did not push into growth at all, or when they did bore simply the male catkins. He was fully satisfied that there is not so great expenditure of vital force on the production of male flowers as there is in female flowers.

PARIS

Academy of Sciences, Nov. 24.—M. de Quatrefages, president, in the chair.—The following papers were read:—On the development of polyps and their corals, by M. H. de Lacaze-Duthiers. The author described some results obtained by him in a cruise on board the *Narval*, off the North African coast of the Mediterranean during the summer.—Remarks on the South American fauna, with anatomical details of some of its most characteristic types, by M. P. Gervais.—Observations on the expansion of water below 4°, in relation to M. Piarron de Mondesir's note, by M. F. Hement. The author suggests that the phenomenon in question is due to a re-arrangement of the molecules of the water just as a box of pins when shaken up will occupy more room than they did when arranged in regular layers.—A long extract from a letter by M. A. Poëy was read relating to his observations of the relation between solar spots and terrestrial hurricanes. The author stated that during the last 125 years there have been 12 maximum periods of hurricanes and 10 of these correspond to sun-spot maxima and 11 periods of hurricane minima, of which 5 correspond to sun-spot minima.—Observations on the analogies which exist between the solar spots and terrestrial cyclones, by M. Marié Davy.—Note on solar and terrestrial cyclones, by M. H. de Parville.—On the discharge of electrified conductors, by M. J. Moutier.—On the variable state of electric currents, by M. P. Blaserna, an answer to M. Cazin.—Application of the phosphates of ammonium and barium to the purification of saccharine products, by M. P. Lagrange.—On the physiological and therapeutic action of hydrochlorate of amylamine, by M. Dujardin-Beaumetz. During the meeting Dr. A. W. Williamson and M. Zinin were elected Correspondents.

December 1.—M. de Quatrefages, president, in the chair.—On solar and terrestrial whirlwinds, by M. Faye. The author argued against Reye's ascending axes in the cases of these cyclones, and urged that both by theory and observation there is a down-rush about the axis.—On the conclusion of the note, General Morin made some remarks on the small eddies observed in rivers as examples of the descending current in the centre of similar vortexes.—On the directions of the vibrations in the rays refracted in uniaxial crystals, by M. Abria.—Analytical and experimental investigations of the interference of elliptical rays, by M. Croullebois.—On the return of carrier pigeons during the siege of Paris, by M. W. de Fonvielle.—On the habits of the *Phylloxera*, by M. Max. Cornu.—On a theorem of celestial mechanics, by M. F. Siacci.—Note on magnetism, by M. A. Trève.—On the difference of physiological action caused by induced currents from coils formed of different metals, by M. Onimus. The author stated that, with a coil made of a badly conducting metal the contraction of the muscles was greater and the effect on the cutaneous nerves smaller than when the coil is made of a good conductor.—On the conjunctive elements of the spinal marrow, by M. L. Ranvier.—On the *Anthracotherium*, discovered at Saint Menoux by M. Bertrand, by M. Gaudry.—On the secretions of the flowers of *Eucalyptus globulus*, by M. Gimbert.

BOOKS RECEIVED

ENGLISH.—The Pearl of the Antilles: Walter Goodman (H. S. King and Co.).—The Internal Parasites of our Domesticated Animals: Dr. Spencer Cobbold (*Field* Office).—A Phrenologist among the Todas: Col. Marshall (Longmans).—The Bible and the Doctrine of Evolution: W. Woods Smyth (H. K. Lewis).—The Threshold of the Unknown Region: Clements R. Markham (Sampson Low).—Easy Introduction to Chemistry: Arthur Rigg (Rivingtons).—Chemistianity: J. C. Sellars (Author).—The Romance of Peasant Life: Francis George Heath (Cassell).—Cholera, how to Avoid and Treat it: Henry Blanc, M.D. (H. S. King & Co.).—Centrifugal Force and Gravitation, Supplement B: John Harris (Trübner & Co.).—Kant's History of Ethics. Translated by T. K. Kingsmill (Longmans).—Physical Geography in its relation to the Prevailing Winds and Currents: J. K. Laughton (J. D. Potter).—A Treatise on Medical Electricity: Dr. Althaus (Longmans).—Weather Folk-Lore: Rev. C. Swainson (Blackwood).—Ganot's Physics. Translated by Atkinson. 6th edition (Longmans).—Waste Products and Undeveloped Substances: P. L. Simmonds (Hardwicke).—Man and Apes: St. George Mivart (Hardwicke).—Body and Mind: Alex. Bain (H. S. King & Co.).—Metamorphoses of Insects: Sir John Lubbock (Macmillan & Co.).

CONTENTS

THURSDAY, DECEMBER 18, 1873

THE TRANSIT OF VENUS EXPEDITIONS

SOME time ago we called attention to the admirable opportunity which would be afforded by the approaching Astronomical Expeditions for the observation of the Transit of Venus to investigate the Natural History of several little-known islands of the Pacific. The addition of one or two members to these expeditions could make but a comparatively trifling addition to the expense, and while the Astronomers were observing, the Naturalists would be busily employed in collecting. We are glad to be informed that at a recent meeting of the Council of the Royal Society it was determined to take action in this matter, and to advise the Government to attach a small staff of Naturalists to the two expeditions destined to observe the transit in the Island of Rodriguez and Kerguelen's Land. There can be little doubt, we presume, that the Government will readily accede to the advice thus offered to them.

Rodriguez, an outlier of the Mascarene group, is in many ways specially worthy of thorough investigation. As a general rule oceanic islands lying at a distance from the great continents are of volcanic origin. The Seychelles and the island of Rodriguez are almost the only known exceptions to this rule. Rodriguez, so far as the slight information we possess on the subject extends, is believed to be composed of granite overlaid by limestone and other recent rocks. It is, therefore, of great importance that an accurate geological examination should be made of this island, more especially as its nearest neighbours Bourbon and Mauritius follow the ordinary rule of being volcanic. A second rich field of biological research in Rodriguez will be found in the fossil remains to be met with in the caves of the limestone rocks. These have already yielded good fruit to the investigations of Mr. Edward Newton. the Colonial Secretary of Mauritius, aided by grants from the British Association. The complete skeleton of *Pezophaps solitaria*, a bird allied to the Dodo of the Mauritius—has been restored from these remains, as is well-known from the excellent memoir upon this extinct bird published by Mr. Newton and his brother, Prof. Newton of Cambridge, in the Philosophical Transactions of the Royal Society. But besides additional bones of the Solitaire, which will be welcome to many Museums, it will be desirable to become acquainted with the other animals which were the Solitaire's fellow-creatures when in existence. Some of these are also obscurely known through the exertions of the Messrs. Newton, but it cannot be doubted that ample materials of this kind are still lying hid in the caves of Rodriguez for the benefit of future explorers.

The recent Zoology and Botany of Rodriguez also merit thorough investigation in order to ascertain whether they show any parallel differences to that of its geological structure as compared with the rest of the Mascarene group of islands.

Kerguelen's Land, the second point selected for biological investigation, is also likely to give ample occupation for a naturalist who will be able to devote several months to its exploration, while the necessary preparations are being made for the observation of the great astronomical event. In 1840 Kerguelen's Land was visited by the Antarctic Expedition under Sir James Ross. The distinguished naturalist who accompanied the expedition ascertained that it contains a scanty land-flora of flowering plants, some of which belong to types elsewhere unknown, and an extraordinary profusion of marine forms of both the animal and vegetable kingdoms. Of the land-plants a good series was obtained, but as regards the marine flora and fauna much must remain to be done—especially as Sir James Ross's visit took place in mid-winter. The *Challenger* will visit Kerguelen's Land early next year in order to ascertain the best station for an Astronomical Observatory, and her excellent staff of naturalists will, without doubt, not neglect the opportunity thus given to them. But looking to the great size of the island, which measures nearly 100 miles by 50, and to what is reported of the excessive richness of the marine forms of life, there will certainly be ample occupation left for the naturalist whom it is proposed to send there along with the Transit expedition.

There is, in fact, no doubt that it would be difficult to find two spots on the earth's surface where investigation is more likely to lead to satisfactory results than in the case of these two little-known islands. Nor is the opportunity now offered of obtaining these results at a very small cost to the nation likely to recur, if now neglected. We trust, therefore, that on the part of the Government there will be no hesitation in acceding to the scheme put before them by the Council of the Royal Society.

ELLIS'S LIFE OF COUNT RUMFORD

Memoir of Sir Benjamin Thompson, Count Rumford, with Notices of his Daughter. By George E. Ellis. (Published in connection with an edition of Rumford's complete Works by the American Academy of Arts and Sciences. Boston.)

THIS biography supplies a want that has been sorely felt by all who have desired to obtain a reliable account of Count Rumford's eventful life. It is, I think, impossible to name any equally eminent man of modern times concerning whom so little was known before the publication of this work. The only preceding sources of information, Prof. Pictet's letters, Prof. Renwick's sketch in "Sparks's Library of American Biography," Cuvier's *Eloge* and the Cyclopædia biographies made up from these and each other, are most vexatiously contradictory on points of primary interest. Aided by Rumford's own correspondence, and other original and direct sources of information, Mr. Ellis's industry has at last rescued us from these perplexities.

The career of scientific notables is usually of a simple and uneventful character, but that of the poor schoolmaster of New Hampshire is sufficiently adventurous and romantic to supply materials for a sensation-novel writer.

He married early; to quote his own words—"I took a wife, or rather she took me, at 19 years of age." He describes his married life as both happy and profitable, but it lasted scarcely three years, during which he became a prominent public man and a full-blown soldier, with

the rank of major at 20 years of age. The part he took in connection with the American rebellion excited popular indignation against him, led to his imprisonment, the confiscation of his property, and his subsequent flight from home shortly after the birth of his daughter. He never saw his wife again, nor did he see his daughter until 20 years afterwards, when she rejoined him in Europe.

At the age of 23, he appears in a new character upon another scene. He is now a diplomatist, presenting his first state paper to Lord George Germaine in London. He steps at once into a responsible position in the Colonial Office, and presently becomes the "Secretary of Georgia." In the meantime he is doing important scientific work, is elected Fellow of the Royal Society in 1779, when 26 years of age, and suddenly appears on board the *Victory* as a volunteer sailor under Sir Charles Hardy, experimenting with ship's guns, and writing treatises on naval signals and naval architecture. In the following year he is promoted to the office of "Under Secretary of State for the Northern Department" (Colonial).

Thirteen months after this he re-appears in military uniform as Lieut.-Colonel Thompson commanding "The King's American Dragoons," and profoundly occupied with experiments upon light artillery, &c. Before 1781 is ended, we find him on the other side of the Atlantic with his dragoons on Long Island, and fighting in the neighbourhood of Charleston at the beginning of 1782. In April we hear of him in New York, and presently find that he has returned to England promoted to the rank of full colonel, and otherwise honoured for his American services.

In the midst of all this activity and excitement he is busily engaged in scientific research chiefly upon subjects connected with gunpowder, bullets, and artillery. With his characteristic exaltation of present pursuits he is now consumed by military ardour, and, dissatisfied with his late inglorious outpost skirmishing in America, obtains appointment for active service in the defence of Jamaica against the French, but is frustrated by the temporary pacific re-action that suddenly prevails. He offers to serve in India, but the Government has become economical. Determined to fight somebody, he selects the Turks, with whom Austria is temptingly disposed to quarrel, and, having obtained the King's permission, proceeds to Vienna, with war-horse, arms, and uniform. Halting on his way he creates considerable sensation by appearing as a visitor on the garrison parade at Strasburg, displaying his handsome figure, brilliant English uniform, and his skilful management of an English blood-horse. Field-Marshal Prince Maximilian de Deux Ponts rides up to the stranger, salutes, and asks a few questions. Thompson, with the polished courtesy and tact of which he is so accomplished a master, turns this introduction to good account, secures the friendship of the Prince, who is so strongly impressed with the varied attainments of the brilliant soldier, that he presses him to pass through Munich on his way to Vienna and visit the reigning Elector of Bavaria, an uncle of the Prince.

The visit is made most successfully, and, with additional introductions, Thompson proceeds to Vienna with a ready-made continental reputation, though only a few weeks old. Here, as he says, "I owe to a beneficent Divinity that I was cured in time of that martial folly." The agent or Divinity of this reformation, was a lady, who, as he says, "formed an attachment to me, gave me wise advices, and imparted a new turn to my ideas, by presenting me in perspective other species of glory than that of conquering battles." It is proper to add, in explanation, that the lady was seventy years of age.

In the meantime the Elector of Bavaria invites Thompson to enter his service. For an English officer to do this, permission from the king was necessary. This was obtained in London, and with it the honour of knighthood, which was conferred in February 1784, with a continuance of half-pay as colonel.

Sir Benjamin Thompson proceeds immediately to Munich, and there enters upon the most remarkable part of his extraordinary career. The task which he set before himself in Bavaria was nothing less than a complete reformation and re-organisation of the army, and a general improvement of the physical and social condition of the whole nation. Invested with full powers by the Elector he sets about his work in a strictly philosophical manner. The first four years—1784 to 1788—are devoted to a cool, impartial, and systematic investigation of the social statistics and general condition of all classes, civil and military, in Bavaria. Having thus inductively collected and generalised his data, he now proceeds deductively to devise his remedies for the evils thus demonstrated. In all his efforts, from the improvement of saucepan-lids and gridirons to the moral reformation of a whole nation of human beings, he is rigidly methodical and strictly scientific, and his success follows as a direct and visible consequence of this scientific mode of proceeding.

His well-known and important researches on the Convection and general Transmission of Heat were undertaken and carried out mainly for the purpose of determining the best and most economical means of clothing the Bavarian soldiers, and the construction, warming and ventilation of their barracks. Another equally important though less known series of researches were instituted for the purpose of learning how to feed in the most economical manner the beggars, rogues, and vagabonds, whose sustenance and reformation he had projected.

His success in reorganising both the men and materials of the army was marvellous. It was in the course of his work in erecting cannon foundries and remodelling the Bavarian artillery that his celebrated demonstration of the immateriality of Heat was suggested.

It may safely be affirmed that the foundation of the present military system and of the recent military successes of Germany was laid by Benjamin Thompson in Bavaria. He tells us that the fundamental principles upon which he proceeded were "to unite the interest of the soldier with the interests of civil society, and to render the military force, even in times of peace, subservient to the public good;" and further, "that to establish a respectable standing military force which should do the least possible harm to the population, morals, manufactures, and agriculture of the country, it was necessary *to make soldiers citizens, and citizens soldiers.*"

Besides the important technical reforms of discipline, arms, barracks, quarters, military instruction, &c., which he carried out, "schools were established in all the regiments, for the instruction of the soldiers in reading,

writing, and arithmetic, and into these schools not only the soldiers and their children, but also the children of the neighbouring citizens and peasants were admitted gratis." Military schools of industry were also established where the soldiers learned useful trades; thus the military clothing was spun, woven, and made up by the soldiers themselves; roads and other public works were made and erected, and the men were permitted to hire themselves out in garrison towns. Besides this the soldiers were used as industrial missionaries for the introduction of improvements in agriculture, manufactures, &c. The potato, until then almost unknown in Bavaria, was thus introduced by the aid of Thompson's military gardens or model farms. One of these gardens still remains, viz. the well-known "English Garden" at Munich.

Still more remarkable was his success in radically curing the overwhelming curse of Bavaria, which was infested with hordes of beggars and vagabonds that had defied every previous effort of suppression or diminution Here again the same strictly philosophical method of proceeding was adopted. Human materials and motives were handled precisely as we manipulate the physical materials and forces of the laboratory, and the results were similarly definite, reliable, and successful. The scientific social reformer not only cleared the country of its rogues, vagabonds, and beggars, but made their industry pay all the expenses of their own feeding, housing, and clothing, besides those of the industrial and general education of themselves and their children. In addition to all this they made clothing for the military police who took them into custody, and earned a handsome net profit in hard cash.

It is not surprising that such success should have earned for him a long list of Bavarian honours and titles which need not be here recounted, and that he should now appear as "Count of the Holy Roman Empire and Order of the White Eagle," or, as better known to us, in the title of his own choice, "The Count of Rumford." Neither need we be surprised that his health should fail, and that in spite of repose and change of scene we next find him lying dangerously ill at Naples.

On his recovery he returns to England, and while busily engaged there in literary and scientific work, is suddenly recalled to Munich, which now has the Austrians at its gates, and is simultaneously threatened by the French. Matters become so serious that the Elector saves himself by flight, only eight days after Rumford's arrival; but before leaving the monarch hands over to the philosopher the command-in-chief of the army, and the practical dictatorship of the capital. During the three months of this supreme command Rumford succeeds in overawing and checkmating both French and Austrians, and saving the city, after which the Elector returns.

This is the climax of the great philosopher's career, and now we find him a second time stricken by dangerous illness. On recovering he returns to London, founds the Royal Institution, publishes his essays, and then leaves England for the last time to reside in Paris, where he marries the "Goddess of Reason," Madame Lavoisier.

Here the curtain falls upon all his greatness, for though but fifty-two years of age, the brilliant career of the Count of Rumford is ended, and the subsequent scenes of his life display a miserable contrast with all that preceded them.

His biographers are evidently puzzled by what follows, and painfully seek apologies for his matrimonial squabbles, his general irritability, his morose seclusion, and the small results of the fussy labours of the last ten years of his life. My own theory is that the illness at Munich —where he describes himself as being "sick in bed, worn out by intense application, and dying, as everybody thought, a martyr to the cause to which I had devoted myself"—was followed by chronic and permanent cerebral disease, and that the gradually developing change of character which he displayed from the date of his return to England in 1798, until his death in 1814, was but a natural symptom of this growing malady.

Present space does not permit me to state in detail the evidence upon which I base this conclusion, but I cannot conclude without protesting against the explanation of Cuvier, who in his *Eloge* states that "It would appear as if, while he had been rendering all these services to his fellow-men, he had no real love or regard for them. It would appear as if the vile passions which he had observed in the miserable objects which he had committed to his care, or those other passions, not less vile, which his success and fame had excited among his rivals, had embittered him towards human nature." Cuvier, if I am right, only knew the diseased wreck of the brilliant, courteous, and even fascinating "soldier, philosopher, and statesman," and I suspect that the unjust oblivion of his merits which so speedily followed his death, was largely due to the bad impression made, not only upon the French Academicians, but also upon his Royal Institution associates, by the moral obliquities and eccentricities due to a diseased brain.

The main interest of the career of this wonderful man appears to me to lie in this, that it affords a magnificent demonstration of the practical value of scientific training, and the methodical application of scientific processes to the business of life. I have long maintained that every father who is able and willing to qualify his son to attain a high degree of success either as a man of business, a soldier, a sailor, a lawyer, a statesman, or in any other responsible department of life, should primarily place him in a laboratory where he will not merely learn the elements of science, but be well trained in carrying out original physical research, such training being the best of all known means of affording that systematic discipline of the intellectual and moral powers upon which all practical success in life depends. The story of Count Rumford's life, and the lesson it teaches, afford most valuable evidence in support of this conclusion, and cannot fail powerfully to enforce it.

This subject is specially important at the present moment, particularly to those Englishmen whose minds are still infested with the shallow foolishness that leads them to believe that scientific men are dreamy theorists, and disqualified for practical business. Let them follow in detail the practical triumphs of this experimental philosopher, and ask themselves candidly whether such success could have been possible had he been trained in the mere word-exalting study of the Greek and Latin classics, instead of the practical school of experimental research.

W. Mattieu Williams

GARRETT'S FISHES OF THE PACIFIC

Andrew Garrett's Fische der Südsee beschrieben und redigirt. Von Albert C. L. G. Günther, Heft i. (Hamburg: L. Friederichsen & Co., 1873.)

THE house of Hr. Cesar Godeffroy & Co. of Hamburg have for several years employed scientific collectors in various parts of the Pacific to prepare and send home specimens of natural history. These have been stored up at Hamburg, in what is now a well-known scientific institution, the "Museum Godeffroy," under the care of an active superintendent, whose services have been engaged to take charge of and arrange the various objects thus accumulated. But not content with thus bringing the rarities of the Pacific within the grasp of European naturalists, Herr Godeffroy has obtained the assistance of some of the best known workers in Science for examination of these materials. The extensive collections of birds made for him by Dr. Edward Gräffe were submitted to the well-known ornithologists Drs. Finsch and Hartlaub of Bremen, and formed the basis of their excellent work on the "Birds of Central Polynesia," published a few years since. For the working out of the Polynesian Fishes, of which we believe, Herr Godeffroy's collection is still more complete, the co-operation of Dr. Günther of our National Museum, the most distinguished of living ichthyologists, has been obtained, and the book now before us contains the first-fruits of Dr. Günther's labours.

The brilliant colours which adorn many of the Polynesian fishes have been well known to travellers in those regions since the days of Cook, and have been frequently described in lively terms. Unfortunately, however, these colours entirely disappear in fishes preserved in spirit after the ordinary fashion, so that their beauty can only be appreciated by visitors to the distant seas which they inhabit. In order to exhibit these colours in the present work, Herr Godeffroy has acquired a large series of drawings, taken from living specimens, by Mr. Andrew Garrett, who has been many years resident in the Sandwich and Society Islands, and in other parts of Polynesia. Under these circumstances we may well anticipate the production of a first-rate work, more especially as the services of the unrivalled lithographic artist, Mr. G. H. Ford, have been secured to put the drawings on the stones.

Dr. Günther commences his work in systematic order with the Serranidæ, of which numerous brightly coloured forms inhabit the various Archipelagoes of the Pacific. Twenty splendid plates illustrate the letterpress, and it is only wonderful how they can be produced at so small a cost. Nine similar parts will complete the work, which bids fair to become one of the most perfect icthyological monographs ever issued.

OUR BOOK SHELF

Manual of Comparative Anatomy and Physiology. By S. M. Bradley, F.R.C.S. Second Edition. (Manchester: Cornish; London: Simpkin, Marshall and Co.)

ENCOURAGED by the success of an earlier and much smaller edition of this work, the author has entirely re-written the new one. In so doing, we think that he could not have made a greater mistake, as the small size of the original precluded the introduction of detail with which he is not acquainted, and so prevented his exposing his ignorance to the world at large. The impression which remains after the perusal of a few pages is, that the author, after reading rapidly through some one of the standard text-books on Zoology, wrote down his impressions as far as his memory served him. Faults of omission are not uncommon in text-books, especially when they are written by those who are not practically acquainted with their subject, but faults of commission are, fortunately, much less common. In the work before us there are several of the former, and they cannot all be laid down to want of space; for in the case of the Myriapoda, respecting the peculiarities of the main divisions of which the position of the legs is not referred to, two-thirds of the page on which they should have been found is left blank before the commencement of the following chapter. The faults of commission are so numerous that they admit of easy classification. There are those of sheer carelessness from inattentive reading, otherwise, how is it that we are told that the Dugong has six cervical vertebræ, and that the *Tragulinæ*, or Musk Deer (!) have all the tarsal bones anchylosed. Others arise from a want of power to realise the meaning of the ordinary descriptions of well-known anatomical facts, as when it is indicated that the ventricles of the Crocodile's heart are not completely separated, and the marsupium, or pouch of the female Kangaroo in the male is everted, and supports the penis. Absolute and inexcusable errors it is difficult to explain, but among such we are told that the Nummulites are Cephalopoda; the Marsipobranchii have more than one nasal sac; that in the Lepidosiren the nasal canals are not open at both ends, and the vertebræ are ossified; and that in the Bear the clavicles are more developed than in other Carnivora, when they are in reality absent altogether. Peculiarities found in one division are omitted with regard to them, and referred to others entirely different, as when it is stated that among the Marsupialia "each oviduct in the female leads into a perfectly distinct uterus, which opens into a separate vagina, which is also the passage of the urine," and that in the male the vasa deferentia "open into a cloaca common to the urinary and generative secretions." These remarks apply to the Monotremata well enough, how is it they are omitted in speaking of them, and stated of their allies, which in these respects are quite differently constructed. We rarely remember to have seen a work so carelessly undertaken, and by so incompetent an author.

Seventeenth Half-Yearly-Report of the Marlborough College Natural History Society for the Half-Year ending Midsummer, 1873. (Marlborough: Perkins.)

ALTHOUGH the tone of the Preface to this Report is not quite so desponding as that of the previous one, still it contains a good deal of complaint. It seems to be the rule, for which we cannot see any reason, that members on entering the fifth form resign their membership. Is it because their schoolwork occupies all their time? or is it considered beneath the dignity of a fifth-form boy to belong to such a society? Probably no satisfactory reason could be assigned for the practice, therefore we hope it may not be continued. Another discouragement to the society has been the difficulty of getting papers except from a very few, who, after a time, "struck work," because they "felt that others ought to help in keeping up the interest of the meetings." We think the few workers would have been more likely to attain this end had they continued to prepare and read papers amid all discouragements; by this means, we think, they would be more likely "encourager les autres." We see no reason why the reading of papers should not be combined with the exhibition of objects and with discussions. Is not the Marlborough College Society too sensitive? From the reports of the field-work done and the collections

made, it seems to possess a few admirable workers, who possess energy, knowledge, and earnestness enough to keep any such society from collapsing. The Botanical list is a model one. The papers in the Report are,—"Heraldry," by Mr. F. E. Hulme, F.L.S.; "On the Perception of the Unseen," by Mr. G. F. Rodwell; "A Walk across the Karst," by the Rev. J. Sowerby; and "The Luschari (Heilige) Berg in Carinthia," by the same gentleman.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Prof. Agassiz

THE sad intelligence received in London this morning of the death of Prof. Agassiz adds another illustrious name to the long roll of victims to the insidious demon, "over-work." May I ask you to give room in your next issue to the following passage from a letter (probably one of the last he penned) received from Prof. Agassiz only last week, which may be interesting to his many sorrowing friends on this side the Atlantic, as attesting indirectly to the cause of his death, viz., excess of mental and physical exertion. P. DE M. GREY EGERTON

Athenæum Club, Dec. 16

"Museum of Comparative Zoology,
"Cambridge, Mass., Nov. 26, 1873

"A feeling of despondency comes over me when I see how long a time has elapsed since I received your last letter, which at the time I meant to answer immediately. With returning health, I have found the most frightful amount of neglected work to bring up to date, with the addition of a new institution to organise. I have given myself up to the task with all the energy of which I am capable, and have made a splendid success of the Anderson School, which cannot fail henceforth to have a powerful influence upon the progress of Science in the United States. But this has driven out everything else, and I should have neglected even the Museum had not a constant appeal to my attention arisen from the close connection in which the Anderson School stands to the Museum, of which it is, as it were, the educational branch. So School and Museum have made gigantic strides side by side; but I am down again. At least I feel unable to exert myself as usual, and such a feeling in the beginning of the working season is disheartening. When I last wrote I had strong hopes of an easy summer with my family, and confidently expected to be able to pass the greater part of the winter in Europe, and to have prepared the volume on Selachians of the 'Poissons Fossiles' for a new edition, or rather an English work on the subject. Now that hope is gone; the immense accessions to our Museum make even the progress of the Coal Fishes from Iowa slow and almost hopeless. With 22 assistants and 14 sub-assistants in the Museum, I have my hands full with administrative duties and responsibilities, and science and friends suffer.

"Ever truly your friend,
"(Signed) L. AGASSIZ"

Experiments on Frogs

WILL you grant me the space in your journal for a few words called forth by Mr. Lewes's letter in your number of December 4, on "Sensation in the Spinal Cord"?

In that letter the writer describes some experiments on frogs of such excessive cruelty that I cannot refrain from entering a protest against the principle which justifies such actions.

The right to perform such actions as vivisection, &c., in the cause of Science, has often before been questioned; but the present case—a case in which the infliction of pain is not an unavoidable *attendant* on the experiments, but the very essence or object of them, and the slowness and prolongation of agony a necessary part—stirs and revolts the whole mind, and brings the question again prominently to the front.

The question then is—are either the possible or probable benefits to a portion of mankind, or the advancement of Science for its own sake, sufficient reasons for the infliction of intense suffering on our fellow-animals? Of course much may be urged in favour of vivisection. It may be said that without its assistance Science, and especially the science of medicine, could never have advanced to the point it has now reached; and mankind urges that the good of mankind is of such paramount importance that that of all other animals must be subordinated to it unconditionally, and consequently that the smallest good to mankind balances the greatest evil to other animals.

To many this would be considered an amply sufficient reason for answering the question in the affirmative, but at least it should be remembered at what tremendous cost to one portion of creation these benefits to another portion are purchased.

As time and Science advance it is becoming more recognised that other animals have their rights as well as men; and perhaps it may some day be found that the right which mankind assumes to himself of supremacy over his fellow-animals (including the right to inflict deliberate torture, for whatever purpose) is, after all, but the right of the strongest or most powerful.

It seems to me so shocking that such things should be written of and read with indifference, and without evoking one word of protest on the other side, that on this ground alone, *i.e.*, that the assumption of the right to inflict torture may not pass quite unchallenged, I venture to beg for the insertion of this letter.

Dec. 8 X.

Proposed Alterations in the Medical Curriculum

IN a recent number of NATURE, remarks are made in regard to the present Medical Curriculum, more especially in connection with the proposal of Prof. Huxley to alter the Curriculum for medical graduation in the University of Aberdeen. His object is to remove the subjects of Botany and Natural History from that Curriculum, and to put them in the category of a preliminary examination, without any compulsory attendance upon lectures. Such a proposal if carried into effect would tend in no small degree to limit the medical student's acquirements in the biological sciences, as he will not be required to take full scientific courses on these subjects. The tendency of such a system will be to encourage what is commonly called "cram," inasmuch as there will be no guarantee for methodical practical instruction under a qualified teacher.

While it may be true that those who take the diplomas of the medical corporations are not called upon to attend courses of lectures on these subjects, and rarely undergo an examination on them, the case is quite different with those students who aspire to university degrees. The latter look not merely for a license to practise, but desire also a university honour. An important distinction at the present day, between the licentiates of colleges and the graduates of universities, is that the latter are expected to have a higher literary and scientific knowledge. In place of reducing the qualifications for degrees, so as to compete with colleges, we ought to keep up the standard, and send forth medical men who are not only well fitted for the practical duties of the profession, but who can also occupy a prominent position in the scientific world. In accomplishing this object we should arrange the curriculum in such a way as to put the study of the sciences in its proper place. The student ought to commence the study of botany and natural history in summer, before entering upon anatomy, surgery, and other purely medical subjects. This is now to a large extent carried out in the University of Edinburgh, and by so doing a three months' course of scientific study is added to the curriculum. The student might be encouraged to take his science examination at an early period of his curriculum, say at the end of his first year of study. The training which these studies give to the mind of the young medical student, is most important. They call forth his powers of observation and diagnosis; they present to him the principles of classification, and they enlarge his views of anatomy and physiology. In primary schools of the present day we frequently find that the elements of botany and zoology constitute a part of the teaching, and most properly so. But this is not enough for the graduate in medicine. He must supplement this by going through the higher University Curriculum.

The commissioners for visiting the Universities of Scotland, remark in their report "that it is desirable that graduates in medicine should have that degree of literary and scientific attainment which will prevent them when mingling as they must do with mankind, in the exercise of their profession, from being looked upon with contempt; or from committing errors in conversation and in writing, for which others would be despised; because even upon the supposition that they have high professional acquisitions, the law of association will operate, and the conclusion will be drawn that much confidence cannot be placed in them." The value of university training was strongly insisted on by the late Prof. Edward Forbes, when speaking of the relation which scientific studies bear to medicine. The following are his remarks:—"It is the training of the mind in correct methods of observation that gives the Natural History Sciences so much value as instruments for preparation in professional education. Not unfrequently do we hear the short-sighted and narrow-minded ask—what is the use of zoology or botany or geology to the physician and surgeon? what have they to do with beasts or plants or stones? Is not their work among men healing the sick? Of what use save as remedies, are the creeping things, or the grass that grows upon the earth, or the minerals in the rock? Vain and stupid questions all—yet they are sometimes put by persons who profess to promote the spread of education. They want something, but the best of them mistake the end for the means. The best want knowledge, but have not learnt that the mind must be trained ere it is prepared to gather and digest knowledge. They want science, but science turns mouldy and unwholesome in our unprepared mind. They forget or do not know that education consists chiefly in training, not in informing.

"We must counteract the natural tendency of purely professional studies—the tendency to limit the range of mental vision. We can do this most beneficially through the collateral sciences, which are sufficiently different to give them a wider sphere of action. It is from this point of view that we should regard the natural history sciences as branches of medical education. For my part," continues Forbes, "after much intercourse with medical men who had studied at many seats of professional education, some collegiate, some exclusively professional, I have no hesitation in saying that, as a rule, the former had the intellectual advantage. There are noble and notable exceptions old and young, but the rule is true in the main. The man who has studied at a seat of learning, university or college, has a wider range of sympathies, a more philosophical tone of mind and a higher estimate of the objects of intellectual ambition, than his fellow-practitioner who, from his youth upwards, has concentrated his thoughts upon the contractedly professional subjects of an hospital school. I will not believe that the practitioner of medicine, any more than the clergyman, or the lawyer, or the soldier or merchant, is wiser, or better able to treat the offices of his calling, because his mind takes no note of subjects beyond the range of his professional pursuit. It is a great pleasure, both to patient and neighbourhood, to find in our doctor an enlightened friend, one who, whilst he does his duty ably and kindly, has a sympathy and an acquaintance with science, literature, and art."

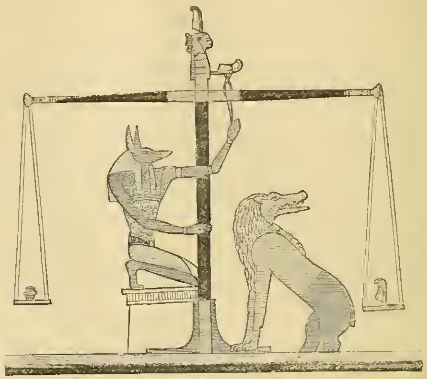
In Scotland a university is not merely a board authorised to examine students and grant degrees, it is an educational institution, intended to exercise a surveillance over the studies of youth, to train their minds for the proper acquisition of knowledge, and to direct their energies in such a way as to insure that mental culture which will fit them for all the duties of life. We speak of our University in Scotland as our *Alma Mater* because she acts the part of a mother to her *alumni*, educating them and superintending their progress in liberal studies.

It appears to me that a great injury would be inflicted on the character of our medical degrees if the required curriculum did not embrace the natural sciences To study these properly something more than books is required. There must be practical training under an able teacher, examination of living objects both with the naked eye and with the microscope, and a certified course of study. I am sure that everyone, in Scotland at all events, who desires to make graduation in medicine a University honour will aid in keeping up a scientific curriculum under qualified teachers.

Edinburgh University JOHN H. BALFOUR

Ancient Egyptian Balances

I HAVE to thank Mr. Rodwell for calling my attention, in NATURE, vol. ix. p. 8, to the curious representation of an equal-armed Egyptian balance in a papyrus, now in the British Museum. This papyrus, which is perhaps the most beautiful in the whole collection, all the colours and lines being as bright and distinct as when originally painted, has been shown to me by Dr. Birch, who also informed me where I could procure a photograph of it, being one of a series of photographs from the collection at the British Museum, taken by S. Thompson, and published by Mansell and Co., 2, Percy Street. By Mr. Mansell's permission the following drawing has been made.



From an ancient Egyptian papyrus in the British Museum, of Hennefer, superintendent of the cattle of Seti I., 19th Dynasty, about 1350 B C., representing the "Ritual of the dead." The heart of the deceased is being weighed in an equal-armed balance, and found lighter than a feather. In the papyrus, the weighing is being made in the Hall of perfect Justice, in presence of Osyris.

It may be seen that what Mr. Rodwell mentions as a sliding weight on one side of the beam, appears rather to be a loop or ribbon for limiting the oscillation of the beam. In the original papyrus the middle and both ends of the beam, as well as the lower part of the column, are coloured to represent polished brass, whilst the other parts of the balance are dark, as if of bronze. It should be observed that the balance beam has box-ends for suspending the pans. Judging from the height of the human figures, the length of the balance beam represented is about six feet, and the height of the column of the balance is nearly the same. Several similar, though rougher, representations of weighing the heart of the deceased may be seen in the papyrus drawing on the staircase leading from the Egyptian sculpture room to the upper Egyptian room in the British Museum. H. W. CHISHOLM

Stalagmitic Deposits

IN a former number of NATURE (vol. viii. p. 462), Mr. A. R. Wallace, in reviewing Sir Charles Lyell's last edition of the "Antiquity of Man," makes use of the rate of deposits of stalagmite as data for ascertaining the age of animal remains which are found buried in caves. It is evident that the variations of rate will render unreliable data for arriving at correct conclusions; still, calculations based thereon may be of service.

Some thirty years ago I procured a piece of lime deposit from a lead mine at Boltsburn, in the county of Durham; it measured about 18 in. in length, 10 in. in breadth, and fully ¾ in. thick; it was compact and crystalline, and showed distinct facets of crystals on its surface, over which the water was running. I had indisputable evidence that the deposit had taken place in fifteen years. The water, from which it was produced, issued from an adit driven in the Little limestone, which is about 9 ft. thick. After leaving the adit, the water ran down the perpendicular side of a rise, for some fathoms, on to some rock *débris*, which was lying on the bottom of a hopper, whence it proceeded from the upper part of the hopper mouth, then perpendicularly down over two narrowish wood deals, which were set on edge, and put across the mouth of the hopper to retain the worked materials. It was from off these deals that I obtained the specimen above described. On its back side the forms of the deals

were well defined; on the front one the crystals were best developed where the stream was most active.

In accordance with the above rate of increase of deposit, namely, $\frac{3}{8}$ in. in fifteen years, 5 in. would require 100 years, 4 ft. 2 in. 1,000, and 41 ft. 8 in. 10,000 years. The data given to arrive at these results may be relied on as being accurate. In the case now related, the rate of increase of deposit was likely to continue tolerably uniform; as the surface water could have no appreciable influence in augmenting or lessening the flow from the adit.

Boltsburn, Nov. 26 JOHN CURRY

Shooting-stars in the Red Sea

ON my way to India, in November 1872, I witnessed in the Red Sea the splendid phenomenon of a star-drift, a note about which may be of interest, in comparison with the observations at the same time in Europe.

November 24, at 8 P.M., about 600 miles to the south of Suez, I first saw a series of shooting-stars falling from about 70° W.N.W., but not in such a quantity that my attention was much attracted; I only made a note about it in my diary.

In the night of the 25th–26th I noticed nothing particular, but in that of the 26th–27th again many shooting-stars were to be seen.

But in the night of the 27th–28th, about 100 miles to the west of Aden, the phenomenon reached its height. Through the whole night many thousands of shooting-stars were falling from every quarter of the heavens, and in all directions. It was impossible for me to count the average number falling in one minute, although I tried several times to do so, because the eye could not be everywhere, and the shooting-stars did not come from one point only. I sat the whole night on deck, to witness this sublime phenomenon of nature, which certainly was far more splendid here in the tropics than in Europe, on account of the generally greater brightness of the stars in these latitudes.

A. B. MEYER

Cuckoos

IN vol. v. p. 383 of NATURE, you were so good as to publish a note of mine, in which I tried to describe exactly all that took place when I saw a young cuckoo throw a young pipit out of the nest.

I am much flattered to find that Mr. Gould has thought my note fit to be transferred to the introduction of his magnificent "Birds of Great Britain," and a rough sketch of mine worthy to be made the foundation of one of his large coloured plates. As, however, I have always tried in my drawings of facts in natural history to express neither more nor less than what I saw, I think it right to say that I am not the authority for many of the details in the large plate.

None of us saw the parent pipit looking on while the young cuckoo behaved so naughtily; we saw only two young pipits besides the young cuckoo, and no egg-shells. The young cuckoo was absolutely naked and blind, the young pipits partly fledged and bright eyed.

One curious point I tried to call attention to in my former note in these words:—"The nest . . . . was below a heather-bush on the declivity of a low abrupt bank . . . . The most singular thing of all was the direct purpose with which the *blind* little monster made for the *open* side of the nest, the only part where it could throw its burthen down the bank." This peculiarity my rough sketch could not, and Mr. Gould's plate does not, express.

J. H. B.

*ASTRONOMICAL ALMANACS**

VII.—*Continuation of the History of the "Nautical Almanac."*

UNTIL towards the end of the life of Maskelyne, its founder, the *Nautical Almanac* had the approbation of the English, and knew how to deserve the praise of foreigners; it was, according to Lalande, the most perfect ephemeris that had ever existed.* But, in 1808, death deprived Maskelyne, who was then about 76 years of age, of his pupil and industrious *collaborateur*, R. Hitchins, upon whom he had depended for ten years for the most important part of his work, the verification of the calculations, and who was during that time the real editor of the *Nautical Almanac*. The advanced age of Maskelyne no longer permitting him to undertake any active occupation, the work passed into irresponsible hands, the calculations fell into great confusion, and "while astronomy advanced, the *Nautical Almanac* remained stationary, and even retrograded."† Maskelyne died shortly afterwards, in 1811, and Brown of Tiedeswill (Derbyshire), was appointed to succeed him. The new director did not improve the *Nautical Almanac*, and English mariners and astronomers complained loudly; a reform was necessary. The Board of Longitude being incompetent to improve the work of which it had charge, Government abolished that body in 1818, by advice of the Admiralty, to which the publication of the work was entrusted, and which replaced the former body (which numbered sixteen members) by another much less numerous.

This new Board of Longitude was ingeniously formed; it was composed of a Resident Committee "of three persons well versed in mathematics, astronomy, and navigation, nominated by Government," to which was added, a Commission of the Royal Society, consisting of the president and three members, charged to support it, and, if need be, to control it. The members of the resident committee had to live in London, or its neighbourhood, and to lend their aid to the Commissioners of the Royal Society for the scientific questions within the domain of the Commission. They received a salary of 100*l.*, and the secretary of the committee, who was charged with the publication of the *Nautical Almanac*, a salary of 500*l.* Captain Kater, Dr. Wollaston, and Dr. Young were appointed resident members, and the latter, the secretary of the committee, had the editorship of the *Nautical Almanac*.

Young did much to improve the work, to restore to it the reputation for accuracy which Maskelyne had given it, and to render it capable of satisfying the constantly increasing wants of navigation. Thus, he introduced into the *Almanac*, in 1822, the apparent position, for every ten days, of twenty-four fundamental stars, which number was increased to sixty in 1827; mariners had thus constantly at their command the exact position of their reference points. Moreover, it is to him that we owe the publication of the elements by means of which we can predict occultations of stars by the moon, phenomena so useful to astronomers on an expedition, and to sailors whose ships are in a foreign harbour.

But these improvements were by no means the only ones which English astronomers and mariners demanded; as it was, the *Nautical Almanac* satisfied neither the one nor the other of these; sailors stood in need of the ephemerides and planetary distances of Schumacher, and astronomers of the supplement to these ephemerides.‡ Moreover, it often happened that these ephemerides appeared too late to be of any service to mariners who were setting out on a long voyage. Thus Young was exposed to criticism, very just, no doubt, but sometimes extremely violent. The result was an excessively sharp controversy, which, although sustained by most of the English

* Continued from p. 70.

* "Correspondance astronomique francaise," of Baron de Zach, vol. iv. pp. 87, *et seq.*

† Sir James South's Address to the Royal Astronomical Society, February 12, 1830.

‡ The first of these ephemerides was due to the Baron de Zach, and Rear-Admiral Hövernörn caused them to be adopted by the Danish Governor in 1800. The Director of Copenhagen Observatory, Thomas Bugge, was then entrusted with their editorship; they were continued by Schumacher, and a little later were published, partly at the expense of the British Government. They gave the position of the planets Venus, Mars, Jupiter, and Saturn for every day in the year, and their distances from the moon every three hours.

astronomers, was concentrated in two eminent men, especially remarkable for their intense love of astronomy. The one was Sir James South, a rich landowner, who carried his love of astronomy so far as to devote the greater part of his income to the construction and maintenance of his observatory of South Villa. The other was Francis Baily, who, by dint of his persevering efforts, got the Board of Longitude to publish, in 1825, the original observations of T. Mayer, and who was, at a later period, the promoter of the measures taken for the publication of the numerous observations of Lalande. Behind these was the Royal Astronomical Society.

The end to be attained was as clear as it was legitimate; it was sought to make the astronomical part of the *Nautical Almanac* more complete and make it answer all wants. Young and the other members of the Board of Longitude opposed to these attacks a resistance unhappily too energetic. But public opinion was formed, and the first satisfaction it obtained was the suppression of the Board of Longitude in 1828. Young was then in very bad health; indeed, it was seen that he could not live long, and it was not thought right to sadden his last days by taking from him the direction of the *Nautical Almanac*.

In the meanwhile, an event of the greatest importance took place on the Continent, which rendered reforms more urgent than ever. We speak of the radical change which the illustrious Encke had introduced into the "Jahrbuch" of Berlin, a change which embodied the greater part of the desiderata named long before by Baily and Sir James South, and for which was awarded to its author the gold medal of the Astronomical Society. To comprehend this completely, it is necessary to go a little further back, and learn the history of the "Jahrbuch" from the point where we left it.

VIII.—*Continuation of the History of the "Jahrbuch"*

After the death of Lambert, Bode was entrusted with the care of the *Jahrbuch* under the direction of the Berlin Academy. But soon the difficulties which resulted from the publication of this special work, under the orders of a numerous assembly, "in which everybody had the right of criticism, but in which no one had the effective responsibility," difficulties which, during the life of Lambert, had not had time to manifest themselves, became such that in 1783 the Academy of Sciences of Berlin decided of its own accord to give up the direction of the *Jahrbuch*, and to leave to that member who had the actual editorship the complete responsibility as well as the honour of that publication. It was, besides, by the advice of the celebrated Lagrange that Bode was consulted. The latter then became editor of the *Jahrbuch*, which was now published only "with the approval of the Academy."

This astronomer, however, followed religiously the plan traced by Lambert, not attempting any essential modification in the form of the *Jahrbuch*. But in attempting to render perfect the ephemerides, he sought chiefly to collect in the second part the most remarkable astronomical results of Germany and foreign countries. For this purpose he entered into correspondence with nearly all the astronomers of Europe, and the *Jahrbuch* of Berlin soon attained, in this respect, such a renown that, "from this time," says Lalande in his "Bibliographie Astronomique," "all astronomers are obliged to know German, for this work cannot be dispensed with." In the ephemerides the only modification of any importance on the plan of Lambert which Bode allowed himself during the whole of his editorship, was the addition of a table giving the corrections which it was necessary to make on the times of the rising and setting of the heavenly bodies at Berlin to obtain the times of the same phenomena in other latitudes.

During this time, however, astronomy had progressed. The beautiful memoirs of Bessel on the determination of the apparent positions of the stars, the improvement made on instruments, the convenience of the methods by which Bessel had learnt to correct and revise the results of these, had increased the wants of astronomers. On the other hand, the theory of the planetary movement had made immense advances, and the planetary system itself had been enriched by four telescopic planets—Ceres (Piazzi, Jan. 1, 1801), Pallas (Olbers, March 28, 1802), Juno (Harding, Sept. 1, 1804), and Vesta (Olbers, March 29, 1807). All presented the same peculiarity, that of revolving between Mars and Jupiter. It became necessary then to publish the ephemerides of these new planets, in order that astronomers might be able to observe them.

But Bode, who held for nearly half a century the astronomical sceptre of Europe, had then reached an advanced age, when the mind does not take easily to reforms.*

Bode died at Berlin, Nov. 23, 1826. J. F. Encke, then astronomer of the Observatory of Seeberg, near Gotha, Saxony, was called to the direction of the Observatory of Berlin and of the *Jahrbuch*.†

From the first volume which he published (*Jahrbuch* for 1830, May 1828), he realised all the reforms that German astronomers demanded. What then were those reforms universally called for?

IX.—*Programme of Reforms*

If we wish to understand them, it is enough to recall to mind that for a maritime people, ephemerides such as the *Nautical Almanac* and the *Connaissance des Temps* have a double purpose: to be serviceable to mariners and travellers, and also to astronomers, that is to say, to observatories.

At the very outset, it was evidently very useful to all that all the data of the work should be connected with the same kind of time, instead of giving for some the mean time, and for others the true time. And as astronomical tables are necessarily arranged on mean time, as on the other hand it is the most convenient for all the uses of navigation, it was good to take this mean time as the only time of the tables. It was, however, necessary to make an exception for the co-ordinates of the sun at the moment of his passage on the meridian, which, very evidently, ought to be calculated for the apparent noon or the true noon. Besides, from the purely astronomical point of view, it was evidently convenient to calculate the places of the sun, of the moon, and of the planets, with all possible precision, so that the comparison of the observations with the tables might serve to amend the latter. It was necessary then to calculate to the 100th of a second the co-ordinates expressed in time, and to the 10th those expressed in arc. On the other hand, it was necessary to give, for every day in the year, at mean noon, the geocentric (AR, and D), and heliocentric co-ordinates of all the principal planets, and to publish in advance ephemerides of the telescopic planets near their opposition, an epoch favourable for their observation.

Again, the observation of the eclipses of the satellites of Jupiter being one of the best means of determining the longitude of a station, it was evidently of importance that

* Johann Elhert Bode was born at Hamburg on Jan. 19, 1747. He studied under the guidance of his father, who kept a boarding-school, and at first intended him for a teacher. Mathematics, and particularly astronomy, were at an early age his favourite studies. He made his first astronomical observations in a granary, by means of a telescope which he had himself made; at 18 years he knew how to calculate, with considerable precision, eclipses and the course of the planets. Some time after, Dr. Bush, with whom chance made him acquainted, lent him his books and instruments: the vocation for which he was originally destined was from that time abandoned. In 1768 he published his treatise on Astronomy, "Die Anleitung zur Kenntniss des gestirnten Himmels," which had an immense success; shortly after he was made *pensionnaire* of the Berlin Academy. His most important astronomical work is his "Uranography," containing in 20 charts a list of 17,240 stars, double stars, nebulæ, &c.; *i.e.* 12,000 more than in the ancient charts.

† Encke was born at Hamburg, Sept. 23, 1791. Son of a protestant pastor, he studied under the celebrated Gauss at Göttingen; in 1814 he was appointed by B. de Lindenau, Minister of State of Saxony, director of the Observatory of Seeberg.

the tables of these satellites should be brought to a high degree of perfection; and as, according to the opinion of the most distinguished mathematicians, the observation of all the phenomena which are presented by one of these satellites in superior or inferior conjunction is the best means of determining certain elements of the theory of the satellites of Jupiter, it was useful to give in the collection of ephemerides not only the epochs of the eclipses, but also those of the contact of the shadow of the satellite with the planet. Tables for the observation of the satellites at the time of their maximum elongation would also be very desirable.

From the mariners' point of view, for whom the moon is the principal heavenly body, the positions of the moon calculated for noon and midnight of every day would be insufficient on account of the considerable proper movement of our satellite. To obtain the longitude of a place by means of the observation of the passage across the meridian of one of the limbs, there would be required an excessively laborious calculation; the use of that method, however convenient, was then illusory. It was necessary to give the right ascension and the declination for every hour of the day, for the purpose of avoiding the employment of second differences except in cases where very great precision was sought for.

Then, when accurate tables of the movements of the planets were obtained, it was useful to add to the distances of the moon from the sun and from the stars, the distances of that body from the principal planets, the observation of which is more convenient and more certain than that of its distances from the stars.

But it was necessary to consider not only astronomers in observatories and sailors on board their ships, it was useful to enable astronomers on an expedition, and sailors when in a foreign harbour, and also geographers, to obtain the geographical co-ordinates of their station with ease and accuracy. From this point of view the method known as that of the Lunar Culminations holds the first rank, a method to which a beautiful work by Nicolaï * gave a capital importance. The learned director of the Observatory of Mannheim showed with what facility the observations of the passage of the moon combined with those of a certain number of stars, called "stars of the moon," bordering on its parallel, and passing the meridian a little before or a little after (half-an-hour at the most), could give, sufficiently approximately, the difference of the longitudes of two places, even with a meridian instrument which was not perfect. On the other hand, Bessel and Hansen had given simple methods for calculating the horary movement of the moon. To apply this method of lunar culminations, it was then necessary to choose "stars of the moon," and to publish their positions every year, day by day, at the same time as those of the moon at the moment of its passing the meridian. This addition had, moreover, this advantage, that by indicating by an asterisk the stars comprehended between 4° and 14° of declination, the observers of the two hemispheres would have the elements most useful for improving continuously (*d'une façon continue*) the value of the lunar parallax. The phenomenon of the occultation of the stars of the moon offers, besides, an excellent means of determining longitudes. It was then important thus to calculate in advance and to publish all the elements likely to serve for predicting all the occultations in a given place, for the purpose of rendering the employment of this method easy to the navigator.

Finally it was indispensable, as well for the astronomical operations of observatories as for those connected with an astronomical or a geodetic expedition, that the collection of ephemerides should contain, for epochs sufficiently close to permit calculation for intermediate dates by simple proportion, the apparent positions of a very large number of stars of the greatest magnitude, and distributed both in the north and south hemispheres. It was useful, moreover, to join to this catalogue the values for very close epochs of the constants of Bessel, which enable one to pass from the mean position of a star at the commencement of the year to its apparent position on any day whatever.

For the principal circumpolars, α and δ Ursæ Minoris, the importance of which is so great in determining the various constants of a meridian instrument, and whose apparent positions vary much more rapidly than those of stars at a distance from the pole,—the apparent positions ought to be given every day.

Such is, with the exception of a few unimportant details, the list of reforms which the general opinion of astronomers demanded in England and Germany.

(*To be continued.*)

* "Uber die Methode, längen durch Rectascensions-Differenzen gewählten Vergleichsterne vom Monde zu bestimmen" (*Astronomische Nachrichten* for 1823 and 1824.)

ON THE SECONDARY WAVES IN THE SPHYGMOGRAPH TRACE

IN a letter printed in this journal a short time ago (vol. viii. p. 464), Dr. Galabin refers to a paper which has been since published in the *Journal of Anatomy and Physiology* (No. XII. p. 1), for a fuller account of his views as to the theory of the pulse, of which we gave a short notice and criticism in a former number (vol. viii. p. 330). This second and more detailed description calls for further remark, especially as the author has found reason somewhat to modify his opinion on one important point.

As is well known, the sphygmograph trace of a pulse beat (see Fig. 1) consists of a primary rapid rise, followed by a more gradual fall, broken by a considerable undulation, termed the dicrotic wave, which varies in its distance from the next primary rise according to the rapidity of the pulse. Between the primary and the dicrotic rises in the trace, the descending curve is sometimes interrupted by another small undulation termed the "tidal" wave, by Mr. Mahomed, though the name *predicrotic* is better, as it does not involve any theoretical conceptions. It is the development in the trace of these predicrotic and dicrotic waves that Dr. Galabin discusses and his explanation of the former is the following.—The separation of the primary and tidal (predicrotic) waves is due to an oscillation in the Sphygmograph, caused by the inertia of the instrument. . . . In some cases the lever may be separated slightly from the knife-edge on which it rests, but generally the oscillation takes place in the instrument as a whole, and it may be followed by others in a descending series. With reference to this interpretation, it may be first remarked that it seems almost impossible that the whole sphygmograph should acquire a momentum in each pulsation, for it should be so adjusted on the arm that no part except the tip of the spring is in any way in contact with the artery, and when such is the case it is difficult to conceive of any shock being communicated to the whole. Again, any sudden upward impulse given to the instrument itself would be attended with a descent in the trace, for as the lever is only attached at one end, and there only on points, its pen would be slow to participate in the general movement of the framework, and would not rise so rapidly as the recording paper. The momentum acquired by the lever is a different thing. Marey and Sanderson have both shown that the primary rise in the trace may be attended with a sudden sharp-pointed wave, in the production of which the lever leaves the knife-edge on which it rests, returning to it after a very short excursion. *To prevent the excessive development of this imperfection* Marey has employed a small secondary spring to depress the lever; this spring Dr.

Galabin persists in not employing, because he thinks—though the evidence he brings forward on the subject is extremely small—that it increases the number of minor vibratory undulations. Nothing of the kind, however, is the case. Nearly all properly-taken tracings from the pulse in health present, if there is a secondary spring employed, no percussion wave at all; and when it is present the true predicrotic wave is quite independent, as may be seen in Fig. 2, which is from a powerful, healthy pulse of 44 a minute, in which the rise *a* is the percussion, *b* the primary, *c* the predicrotic, and *d* the dicrotic wave. This true predicrotic wave varies in development with

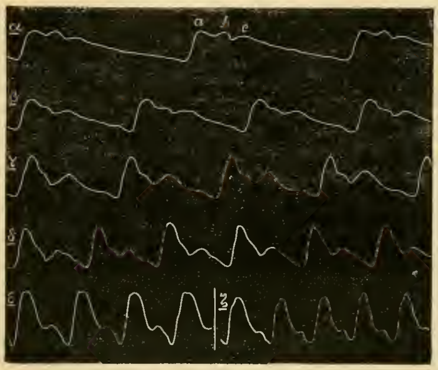


Fig. 1.—Sphygmograph tracings of healthy pulses, drawn to one scale, with rates between 44 and 170 a minute. They read from left to right.

different pulse rates, being much more conspicuous in very slow pulses, and entirely absent in very quick ones, in which last a slight percussion wave is frequently found (see Fig. 1). Dr. Sanderson has previously described these two waves as co-existing, and he is undoubtedly right, as any who have had any considerable experience in Sphygmography in health will agree. It is Dr. Galabin who is in error, and it is but little compliment to other workers in the same field even to suppose that they have been sufficiently simple-minded to study and describe as physiological phenomena, instrumental errors so uncomplicated in origin and so readily comprehended. The

Fig. 2.—A tracing of a healthy pulse beating 44 a minute.

chief argument he brings forward in favour of his explanation is that by placing a weight on the lever at different parts, and so altering its moment of inertia, the length of the predicrotic wave is varied. That the percussion wave which is developed when no secondary spring is employed is so affected, no one will doubt, because the resistance of the pen is less significant when the lever is heavy than when it is light, and therefore the wave is of shorter duration when it is weighted. This wave, however, is even then of such considerable length that it has not ceased before the true predicrotic wave has commenced, and it therefore disguises the true nature of the trace. It is, therefore, only when the secondary spring is employed that a proper trace can be obtained; because then only is it possible to see the full extent of the true predicrotic wave, uncomplicated by the superposition of the extraneous percussion wave. The latter does not appear as an extra element of the curve, but entirely disguises its true nature, on account of its being developed quite independently, when the lever is no longer in connection with the rest of the instrument, and therefore unaffected by whatever change may be occurring in the artery.

The cause of this predicrotic wave, which Marey gives of the similar one that appears in the hæmadromometer trace (Fig. 3, β) though considered by Dr. Galabin scarcely worthy of refutation, is supported by a large number of facts, especially by the hæmadromometer trace itself (Fig. 3, α, β). Its commencing in the radial artery as well as the carotid, at the moment of closure of the aortic valve, is also strongly in favour of the supposition that it is of shock origin; and that a shock may be transmitted through a column of fluid, which Dr. Galabin and some others seem to doubt, can be easily proved by suddenly closing an ordinary tap through which a large volume of water is passing, whereupon several oscillations of the retained liquid occur, producing a series of blows against the tap and perhaps the side of the tube, which are heard without difficulty.

The hæmadromometer trace (Fig. 3) shows also how completely the dicrotic wave is the result of the closure of the aortic valve, as Dr. Galabin also thought

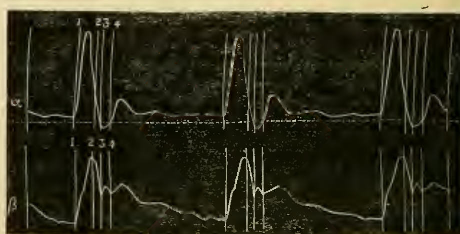


Fig. 3.—Hæmadromograph trace rom the carotid. α, Curve of direction and force of blood current, all above the dotted line indicating an onward and all below a heartward stream. β, Simultaneous sphygmograph trace.

in his earlier paper; but in his second he attributes it to the oscillatory result of the inertia of the arterial walls, and the lateral momentum acquired by the blood. The mass of the arterial walls, and the lateral movement of the blood during distension are so slight, that neither are in any way competent to explain a movement so constant and so considerable as the dicrotic wave, especially when one so much more reasonable is to be obtained as the result of the valve closure. At all events no theory can be considered at all satisfactory which does not explain, in one way or another, the hæmadromometer trace, which is one of the foundations of arterial dynamics, and has been verified in all its details by Dr. Lortet of Lyons. Neither Dr. Galabin's theory, nor that of Mr. Mahomed, can be said in any way to take cognizance of the facts which it discloses, and they are incapable of doing so, therefore they must be considered inaccurate. Both these authors complicate their results by arguing from the analogy of a schema or model of the circulation constructed with elastic tubes; the arteries, however, are not simple elastic tubes, but tubes cut in elastic solids, being surrounded on all sides by yielding tissues, and they are not therefore comparable with tubes experimented on in air, and will not allow of comparative deductions being drawn from them.*

A. H. G.

* The blocks for Figs. I and III. are kindly lent by Prof. Humphry.

POLARISATION OF LIGHT

I.

LIGHT is said to be polarised when it presents certain peculiarities, hereafter to be described, which it is not generally found to possess. These peculiarities, although very varied in their manifestations, have one feature in common, viz. that they cannot be detected by the unassisted eye; consequently, special instrumental means are required for their investigation.

FIG 1.

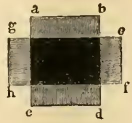


FIG. 2

The origin and meaning of the term polarisation will be better understood when some of the phenomena have been witnessed or described, than beforehand, and I therefore postpone, for the present, an explanation of it.

The subject of polarisation may be approached by either of two roads, the experimental or the theoretical. The theoretical method, which proceeds upon the principles of the Wave Theory of Light, is remarkably complete and explicit; so much so that it not only connects

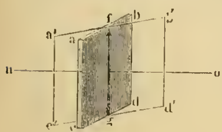


FIG. 3.

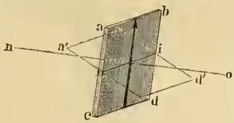


FIG. 4.

together many very diversified phenomena, but even, in some cases, has suggested actual prediction. But inasmuch as the theory without experimental facts would be little better than a study of harmony without practical music, it will be best to begin with experiment.

It was stated above that certain instrumental means were requisite for detecting polarisation. Now there are various processes, some occurring in the ordinary course of natural phenomena, others due to instrumental appli-

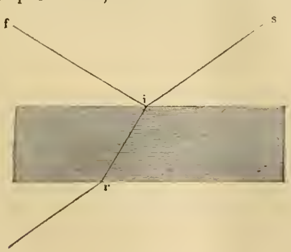


FIG. 5.

ances, whereby a ray of light may be brought into the condition in question, "or polarised." And it is a fact both curious in itself and important in its applications, that any one of these processes (not necessarily the same as that used for polarising) may be used also as a means of examining whether the ray be in that condition or not. This latter process is called "analysation." When two instruments, whether of the same or of different kinds are used, they are called respectively the "polariser" and the "analyser;" and the two together are included under the general name of "polariscope."

The four principal processes by means of which a ray of light may be polarised are, reflexion, ordinary refraction, double refraction, and scattering by small particles. These methods will be considered in order; but before doing so, it will be convenient to describe the phenomena of polarisation as exhibited by some instrument tolerably simple in its action and of easy manipulation. For such a purpose a plate of crystal called tourmalin will perhaps serve better than any other to begin with.

Tourmalin is a crystal of which there are several varie-

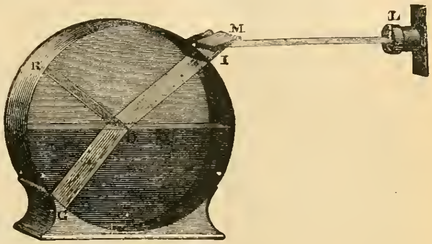


FIG. 6

ties, differing only in colour. Very dark specimens generally answer the purpose well, excepting that it is difficult to cut them thin enough to transmit much light. Red, brown, or green specimens are usually employed; the blue are for the most part optically unsuitable. Some white, or nearly white, specimens are very good, and may be cut into thicker plates without loss of light.

If we take a plate of tourmalin cut parallel to a particular direction within the crystal called the optic axis (the nature and properties of which will be more particularly explained hereafter), and interpose it in the path of a beam of light at right angles to the direction of the beam, the

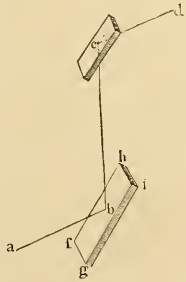


FIG. 7.

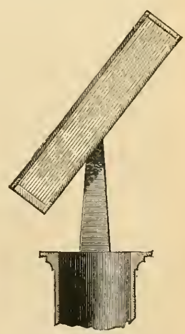


FIG. 8.

only effect perceptible to the unassisted eye will be a slight colouring of the light after transmission, in consequence of the natural tint of the particular piece of crystal. But if we examine the transmitted beam by a second similar plate of tourmalin placed parallel to the former, the following effects will be observed. When the two plates are similarly placed, *i.e.* as if they formed one and the same block of crystal, or as it is technically expressed, with their optic axes parallel, we shall perceive only, as before, the colouring of the light due to the tints of the two plates. But if either of the plates be then turned round in its own plane, so as always to

remain perpendicular to the beam, the light will be observed to fade gradually, until, when the moving plate has been turned through a right angle, the light becomes completely extinguished. If the turning be continued beyond the right angle, the light will begin to revive, and when a second right angle has been completed, the light will be as bright as at the outset. In Figs. 1 and 2 a, b, c, d, e, f, g, h represent the two plates ; in Fig. 1 the two plates are supposed to be in the first position ; in Fig. 2 the plate e, f, g, h has been turned through a right angle. Of the parts which overlap, the shading in Fig. 1 represents the deepened colour due to the double thickness of the crystal ; in Fig. 2 it indicates the complete extinction of the light. The same alternation of brightness and extinction will continue for every right angle through which the moving plate is turned. Now it is to be observed that this alternation depends only upon the angle through which one of the crystals has been turned, or, as it is usually stated, upon the relative angular position of the two crystals. Either of them may be turned, and in either direction, and the same sequence of effect will always be produced. But if the pair of plates be turned round bodily together no change in the brightness of the light will be made. It follows, therefore, that a ray of ordinary light possesses the same properties all round, or as it may be described, in more technical language, a ray of ordinary light, is symmetrical in respect of its properties about its own direction. On the other hand a ray of light, after traversing a plate of tourmalin has properties similar, it is true, on sides diametrically opposite to one another, but dissimilar on intermediate sides or directions; the properties in question vary in fact from one angular direction to another, and pass through their phases or an entire period in every angle of 18 degrees. This directional character of the properties of the ray, on account of its analogy (rather loose, perhaps) to the directional character of a magnet or an electric current, suggested the idea of polarity, and hence the condition in which the ray was found to be was called polarisation.

Having so far anticipated the regular order of things on the experimental side of the subject, it will perhaps be worth while to make a similar anticipation on the side of theory. It is considered as established that light is due to the vibrations of an elastic medium, which, in the absence of any better name, is called ether. The ether is understood to pervade all space and all matter, although its motions are affected in different ways by the molecules of the various media which it permeates. The vibrations producing the sensation of light take place in planes perpendicular to the direction of the ray. The paths or orbits of the various vibrating ethereal molecules may be of any form consistent with the mechanical constitution of the ether ; but, on the suppositions usually made, and none simpler have been suggested, the only forms possible are the straight line, the circle, and the ellipse. But in ordinary light the orbits at different points of the ray are not all similarly situated ; and although there is reason to believe that in general the orbits of a considerable number of consecutive molecules may be similarly situated, yet in a finite portion of the ray there are a sufficient number of variations of situation to prevent any preponderance of average direction.

This being assumed, the process of polarisation is understood to be the bringing of all the orbits throughout the entire ray into similar positions. And in the case of the tourmalin plate the orbits are all reduced to straight lines, which consequently lie in one and the same plane. For this reason the polarisation produced by tourmalin, as well as by most other crystals, is called rectilinear, or more commonly, plane polarisation. This property of tourmalin may also be expressed by saying that it permits only rectilinear vibrations parallel to a particular direction determined by its own internal structure to traverse it.

Adopting this view of polarisation as affected by a plate of tourmalin, it would be interesting to ascertain the exact direction of the vibrations. And a simple experiment will go far to satisfy us on that point. The argument, as now stated at least, is perhaps based upon general considerations rather than upon strict mechanical proof; but the experimental evidence is so strong that it should not be denied a place here. Suppose for a moment that the tourmalin be so placed that the direction of vibration lies either in or perpendicular to the plane of incidence (that is, the plane containing the incident ray, and a perpendicular to the surface on which it falls at the point of incidence) ; then it is natural to expect that vibrations executed in the plane of incidence will be far more affected by a change in the angle of incidence than those perpendicular to that plane. In fact the angle between the direction of the vibrations and the surface upon which they impinge, will in the first case vary with the angle of incidence ; but in the second case it will remain unchanged.

In Figs. 3 and 4, n, o represents the ray of light ; the arrow the direction of vibration, a, b, c, d, a′, b′, c′, d′, the plate in two positions, turned in the first instance about the direction of vibration, in the second about a line perpendicular to it.

Dismissing, then, the former supposition, and supposing that nothing whatever is known about the direction of vibration ; then, if all possible directions be taken in succession as pivots about which to tilt or turn the second tourmalin, it will be found that for one direction the intensity of the light diminishes more rapidly with an increase of tilting (or, what is the same thing, with an increase of the angle of incidence) than for any other. And further, that for a direction at right angles to the first, the intensity of light diminishes less than for any other ; while for intermediate directions the diminution of intensity is intermediate to those above-mentioned. In accordance, therefore, with what was said before, we may conclude that the vibrations are parallel to the line or pivot about which the plate was turned when the diminution of light was least.

Secondly, polarisation may be effected by reflexion. If light reflected from the surface of almost any, except metallic, bodies be examined with a plate of tourmalin, it will in general be found to show traces of polarisation · that is to say, if the plate be caused to revolve in its own plane, and the reflected rays be viewed through it, then in certain positions of the plate, the reflected light will appear less bright than in others. If the angle at which the original rays fall upon the reflecting surface be varied, it will be found that the amount of alteration in brightness of the light seen through the revolving tourmalin (or analyser) will also vary. This fact may also be expressed thus : in polarisation by reflexion, the degree of polarisation, or the amount of polarised light in the reflected rays, varies with the angle of incidence on the reflecting surface. But at a particular angle, called on that account the polarising angle, the polarisation will be a maximum. This angle (usually measured between the incident ray and the perpendicular to the reflecting surface) is not the same for all substances ; in fact it varies with their refractive power according to a peculiar law, which, when stated in the technical language of science, may be thus enunciated : the tangent of the polarising angle is equal to the refractive index. Simple geometrical considerations, combined with the usual expressions for the laws of reflexion and refraction, will show that this relation between the polarising angle and the refractive index may be also expressed in the following way : If light be incident at the polarising angle, the reflected and refracted rays will be at right angles to one another.

In Fig. 5, s, i represents the incident, i, f the reflected, and i, r the refracted ray. Then s, i will be incident at the polarising angle when the angle s, i, r is a right angle.

An apparatus devised by Prof. Tyndall for experimentally demonstrating the laws of reflexion and refraction is admirably adapted for verifying this law. The following description is quoted from his Lectures on Light:—"A shallow circular vessel R I G (Fig. 6) with a glass face, half filled with water rendered barely turbid by the admixture of a little milk or the precipitation of a little mastic, is placed upon its edge with its glass face vertical. By means of a small plane reflector M, and through a slit I in the hoop surrounding the vessel, a beam of light is admitted in any required direction." If a little smoke be thrown into the space above the water, the paths of the incident, the reflected, and the refracted beams will all be visible. If then the direction of the incident beam be so adjusted that the reflected and the refracted beams are at right angles to one another, and a Nicol's prism be interposed in the path of the incident beam, it will be found that by bringing the vibrations alternately into and perpendicular to the plane of incidence we shall alternately cut off the reflected and the refracted ray. Thus much for the verification of the law. But not only so, if we take different fluids and for each of them in succession adjust the incident beam in the same manner, we shall only have to read off the angle of incidence in order to ascertain the polarising angle of the fluid under examination.

The polarising angle for glass is 54° 35′, water.

Thus, in Fig. 7, let a, b be the incident, and b, c the reflected ray at the first plate; b, c the incident, and c, d the reflected ray at the second plate; then the ray will be polarised more or less according to the angle of incidence, at b, and will be analysed at c.

But in accordance with the principle stated above, viz. that any process which will serve for polarising, will serve also for analysing, we may replace the analysing tourmalin by a second plate of glass (or whatever substance has been used for the first reflexion) placed parallel to the first, and in such a position as to receive the reflected ray; and if the second plate be then turned round the ray reflected from the first plate b c, as an axis, it will be found that at two positions of rotation (first when the plates are parallel and secondly when one of them has been turned through 180°) the light reflected from the second plate is brightest, and at two positions at right angles to the former the reflected ray is least bright. The degree of dimness at the two positions last mentioned will depend upon the accuracy with which the reflecting plates have been adjusted to the polarising angle; and when this has been completely effected, the light will be altogether extinguished.

Suppose now that the reflecting substance be, as in the case of glass, transparent. Then it will not be surprising if, when the reflected ray is polarised, the refracted ray should also exhibit traces of polarisation. And in fact every ray of ordinary light incident upon a transparent plate is partly reflected and partly refracted; the reflected ray is partially polarised, and so also is the refracted ray. This being so, if, instead of a single plate, we use a series of plates placed one behind the other, each plate will give rise to a series of reflected rays, due to successive internal reflections. The sum of all these will give the intensity and the amount of polarisation of the total reflected light. The phenomenon of these reflexions is therefore rather complicated; and the modifications due to the additional plates do not materially alter the proportion of polarised to unpolarised light. It is, however, otherwise with the refracted rays. The rays transmitted by the first plate enter the second in a state of partial polarisation, and by a second transmission undergo a further degree of polarisation. If this process be continued by having a sufficient number of plates, the ray finally emergent may have any degree of polarisation required.* And it is worthy of remark that, in proportion as the rays become more and more polarised, so does a less and less quantity of light become reflected from the surfaces of the plates; and consequently, except in so far as light is absorbed by actual transmission through the substance of the plates, the emergent ray suffers less and less diminution of intensity by each additional plate. So that when a certain number has been attained the intensity received by the eye or on a screen is practically unaffected by increasing their number.

Fig. 8 is a general representation of such a pile of plates viewed edge-ways. The plates are secured in a brass frame, and the whole supported on a stand.

W. SPOTTISWOODE

(*To be continued.*)

* Plates of the thinnest description are the best; two or three give good effects, but if the surfaces lie parallel and the glass be highly transparent the number may be advantageously increased to 10, or even 12.

THE ROYAL SOCIETY

THE following extracts from the Minutes of the Council of the Royal Society under the dates given, may be interesting to some of our readers:—

Jan. 26, 1860.—The President having brought under the consideration of the Council the present scale of remuneration of the Secretaries, it was resolved:—"That a Committee be appointed to inquire into the matter and report thereon to the Council; the Committee to consist of the President and the Treasurer, with Mr. Barlow, Mr. Bell, and Dr. Farr."

Feb. 23, 1860.—The President presented the following Report from the Committee appointed on January 26 to consider the question of the remuneration of the Secretaries.

"Your Committee beg to Report to the Council that, in performing the task which was imposed upon them, they have inquired into the duties of the Secretaries at various times, the gratuities which have been awarded to them, and the financial condition of the Society.

"They have been favoured with valuable information and opinions by former Officers of the Royal Society,—Sir John Herschel, Mr. Brande, Dr. Roget, and Sir John Lubbock.

"Previous to the year 1720 no regular salaries were assigned to the Secretaries, but it was customary to present them from time to time with sums varying from 10*l*. to 20*l*. under the name of 'Gratuities.'

"In 1720, on the motion of the President, Sir Isaac Newton, the Council directed that 50*l*. should be paid to each of the two Secretaries annually. In 1732 this amount was increased to 60*l*., and in 1760 to 70*l*. 10*s*. In November 1799, on the motion of the President, Sir Joseph Banks, the amount of the salaries was reconsidered by the Council, and raised to *One Hundred Guineas* to each Secretary, at which amount they have remained from that time to the present.

"The office of 'Foreign Secretary' originated in a legacy of 500*l*. bequeathed to the Society in 1719 by Mr. Robert Keck, for the express purpose of remunerating a person for carrying on foreign correspondence. In 1720 the first Foreign Secretary was appointed, with a salary of 20*l*. a year, which sum has been paid, without increase, from that time to the present.

"It is the concurrent opinion of all who have the best means of knowing, that since the gratuities were last fixed in 1799 the business of the Society and the duties of the Secretaries have largely increased. The increase of Fellows and the larger income of the Society have enabled it to extend its operations. In the ten years 1790 to 1799, 319 papers were communicated to the Society; and in the ten years 1850 to to 1859, the number of such papers was 672. Some of the communications are short notices for publication in the Proceedings, and it is impossible to determine precisely in what ratio the work has increased; but your Committee are disposed to believe that it is represented approximately by the above figures.

The Secretaries now edit the 'Transactions' and the 'Proceedings' which are found so useful by the Fellows, and this latter duty has added considerably to their labour.

"The current revenue of the Society may be set down at about 3,514*l.* of which 1,150*l.* are derived from rents and dividends, and 517*l.* from the Stevenson bequest. The latter sum, it is known, will increase as lives fall in. The annual subscriptions amount to 1,126*l.*; the entry fees, estimated on an average of eleven years, will be about 170*l.*; the compositions 360*l.*; the Transactions will yield 276*l.*; making the aggregate revenue under these heads 1,932*l.* Your Committee see no reason to believe that these sources of income are likely to fail.

"The current annual expenditure may be stated at about 2,839*l.*; namely, 1,177*l.* on printing; 764*l.* on gratuities, salaries and wages; 187*l.* on books and binding; 511*l.* on house expenses; 200*l.* on Catalogue of Periodicals. These items necessarily fluctuate, and the printing bill last year exceeded considerably the above amount; but the amount just stated for printing is estimated from an average of the last eleven years. The income of the Society has thus for some years exceeded the expenditure by about 675*l.*

"Looking at the duties which now devolve upon the Secretaries, of regularly attending Meetings, reading papers, editing the 'Transactions,' preparing the 'Proceedings' for publication, and other work,—looking also at the remuneration which it is found desirable to give gentlemen who discharge less onerous duties merely as editors of literary works in the present day,—your Committee are of opinion that the Council will be acting quite in conformity with the sound principles which were laid down in Sir Isaac Newton's presidency, and have been acted on since, by increasing the gratuity to each of the two Secretaries. As the result of the inquiries made by your Committee, they would suggest that the addition should be 95*l.*, raising each gratuity from 105*l.* to 200*l.* This would involve an increase of 190*l.* in the expenditure.

"The relations of the Society with foreign countries may be largely extended, and your Committee are of opinion that to accomplish this object 80*l.* may be advantageously added to the 20*l.* now voted making the annual gratuity of the Foreign Secretary 100*l.*

"The total augmentation of the expenditure under this arrangement would be 270*l.* leaving a probable annual surplus of 400*l.* to be devoted to the numerous purposes which fall naturally within the scope of the Society's inquiries.

"Your Committee are of the opinion that the offices efficiently discharged will still be to a great extent honorary; and that so long as the Society itself is so fortunate as to have able, industrious, and eminent men as its Secretaries it will be still largely in their debt.

"Should the finances of the Society, through any unforeseen circumstance, require it, there would not, your Committee apprehend, be any difficulty in again revising the scale of gratuities which may be awarded."

This Report having been read, it was, on the motion of the Treasurer, seconded by Sir R. Murchison,

"Resolved—That the recommendation of the Committee respecting the honorarium to be given to the two principal Secretaries be adopted."

June 20, 1872.—On the motion of Dr. Sharpey, [pursuant to notice given, seconded by Mr. Spottiswoode—

"Resolved—That the following mode of procedure be adopted in the nomination of Fellows to be recommended to the Society for election as Council and Officers.

"1. The subject of the new Council shall be taken into consideration at a meeting of Council to be held on the last Thursday of October; and with the summons for that meeting there shall be transmitted a list of the members of the existing Council, with the number of their attendances at meetings up to that date; also a list of the Fellows of the Society, with an indication of those who have at any time served on the Council, and the dates of their service.

"2. At this meeting the names of those members of the existing Council who retire at the ensuing anniversary shall be determined. Thereafter each member present shall hand to one of the secretaries a list of not exceeding ten Fellows whom he proposes for the new Council, of whom five shall not have already served on the Council. Members not able to be present may send in similar lists previous to the meeting. The several lists of names so proposed shall then be read out by the secretary.

"3. Before the next following meeting, the president and officers shall prepare a list of twenty-one names for consideration by the Council, which list shall include ten names selected from those proposed at the previous meeting, or other names, if required to make up that number. The list so prepared, together with a statement of the names proposed and the number of votes given for each, shall be sent out confidentially with the summons for the ensuing meeting, at which meeting the names to be finally recommended shall be balloted for. In taking the ballot, a copy of the list prepared by the officers, with such alterations as he may see fit to make therein, shall be delivered by each member of the Council present and voting, and the names found to have the majority of votes shall form the list to be recommended to the Society.

"The President and Council shall then nominate by ballot, out of the proposed Council, the persons whom they recommend to the Society for election to the offices of President, Treasurer, Principal Secretaries, and Foreign Secretary for the ensuing year."

NOTES

THE present year is already remarkable for the number of eminent scientific men who have gone over to the majority: and now, just a its close, one of the most eminent in his own sphere has taken his departure. A telegram dated New York, December 14, announces the death of Prof. Louis J. R. Agassiz, in his 67th year, he having been born in Switzerland in 1807. We shall content ourselves with the bare announcement at present, hoping to be able to give, next week, a memoir of the great naturalist. Meantime we would draw the attention of our readers to the interesting letter from Agassiz in our correspondence column, sent us by Sir Philip de Malpas Grey-Egerton, Bart.

A MEETING, with Sir William Armstrong as chairman, was held at Newcastle last Thursday, to consider the question of a memorial to the late Mr. Albany Hancock. It was unanimously resolved that the most appropriate memorial that could be raised to Mr. Hancock, would be a Professorship of Natural History in the Newcastle College of Physical Science, to be called, after him and his friend and conjoint worker, the late Mr. Alder, the "Hancock and Alder Professorship." Over 1,000*l.* were subscribed at the meeting, and we have reason to hope, from the general esteem in which the two men were held, the high value of their labours, and the great wealth of Newcastle and the surrounding district, that the remaining 4,000*l.* or 5,000*l.* necessary to endow a Natural History chair, will be raised without difficulty. Very few, even of scientific men, seem to be aware of the great amount and value of the work done by Mr. Hancock. The Rev. A. M. Norman, in speaking at the meeting, said that the nature and extent of the work done by Mr. Hancock, would only be realised by degrees. "His work was abstruse science; work which was labour, day by day, under the microscope; work which was carried on from week to week and from year to year, and which was published in the journals of the scientific associations; work which was at present not thoroughly under-

stood even by scientific men, and which could only be fully appreciated and utilised years afterwards, when others should arise who devoted themselves to the same branches of science as Mr. Hancock had done."

THE Professorship of Zoology in the Royal College of Science, Dublin, has become vacant through the appointment of Prof. Traquair to the Keepership of the Natural History collections in the Museum of Science and Art, Edinburgh. Candidates for the appointment should apply, forwarding testimonials, to the secretary, Science and Art Department, South Kensington, S.W.

ON April 14 and following days, an Exhibition in Natural Science will be offered for competition, in connection with King's College, Cambridge. Candidates must be British subjects under twenty years of age, unless already undergraduates of the College, who are also eligible, if in their first or second year. The Exhibition is worth at least 80*l.* a year, and is tenable for three years, but not with any other Exhibition, Scholarship, or Fellowship. There will be three papers in Natural Science (including Chemistry, Physics, and Physiology), and papers in Elementary Classics and Mathematics.

NINETY-FOUR essays have been sent in in competition for the 100*l.* prize offered by Lord Cathcart, the president of the Royal Agricultural Society, for the best essay on the potato disease and its prevention; but the committee appointed by the council of the society to adjudicate the prize do not advise its being awarded to any of the competitors. They recommended, however, that a sum of money be granted for the purpose of inducing a competent mycologist to undertake the investigation of the life-history of the potato-fungus, *Peronospora infestans*, in the interval between the injury to the potato plant and the re-appearance of the fungus in the following year; and that the society should offer prizes for kinds of potatoes that would resist disease during a series of experiments to be continued for three successive years.

A CORRESPONDENT sends us a letter from Dr. A. B. Meyer in which the latter asserts that D'Albertis did not cross New Guinea at all, and that he himself is the only explorer who has done so. With regard to his statement that the fauna of New Guinea is not rich, he says he refers to the higher vertebrates; he intends to publish shortly a "Prodromus Faunæ Novæ Guinensis." The latitude of the point on MacCluer Gulf, at which he arrived in crossing, was 2° 38′, and not 20° 38′, as by an obvious misprint was stated in his article in vol. ix. p. 79 of NATURE.

A PECULIAR result has been arrived at by Professor Fick, of Würtzburg, in his experiments on the blood-pressure in the heart and aorta of the dog (Verhandl. d. physik. med., vol. iv. p. 223). He finds that if a straight tube is the manometer employed, the column of fluid rises higher when the lower end is in the aorta, than when in the left ventricle itself. There are several objections to the method adopted which might tend to the production of this extraordinary result, so contrary to all preconceivd notions and to the experience of M. Marey, who, when discussing the subject (Circ. du Sang., p. 192) remarks, "Frequently verified measurements, made by the employment of ampoules on the horse, show that the maximum pressure in the aorta is slightly more feeble than in the ventricle, though, in some cases, it is nearly the same." May it not be that the presence of the tube in the ventricle, and the associated imperfect closure of the semilunar valves, reduces the pressure in the one case, and that on its withdrawal into the aorta the heart again resumes its more vigorous action. It seems physically impossible that the aortic pressure should be greater than the ventricular during any portion of the systolic period in which the semilunar valves are open.

A VALUABLE contribution to anatomical science, by Prof. Turner, has appeared in the current number of the *Journal of Anatomy and Physiology*, in which the relations of the different cerebral convolutions to the parts of the brain-case with which they are in contact are discussed. Each lateral half of the scalp is divided with the aid of the best marked prominences and sutures as landmarks, into ten regions, which are again capable of further subdivision, and the convolutions found in each are stated. It is shown that the lobes of the brain by no means correspond exactly with the bones from which they have been named, but frequently extend under the cover of others, or only partially occupy the surfaces of their own. These observations are particularly valuable now that the subject of the localisation of the cerebral functions has attained such prominent importance.

CAPTAIN POTTER of the U.S. whaler *Glacier*, we learn from *La Nature*, says that he has discovered some relics of the Franklin Expedition in the Polar regions. Captain Potter left New Bedford, Mass., on July 19, 1871, and remained absent twenty-six months, most of which time he spent in the neighbourhood of the place where Franklin and his companions abandoned their vessels. At Repulse Bay a party of Esquimaux came to trade with Captain Potter. He was considerably surprised to see them offering in exchange for culinary utensils, part of a table-service of silver, which they declared belonged to the appointments of Franklin. There are two large tablespoons, two large four-pronged forks, an ordinary tea-spoon, and sugar-spoon. All these articles are of old-fashioned make. The natives assert that after having quitted their ships, Sir John and his companions separated into two bands, one of which took the direction of the Red River, and the other made for the territory of the Hudson's Bay Company. They say also that Sir John and his companions died solely from natural causes, and Captain Potter believes they speak the truth.

THE adult female Indian Rhinoceros, which has been in the Zoological Society's Gardens since July 1850, then not larger than a full sized dog, died on Sunday last, having been ill for some time previously. The coldness of the weather and the fog were probably the exciting causes of its death, though no definite pathological changes have been found on *post-mortem* examination. There were no symptoms of senile decay. An interesting point may be mentioned, which is, that one of the wisdom teeth from the lower jaw was found in the cæcum, with the fangs and dentine entirely absorbed. This tooth must have been in this peculiar situation for some time, probably years, as it is almost unworn, whilst the corresponding molar on the opposite side is still in place, much worn, as is the same one in the maxilla of the same side; that opposite to the proper situation of the missing tooth being almost as complete as when it was cut. The large accumulation of hay in the cæcum, in which the tooth was embedded, appeared fresh and but little modified by the digestive process, so that it must have been there but a short time. In a Sumatran Rhinoceros, also, which died some time ago, two large beans were found in the cæcum, which could not have been introduced in the food for at least four or five months before the individual's decease.

WE have received a Catalogue of Apparatus suitable for Lectures and Class Instruction in, Subject VIII. Acoustics, Light, Heat, and IX. Magnetism and Electricity, in connection with the Science and Art Department. The object of the Catalogue, which contains the names of 141 different pieces of apparatus, is to show those articles on which the Department allows a discount of 50 per cent. It is of great importance that this Catalogue should become widely known, and we hope the facilities here offered for the acquisition of serviceable apparatu will be extensively taken advantage of.

THE fourth number of the circulars of the U.S. Bureau of Education for 1873 contains a list of publications by the members of certain college faculties and institutions of learning in the United States from 1867 to 1873, and constitutes quite a valuable record of scientific activity during that time. We hope the Bureau will continue such a publication yearly, and we only wish there was any prospect of a similar undertaking in our own country.

WE would draw attention to the efforts being made by the Directors of the London Polytechnic Institution to give a scientific character to part of the entertainment which they provide for the public. Mr. E. V. Gardner is at present delivering the seventh and eighth of a series of lectures descriptive of "Inventions and Appliances Useful or Necessary to Everyday Life," the subjects being "Sugar: from the Cane to the Teacup," and "The Silber Light and Lightning." We wish the Directors of the Polytechnic success in this attempt to make their institution administer to instruction as well as amusement.

MR. J. D. PAINTER of Macclesfield sends us some very interesting ornithological notes relative to East Cheshire. A short time ago, a bird which had been hovering round the Grammar School for six weeks, was brought him; it had evidently been killed by a violent blow with either a stick or a stone. Upon examination it proved to be the Crested Lark (*Alauda cristata*), which is a common bird throughout the Continent of Europe, but not a native of Britain. Indeed, it is a very rare visitor, since only two or three instances are on record of its having been met with in this country. Occasionally, the neighbourhood of Macclesfield is resorted to by other strangers of the feathered tribe. Some few weeks since the Black-headed Gull (*Larus ridibundus*) was shot in Swithamley Park, and previous to that, on the same estate, the Common Buzzard (*Buteo vulgaris*) had been shot upon the Roaches. A few years further back the Roller (*Coracius garrula*), and a Hobby were killed two or three miles south of the town. In tempestuous weather the Stormy Petrel or Mother Carey's Chicken has been frequently picked up either dead or in an exhausted condition near Macclesfield: and Terns are occasionally shot. The Siskin is a winter visitor, some become victims to the bird-catchers, and the Brambling, also a winter visitor, is now and then shot or snared. Twenty-five years ago, that delightful songster the Woodlark bred about Gawsworth, but in like manner it became completely extinguished. The Grey or Wild Goose (*Anser ferus*) and the Curlew (*Numenius arquata*) came almost every year to breed on Danes Moss, but when the North Staffordshire Railway was carried across it these birds deserted it. Last year, however, the Curlew returned and nested, but some boys took the eggs when just upon the point of being hatched; and this year the birds have not been seen in the neighbourhood. A few Woodlarks have likewise returned lately, and they will most probably share the same fate as their predecessors, unless the forthcoming amended Birds' Act be extended to them and also to the Skylark, which have been most unaccountably omitted in the Act now in force. A few years ago Mr. Painter gave a lecture at the Town Hall upon the Geology, Archæology, Botany, Ornithology, and Zoology of Danes Moss and its borders, when he mentioned some rare and beauitful bog plants. &c. that grew upon it. In the course of a year or two nearly the whole of them were rooted up and carried away, chiefly by strangers.

THE additions to the Zoological Society's Gardens during the last week include a Zebu (*Bos indicus*) born in the Menagerie; a Greater White crested Cockatoo (*Cacatua cristata*) from Moluccas, presented by Mr. T. Towndrow; a Squirrel Monkey (*Saimaris sciurea*) from Guiana, presented by Mrs. Paget; a Parrot Crossbill (*Loxia pityopsittacus*) and two common Crossbills (*L. curvirostra*), European, purchased.

EFFECTS OF ALCOHOL ON WARM-BLOODED ANIMALS *

AFTER referring to what had already been done in reference to this subject, Prof. Binz gave an account of his and his pupils' researches during the last years. They concerned especially two points (1) the influence of alcohol on the temperature of the blood, and (2) the causes of this influence.

As in every powerful attack on our organism, so also in the case of alcohol, the questions arise—In what quantities it worked? and whether the organism to be experimented on was previously accustomed to its influence or not? Taking into exact consideration these two points, so often disregarded, the answer is as follows:—The pretended heat of the organism does not exist. The subjective impression is, at least partially, the consequence of an irritation of the nerves of the stomach and of the enlargement of the vessels arising in the skin. When given in small doses the thermometer shows no extraordinary increase or decrease of the temperature of the blood. Moderate doses, which lead by no means to drunkenness, show a distinct decrease of about half-an-hour duration or more; and inebriating quantities evince a still more decided lowering of 3 to 5 F., which lasts several hours. The decrease in the temperature after moderate doses takes place most successfully in warm-blooded animals, which have had for some time previously no alcohol administered. When inured to it, the organism does not answer on such doses by any measurable cooling or by the reverse.

Good results are yielded more easily by a feverish than by a healthy animal. For these experiments strong guinea-pigs, rabbits, or dogs of the same origin and of the same quality have been used. Under their skin some cubic-centimeter of ichor or putrifying blood was injected. After thus proceeding, the temperature of the animal rises several degrees, and all the symptoms appear which are to be observed in human beings suffering from putrid fever. If the quality of the poisonous substance be right, the animal expires in a few days. Not so, however, if, simultaneously with the ichor, alcohol diluted with water is administered. The temperature then remains lower from the beginning, and the one animal may be seen to die, whilst the other runs about. The analysis of these experiments shows a threefold action of alcohol in putrid fever—(1) the diminution of the heat; (2) reduction of the putrid processes; and (3) rising of the action of the nerves and of the heart.

Prof. Binz then remarked on the causes of such antipyretic action of alcohol. He pointed out several possibilities which here may concur, and has proved by a series of experiments that two of them really take place. It is the action of the heart, together with the enlargement of the vessels of the skin, which allow a stronger evolving of the blood at the surface of the body, and then the moderating influence of alcohol on the chemical metamorphosis of tissues. All these results seem to be suggestive for the use and abuse of alcohol in social life as well as in illnesses, and they explain a great many empiric observations in both departments. The paper of Prof. Binz will be published at length in one of the next numbers of *Humphrey's Journal of Anatomy and Physiology*.

Dr. Brunton remarked that the performance of the vital functions depended on oxidation of the tissues, and Professor Binz's observation that this was lessened by alcohol was the key to an explanation of its physiological effects. These may be nearly all explained on the supposition that the power of the nervous system is diminished, different parts of it becoming successively paralysed. First, the vasomotor nerves become affected and the blood-nerves consequently dilated. After a glass or two of wine, the hands may be noticed to be of a very red colour and plump, showing that arterial blood is flowing freely through the capillaries, and at the same time the veins are dilated and full. All the vessels of the body, however, are not dilated at the same time. In some persons those of the stomach or intestines become dilated, and the blood being thus abstracted from the head the brain becomes anæmic, and the individual dull and sleepy. In others the arteries of the head become dilated first, and in consequence the brain receives a full supply of blood, and the intellect becomes more vigorous. If this stage is not passed the functions return to their normal condition, and no harm ensues, but if more alcohol is taken the paralyis extends to other parts of the nervous system. Sometimes the cerebral lobes, which are the organs of the mental faculties, are first affected, and some-

* Abstract of paper read at the British Association, Bradford, by Prof. Binz, of Bonn, with Dr. Brunton's remarks.

times the centre, for co-ordinated movements usually supposed to be the cerebellum, or, as it is often expressed, "one man gets drunk in his head, another in his legs." When the head is affected judgment becomes impaired, though memory and imagination may still be more active than usual. These faculties next fail, and the emotions become hilarious, pugnacious, or lachrymose. The spinal cord is generally unaffected even when the cerebellum is paralysed, and a man who is utterly unable to walk can still ride, the mere pressure of the saddle upon his thighs being sufficient to cause reflex contraction of his adductor muscles and fix him firmly on his seat, although the upper part of his body may be swaying about like a sack of wheat. The cord itself next becomes paralysed, and lastly the medulla oblongata, which regulates the respiratory movements.

After relating an anecdote illustrative of the effects of alcohol in hastening death during exposure to cold, Dr. Brunton remarked that, notwithstanding all these apparently injurious actions, alcohol was of great service when properly used. Many men came home from their offices completely exhausted, and the stomach, sharing the general exhaustion, is unable to digest the food which lies heavily in it, and incommoding instead of strengthening the individual.

A glass of sherry taken with the food will stimulate the stomach to increased action, and by the time the effect of the stimulus has passed away the food has digested and absorbed, and sustains the effect which the alcohol temporarily produced. When taken in considerable quantities for a long time, alcohol is apt to produce deposit of fat and fatty degeneration of organs, rendering a person not only less capable of work, but liable to uccumb to disease.

SOCIETIES AND ACADEMIES

London

Royal Society, Dec. 11.—"Researches in Spectrum-Analysis in connection with the Spectrum of the Sun."—Part III., by J. Norman Lockyer, F.R.S.

The paper commences with an introduction, in which the general line of work since the last paper is indicated. Roughly speaking, this has been to ascertain the capabilities of the new method in a quantitative direction. It is stated that while qualitative spectrum-analysis depends upon the *positions* of the lines, quantitative spectrum-analysis on the other hand depends not on position but on the *length*, *brightness* and *thickness* of the lines.

The necessity of maps carefully executed and showing the individuality of each line is shown; and it is stated that the execution of these maps required the use of the electric arc to render the vapours of the metals incandescent. A battery of 30 Grove's cells of one pint capacity was accordingly employed in the researches about to be described.

The difficulties of eye-observations of the characters of the lines compelled the application of photography, another reason for the use of which existed in the facility it afforded for confronting spectra with each other, and so eliminating coincident lines, since the lines, if due to impurities, would be longest and thickest in the spectrum to which they really belonged.

The portion of the spectrum at present worked upon is that from H to F.

Another branch of the research has been the construction of a Table of all the named Fraunhofer lines, showing the lengths and thicknesses of the metallic lines to the absorption of which they were due; this Table enabled the author to allocate upwards of 50 lines in the solar spectrum, presumably overlooked by Angström and Thalén. The table was intended as a preliminary to a new photographic map of the spectrum from H to F, on a larger scale than Angström's, which was intended to clear away all the difficulties touching coincidences, and to have below it complete maps of all the solar elements with their long and short lines. This map is incomplete at present, but is making rapid progress

A preliminary search for elements supposed not to be in the sun has also been commenced.

Of the above-named researches the subsequent parts of the paper refer to:—

I. The experiments made on a possible quantitative spectrum-analysis.

II. The method of photographing spectra adopted.

III. The coincidences of spectrum lines.

IV. The preliminary inquiry into the existence in the sun of elements not previously traced.

I. *The Experiments made on a possible quantitative Spectrum-Analysis*

After the two former papers were sent in to the Royal Society, an investigation of the general changes undergone by spectra given by alloys was commenced.

A micrometer eye-piece was mounted on the observing-telescope of the spectroscope. With this the following phemonena were observed:—

I. The lines which remained varied their length as the percentage of the elements to which they were due varied.

II. Some of the lines appreciably varied their thickness or brightness, or both in the same way.

III. In cases where the brightness of a line was estimated through a considerable range of percentage composition by comparison with an air-line, the air-line was observed to grow faint and then disappear as the lightness of the metallic lines increased.

IV. In cases where the brightness or thickness of the line of one element was estimated by comparison with the line adjacent of the other constituent of the alloy, the point of equal brightness was observed to ascend or descend; this method was used to avoid the uncertainty of micrometric measurements of the tips of the lines in consequence of their variation in length due to the unequal action of the spark.

V. In some cases where the percentage of a constituent was so small that none of its lines were visible, there yet seemed to be an effect produced on the vapour of the opposite pole.

As these conclusions were derived from coarse alloys, and it was desirable to observe the effect of very fine gradation, Mr. C. Freemantle, the Deputy Master of the Mint, was begged to allow observations to be made on the gold-copper and silver-copper coinage alloys, and he immediately responded most cordially to the request.

Examples of the behaviour of some coarse alloys of silver and lead are given; they were irregular in their action, but it was observed that silver lines remained in the alloy as long as from ·05 to ·02 per cent. of silver was present. The alloys, however, were very unequal. Experiments on cadmium and tin alloys are described, the cadmium forming 10, 5, 1·0, 0·15 per cent. In the last but one cadmium line was permanent; in the first at least five were seen. In an alloy of 0·099 per cent. of cadmium with a mixture of lead, tin, and zinc constituting the rest of the alloy, the behaviour of the cadmium lines was sensibly the same as in a mixture of 0·1 per cent. of cadmium and 99·9 of tin.

In the Mint-specimens the same phenomena were observed *en petit*, as the coarser alloys showed *en grand*. In a gold-copper alloy $\frac{1}{1000}$ increase in the gold made the lines shorter, and a similar increase in the copper made them longer.

In the silver-copper alloy an increase of $\frac{1}{1000}$ in the silver lengthened the lines, a similar increase in the copper shortened them.

These phenomena can be explained by assuming such alloys to be different physical things, and that the spark acts upon the alloy as a whole as well as upon each vapour separately.

Thus in these Mint alloys, copper is common to both, and their melting-points are:—

Gold . . . 1200° (Pouillet).
Copper . . 1200° to 1000°, the precise point not determined.
Silver . . 1000° (Pouillet).

The intermediate position of copper explains the different action on its lines of gold and silver.

II. *The Method of photographing Spectra adopted*

A camera carrying a 5 × 5-inch plate and a 3-inch lens of 23 in. focus, replaced the observing-telescope of the spectroscope. The lens focused from 3900 to 4500 very fairly upon the plate. The beam passing through collimator and prisms was, as in Mr. Rutherford's researches, very small. As the electric arc in its usual vertical position gave all the lines from pole to pole, the lamp was placed on its side, and the arc used in a horizontal position, the slit being vertical. The dense core of the arc then gave all the short lines in the centre of the field, the longer ones extending beyond them on either side. In order to obtain a scale, it was resolved to photograph the solar spectrum immediately adjacent to the metallic spectrum under examination.

To effect this a portion of the slit was covered up while the solar spectrum passed through the free part, and then the part used for the solar spectrum was covered, while the formerly covered part was opened for the metallic spectrum. This was

effected by a shutter, with an opening sliding in front of the slit ; a diagram of its action and form is given.

The arrangement of the spectroscope, heliostat, &c., for obtaining the sun's light is described. The image of the sun was brought to a focus between the poles of the lamp by an extra lens interposed between the lamp and the heliostat.

The use of the shutter enables us to compare either two or more spectra upon a single plate, or the solar spectrum may be compared with two metallic spectra, being made to occupy the position between the two.

III. *On the Lines coincident in different Spectra*

The bearing of the former papers on the lengths of the lines of the elements is briefly recapitulated.

The examination of the various spectra of metals and alloys indicated the great impurity of most of the metals used, and suggested the possibility of the coincidences observed by Thalén and others being explained in the light of former work.

It is observed that coincidences are particularly numerous in the spectra of iron titanium, and calcium, and that nearly every other solar metallic spectrum has one or more lines coincident with lines of the last element. These coincident lines are, as a rule, very variable in length and intensity in various specimens of the metals in which they occur, and are sometimes altogether absent.

One of the longest calcium lines, that at wave-length 4226·3, is also seen in the strontium spectrum as a line of medium length, and 4607·5, a very long line in strontium, appears in calcium as a short line. Another very long strontium line, 4215·3, is asserted by Thalén to be seen in calcium ; but the author has never seen it till lately, and *then only in a specimen of calcium known to contain strontium*.

We have here, then, a case of coincident lines, in which the one that is long and bright in one spectrum is short and faint in the other, and a case of a line said to be coincident in two spectra being, though always visible in one, sometimes absent in the other of them, and only appearing in it when the two substances were mixed. The hypothesis of impurity at once explains the whole case, even without the third line, which renders the fact of mixture certain.

The longest lines of calcium occur in iron, cobalt, nickel, barium, strontium, &c., and the longest lines of iron occur in calcium, strontium, barium, and other metals.

Other cases are adduced, and the following general statements are hazarded, with a premise that further inquiry may modify them.

1. If the coincident lines of the metals be considered, those cases are rare in which the lines are of the first order of length in all the spectra to which they are common : those cases are much more frequent in which they are long in one spectrum and shorter in the others.

2. As a rule, in the instances of those lines of iron, cobalt, nickel, chromium, and manganese which are coincident with lines of calcium, the calcium lines are long, while the lines as they appear in the spectra of the other metals are shorter than the longest lines of those metals. Hence we are justified in assuming that short lines of iron, cobalt, nickel, chromium, and manganese, coincident with long and strong lines of calcium, are really due to traces of the latter metal occurring in the former as an impurity.

3. In cases of coincidences of lines found between various spectra the line may be fairly assumed to belong to that one in which it is longest and brightest.

A description of some photographs of spectra is then given, a photograph of the coincident lines of calcium and strontium being amongst them, and proving that strontium occurs in the sun ; and the section concludes with a brief description of the method employed in making the new map, showing lengths and thicknesses, and enumerating coincident lines. This is done thus : papers are pasted on to photographs of the solar spectrum on glass ; the lengths of the lines of the metallic spectrum under examination (*e.g.* that of iron) are marked on this paper in prolongation of the solar lines to which they correspond. They are then copied upon a map, and another piece of paper being fixed down, another spectrum is proceeded with in the same way.

IV. *The Preliminary Inquiry into the Existence of Elements in the Sun not previously traced*

The previous researches having shown that the former test for the presence or absence of a metal in the sun, namely, the presence or absence of its brightest or strongest lines in the average solar spectrum, was not conclusive, a preliminary search for other metals was determined on ; and as a guide, Mr. R. J. Friswell was requested to prepare two lists, showing broadly the chief chemical characteristics of the elements traced and not traced in the sun.

The tables showed that in the main those metals which had been traced formed stable compounds with oxygen.

The author therefore determined to search for the metals which formed strong oxides, but which had not yet been traced.

The result up to the present time has been that *strontium*, *cadmium*, *lead*, *cerium*, and *uranium* would seem with considerable probability to exist in the solar reversing layer. Should the presence of *cerium* and *uranium* be subsequently confirmed, the whole of the iron group of metals will thus have been found in the sun.

Certain metals forming unstable oxides, such as gold, silver, mercury, &c., were sought for and not found. The same was the case when chlorine, bromine, iodine, &c., were sought by means of their lines produced in tubes by the jar-spark. These elements are distinguishable as a group by forming compounds with hydrogen.

It is observed that certain elementary and compound gases effect their principal absorption in the most refrangible part of the spectrum when they are rare, and that as they become dense the absorption approaches the less refrangible end ; that the spectra of compounds are banded or columnar, the bands or columns lying at the red end of the spectrum ; that the absorption spectra of chlorine, iodine, bromine, &c., are columnar, and that these are broken up by the spark just as the band spectra of compounds are broken up : and that it is probable that no compounds exist in the sun. The following facts, gathered from the work already accomplished by Rutherford and Secchi are stated :—

There are three classes of stars :—

1. Those like Sirius, the brightest (and therefore hottest ?) star in the northern sky, their spectra showing only hydrogen lines very thick, and metallic lines exceedingly thin.

2. A class of stars with a spectrum differing only in degree from those of the class of Sirius, and to this our sun belongs.

3. A class of stars with columnar or banded spectra indicating the formation of compounds.

The question is asked whether all the above facts cannot be grouped together in a working hypothesis, which assumes that in the reversing layers of the sun and stars various degrees of "celestial dissociation" are at work which prevents the coming together of the atoms which, at the temperature of the earth, and at all artificial temperatures yet attained here, form the metals, the metalloids, and compounds.

In other words, the metalloids are regarded as *quasi* compound bodies when in the state in which we know them ; and it is supposed that in the sun the temperature is too great to permit them to exist in that state in the reversing layer, though they may be found at the outer portions of the chromosphere or in the corona.

It is suggested that if this hypothesis should gain strength from subsequent work, stony meteorites will represent the third class of metalloidal or compound stars, and iron meteorites the other, or metallic stars.

The paper concludes as follows :—

"An interesting physical speculation connected with this working hypothesis is the effect on the period of duration of a star's heat which would be brought about by assuming that the original atoms of which a star is composed are possessed of the increased potential energy of combination which this hypothesis endows them with. From the earliest phase of a star's life the dissipation of energy would, as it were, bring into play a new supply of heat, and so prolong the star's life.

"May it not also be, if chemists take up this question, which has arisen from the spectroscopic evidence of what I have before termed the plasticity of the molecules of the metalloids taken as a whole, that much of the power of variation which is at present accorded to metals may be traced home to the metalloids? I need only refer to the fact that, so far as I can learn, all so-called changes of atomicity take place when metalloids are involved, and not when the metals alone are in question.

"As instances of these, I may refer to the triatomic combinations formed with chlorine, oxygen, sulphur, &c. in the case of tetrad or hexad metals. May not this be explained by the plasticity of the metalloids in question?

"May we not from these ideas be justified in defining a metal, provisionally, as a substance the absorption spectrum of which is generally the same as the radiation spectrum, while the metalloids are substances the absorption spectrum of which, generally, is not the same?

"In other words, in passing from a hot to a comparatively cold state, the plasticity of these latter comes into play, and we get a new molecular arrangement. Hence are we not justified in asking whether the change from oxygen to ozone is but a type of what takes place in all metalloids?"

Abstract of paper "On the Quantitative Analysis of certain Alloys by means of the Spectroscope," by J. Norman Lockyer, F.R.S., and William Chandler Roberts, Chemist of the Mint.

The authors, after referring to experiments which showed clearly that the spectroscope might be employed to detect minute differences in the composition of certain alloys, proceed to give an account of the researches which they had instituted with a view to ascertain the degree of accuracy of which the method is capable.

The image of an electric-spark passing between the unknown alloy and a fixed electrode being thrown by means of a lens on the slit of the spectroscope, the phenomena observed were found to vary with the composition of the alloys; and further, by arranging them together with known check-pieces on a suitable stand, and bringing them in turn under the fixed electrode, the composition of the unknown alloys was determined by comparison with the known check-pieces.

The shape of the electrode ultimately adopted was stated; the pieces were held in their places by suitable metallic clips. Special attention was then directed to the adjustment of the length of the spark, which was found to materially influence the phenomena. The method adopted consisted in placing the variable electrode in the field of a fixed microscope having a 3- or 4-inch objective, and adjusting the summit of this electrode to coincide with the spider lines of the eye-piece.

After a series of experiments on alloys of zinc and cadmium of various compositions, the results of which were shown on a curve, more extended trials were made with the gold-copper alloy employed in coinage, which was peculiarly suited to these researches in consequence of the known method of assay having been brought to so high a state of perfection (the composition being determined with accuracy to the $\frac{1}{10000}$ part of the original assay-piece of about 7 grains), and from the fact that reliance can be placed on its homogeneity. The paper is accompanied by a series of four curves, which show the results of experiments, and in which the coördinates are given by the ordinary method of assay, and by the spectroscopic readings.

The chief practical advantage which appeared to flow from this inquiry was that, if it were possible to replace the parting assay by the spectroscopical method, a great saving of time in ascertaining the value of gold bullion would be effected.

Institution of Civil Engineers, Dec. 9.—T. Hawksley, president, in the chair.—"On the Geological Conditions affecting the Constructing of a Tunnel between England and France," by Mr. Joseph Prestwich, F.R.S. The author reviewed the geological conditions of all the strata between Harwich and Hastings on one side of the Channel, and between Ostend and St. Valery on the other side, with a view to serve as data for any future projects of tunnelling, and to show in what directions inquiries should be made. The points considered were the lithological characters, dimensions, range and probable depth of the several formations. The London clay, at the mouth of the Thames, was from 200 feet to 400 feet thick, while under Calais it was only 10 feet, at Dunkirk it exceeded 264 feet, and at Ostend it was 448 feet thick. He considered that a trough of London clay from 300 feet to 400 feet, or more, in thickness extended from the coast of Essex to the coast of France, and, judging from the experience gained in the Tower Subway, and the known impermeability and homogeneity of this formation, he saw no difficulty, from a merely geological point of view, in the construction of a tunnel, but for the extreme distance —the nearest suitable points being 80 miles apart. The lower Tertiary strata were too unimportant and too permeable for tunnel work. The chalk in this area was from 400 feet to 1,000 feet thick; the upper beds were soft and permeable, but the lower beds were so argillaceous and compact as to be comparatively impermeable. In fact, in the Hainaut coal fields they effectually shut out the water of the water-bearing tertiary strata from the underlying coal measures. Still, the author did not consider even the lower chalk suited for tunnel work, owing to its liabilty to fissures, imperfect impermeability, and exposure in the Channel. The gault was homogeneous and impermeable, but near Folkstone it was only 130 ft. thick reduced to 40 ft. at Wissant, so that a tunnel would hardly be feasible. The Lower Greensands, 260 ft thick at Sandgate, thinned off to 50 ft. or 60 ft. at Wissant, and were all far too permeable for any tunnel work. Again, the Wealden strata, 1,200 ft. thick in Kent, were reduced to a few unimportant rubbly beds in the Boulonnais. To the Portland beds the same objections existed as to the Lower Greensands, both were water-bearing strata. The Kimmeridge clay was 360 ft. thick near Boulogne, and no doubt passed under the Channel, but in Kent it was covered by so great a thickness of Wealden strata as to be almost inaccessible; at the same time it contained subordinate water-bearing beds. Still, the author was of opinion that, in case of the not improbable denudation of the Portland beds, it might be questionable to carry a tunnel in by the Kimmeridge clay on the French coast, and out by the Wealden beds on the English coast. The oolitic series presented conditions still less favourable, and the lower beds had been found to be water-bearing in a deep artesian well recently sunk near Boulogne. The experimental deep-boring now in progress near Battle would throw much light on this part of the question. The author then passed on to the consideration of the Palæozoic series, to which his attention was more particularly directed while making investigations, as a member of the Royal Coal Commission, on the probable range of the coal measures under the south-east of England. He showed that these rocks, which consisted of hard Silurian slates, Devonian and carboniferous limestone and coal measures, together 12,000 ft. to 15,000 ft. thick, passed under the chalk in the North of France, outcropped in the Boulonnais, were again lost under newer formations near to the coast, and did not reappear until the neighbourhood of Frome and Wells was reached. But, although not exposed on the surface, they had been encountered at a depth of 1,032 ft. at Calais, 985 ft. at Ostend, 1,026 ft. at Harwich, and 1,114 ft. in London. They thus seemed to form a subterranean table land of old rocks, covered immediately by the chalk and Tertiary strata. It was only as the southern flank of this old ridge that the Jurassic and Wealden series set in, and beneath these the Palæozoic rocks rapidly descended to great depths. Near Boulogne these strata were already 1,000 ft. thick; and at Hythe the author estimated their thickness might be that or more. Supposing the strike of the coal measures and the other Palæozoic rocks to be prolonged from their exposed area in the Boulonnais across the Channel, they would pass under the Cretaceous strata somewhere in the neighbourhood of Folkestone, at a depth estimated by the author at about 300 ft., and near Dover at about 600 ft., or nearly at the depth at which they had been found under the chalk at Guines, near Calais, where they were 665 ft. deep. These Palæozoic strata were tilted at high angles, and on the original elevated area they were covered by horizontal Cretaceous strata, the basement beds of which had filled up the interstices of the older rocks as though with a liquid grouting. The overlying mass of gault and lower chalk also formed a barrier to the passage of water so effectual, that the coal measures were worked without difficulty under the very permeable Tertiary and upper chalk of the North of France; and in the neighbourhood of Mons, notwithstanding a thickness of from 500 ft. to 900 ft. of strata charged with water, the lower chalk shut the water out so effectually that the coal measures were worked in perfect safety, and were found to be perfectly dry under 1,200 ft. of these strata combined. No part of the Straits exceeded 186 ft. in depth. The author, therefore, considered that it would be perfectly practicable, so far as safety from the influx of the sea water was concerned, to drive a tunnel through the Palæozoic rocks under the Channel between Blanc Nez and Dover, and he stated that galleries had actually been carried in coal, under less favourable circumstances, for two miles under the sea near Whitehaven. But while in the case of the London clay the distance seemed almost an insurmountable bar, here again the depth offered a formidable difficulty. As a collateral object to be attained, the author pointed to the great problem of the range of the coal measures from the neighbourhood of Calais in the direction of East Kent, which a tunnel in the Palæozoic strata would help to solve. These were, according to the author, the main conditions which bore on the construction of a submarine tunnel between England and France. He was satisfied that on geological grounds alone, it was in one case perfectly practicable, and in one or two others it was possibly so; but there were other considerations besides those of a geolo-

gical nature, and whether or not they admitted of so favourable a solution was questionable. In any case, the author would suggest that, the one favourable solution admitted, it might be desirable, in a question involving so many and such great interests, not to accept an adverse verdict without giving all those considerations the attention and deliberation which the importance of the subject deserved. Granting the possibility of the work in a geological point of view, there were great and formidable engineering difficulties; but the vast progress made in engineering science during the last half century, led the author to imagine that they would not prove insurmountable, if the necessity for such a work were to arise, and the cost were not a bar.

Royal Astronomical Society, Dec. 14.—Prof. Cayley, president, in the chair.—Prof. Pritchard gave a verbal account of the Physical Observatory about to be established at Oxford. He said that the University authorities had been induced to grant a site for a physical observatory in the noble park of sixty acres, which they had recently thrown open to the public. He had been anxious that such a site should not be disgraced by an unsightly building, such as observatories usually were. He found himself fortunately situated in having amongst his old pupils Mr. Barry, the well-known architect, who had furnished them with a design which he showed to the meeting, and had devised, amongst other things, a dome with a fine broad shutter, which he trusted would be really ornamental as well as useful. There would be a central tower of three rooms, one above the other; the basement room would be used for storage; above would be the professor's room; and in the floor above that would be mounted the noble reflector which had been presented to the University by Dr. De La Rue. In a side wing there would be a transit instrument to be used for educational purposes, and another telescope which he hoped would be well worked by members of the University. Mr. Barry informed the society that their new rooms at Burlington House would probably be ready by the middle of April.—Capt. Noble mentioned to the society that in the new volume of the *Nautical Almanac* for 1877 tables of Uranus were given, but it was no credit to England that we should have been kept waiting for them until they were presented to us from across the Atlantic by the labour of Prof. Simon Newcomb.

Entomological Society, Dec. 1.—H. T. Stainton, F.L.S., vice-president, in the chair.—Mr. Bond exhibited a hybrid specimen between *Clostera curtula* and *C. reclusa* partaking of the characters of both parents.—Mr. Jenner Weir exhibited specimens of a minute Hymenopterous insect (a species of *Psen*), which he had observed in large numbers (probably 150) in June last on a pear leaf at Lewes. They had congregated together on the surface of the leaf like a swarm of bees, though it was not apparent what motive brought them together.—Mr. Dunning read extracts from a letter from New Zealand stating that the red clover had been introduced into that colony, but that they had no humble bees to fertilise the plant. Also that certain Lepidopterous insects had been accidentally imported into the islands, but that the corresponding Ichneumon flies were wanted to keep down their numbers. It was suggested that the nests of humble bees might be imported, when the bees were in a dormant condition, keeping them in that state (by means of ice) during the voyage.—Mr. Baly communicated a paper on the Phytophagous Coleoptera of Japan, being a continuation of a former paper on the same subject.—Mr. Bates communicated a supplementary paper on the Longicorn Beetles recently brought from Chontales, Nicaragua, by Mr Thomas Belt.—Mr. W. H. Miskin, of Queensland, communicated criticisms on Mr. Masters' Catalogue of the described species of Diurnal Lepidoptera of Australia.—A fourth portion of the catalogue of British Insects, now being published by the society, was on the table. It contained the Hymenoptera (*Oxyura*), by Rev. T. A. Marshall, M.A.

PARIS

Academy of Sciences, Dec. 8.—M. de Quatrefages, president, in the chair.—The president announced the death of M. Cl. Gay, member of the Botanical Section; and the Perpetual Secretary also announced the death of the well-known mineralogist, C. F. Naumann, Corresponding Member of the Mineralogical Section.—The following papers were read:—An answer to M. Pasteur's paper on the origin of beer yeast, by M. A. Trécul. The author contradicted M. Pasteur's statement that the development of *Pencillium glaucum* from *putrid* yeast was an admitted fact. On the contrary, it had been observed to develop itself from perfectly healthy yeast.—On the vitreous substances found included in Santorin lava, by M. F. Fouqué.—On the determination of the ratio of two specific heats by the compression of a limited volume of gas, by M. E. H. Amgat.—On the distribution of the neolithic populations in the department of the Oise, by M. R. Guérin.—On the habits of the *Phylloxera* (continued), by M. Max. Cornu.—A further notice on the connection of storms and sunspots as observed at Paris and Fécamp was received from M. Poëy.—Preliminary note on the elements existing in the sun, by Mr. Norman Lockyer. M. Berthelot then criticised the paper. He held that the phenomena of specific heat, &c., indicated that the elements, so-called, were on a very different basis from the compounds, and that the phenomena they presented in this respect could not be explained if they were not regarded as actually simple bodies. M. Dumas thought that, as he had himself maintained before the Academy, elements ought only to be regarded as elements in relation to human experience and not as absolute elements, a fact which he considered Lavoisier to have established. He considered that modern experiments tended to confirm this opinion.—Note on the identity of Cauchy's formulæ for the determination of the conditions of convergence of Lagrange's series with those given by Lagrange himself, by M. L. F. Ménabréa.—On the November meteors, by M. Wolf.—Note on Faye's periodic comet and on the discovery and observations of twenty nebulæ made at the Marseilles observatory, by M. E. Stephan.—On the movement of an elastic wire one end of which has a vibratory motion, by M. E. Mercadier.—Observations on the action of certain poisons on sea fish, by MM. A. Rabuteau and F. Papillon.—On the embryo cell of the egg of osseous fish, by M. Balbiani.—On the age of the dental follicle in the *mammiferæ*, by MM. E. Magitot and Ch. Legros.—On the use of electrical cauterisation in surgical operations, by MM. Ch. Legros and Onimus.—On the Ostrœacious marl of Fresnes-lès-Rungis (Seine), by M. Stan. Meunier.—Note on a meteor observed at Versailles on Dec. 3, by M. Martin de Brettes.—New analysis of the water of St. Thiébaut's fountain at Nancy, by M. P. Guyot.—Studies on certain combustibles from the basin of Donetz and Toula, Russia, by MM. Scheurer-Kestner and Meunier-Dollfus.

BOOKS RECEIVED

ENGLISH.—Guide to Latin Prose: R. M. Millington (Relfe).—Wild Animals: Wolf (Macmillan & Co.).—Problems of Life and Mind: George Henry Lewes (Trübner & Co.).—Theory of Attraction. 2 vols.: Todhunter (Macmillan & Co.).—The Borderland of Science: R. A. Proctor (Smith, Elder & Co.).—Memoir of Mary Somerville: Martha Somerville (John Murray).—Manual of Comparative Anatomy and Physiology: J. M. Bradley (Simpkin and Marshall).—The River Amazon: H. W Bates (John Murray)—The Chase: Somerville (W. Tegg).—Virgil's Eclogues. Translated: Millington (Longmans).—Quantitative Chemical Analysis. 6th edition: Fresenius (Churchill).—Nautical Almanac, 1877 (John Murray).—The Simplicity of Life: Dr. Ralph Richardson (H. K. Lewis).—Introduction to Quaternions: Kelland and Tait (Macmillan)—Free-thinking and Plain Speaking: Leslie Stephens (Longmans).—United States Geological Survey. 6th Annual Report: F. W. Haydyn (Trübner & Co.)—Harvest of the Sea: Bertram (John Murray).—Mountain, Meadow, and Mere: G. C. Davies (H. S. King & Co.).—Legal Handbook for Architects: Jenkins and Raymond (H. S. King & Co.).—The Conservation of Energy: Balfour Stewart (H. S. King & Co.).—Telegraphic Journal, vol. i. (Gillman).—Primer of Geology: A Geikie (Macmillan & Co.).—Darwinism and Design: G. St Claire (Hodder & Stoughton).—From January to December (Longmans).—Pheasants for Coverts and Aviaries: W. B. Tegetmeier (Horace Cox).

CONTENTS

THURSDAY, DECEMBER 25, 1873

QUATERNIONS

A MATHEMATICIAN is one who endeavours to secure the greatest possible consistency in his thoughts and statements, by guiding the process of his reasoning into those well-worn tracks by which we pass from one relation among quantities to an equivalent relation. He who has kept his mind always in those paths which have never led him or anyone else to an inconsistent result, and has traversed them so often that the act of passage has become rather automatic than voluntary, is, and knows himself to be, an accomplished mathematician. The very important part played by calculation in modern mathematics and physics has led to the development of the popular idea of a mathematician as a calculator, far more expert, indeed, than any banker's clerk, but of course immeasurably inferior, both in resources and in accuracy, to what the "analytical engine" will be, if the late Mr. Babbage's design should ever be carried into execution.

But though much of the routine work of a mathematician is calculation, his proper work—that which constitutes him a mathematician—is the invention of methods. He is always inventing methods, some of them of no great value except for some purpose of his own; others, which shorten the labour of calculation, are eagerly adopted by all calculators. But the methods on which the mathematician is content to hang his reputation are generally those which he fancies will save him and all who come after him the labour of thinking about what has cost himself so much thought.

Now Quaternions, or the doctrine of Vectors, is a mathematical method, but it is a method of thinking, and not, at least for the present generation, a method of saving thought. It does not, like some more popular mathematical methods, encourage the hope that mathematicians may give their minds a holiday, by transferring all their work to their pens. It calls upon us at every step to form a mental image of the geometrical features represented by the symbols, so that in studying geometry by this method we have our minds engaged with geometrical ideas, and are not permitted to fancy ourselves geometers when we are only arithmeticians.

This demand for thought—for the continued construction of mental representations—is enough to account for the slow progress of the method among adult mathematicians. Two courses, however, are open to the cultivators of Quaternions: they may show how easily the principles of the method are acquired by those whose minds are still fresh, and in so doing they may prepare the way for the triumph of Quaternions in the next generation; or they may apply the method to those problems which the science of the day presents to us, and show how easily it arrives at those solutions which have been already expressed in ordinary mathematical language, and how it brings within our reach other problems, which the ordinary methods have hitherto abstained from attacking.

Sir W. R. Hamilton, when treating of the elements of the subject, was apt to become so fascinated by the metaphysical aspects of the method, that the mind of his disciple became impressed with the profundity, rather than the simplicity of his doctrines. Professors Kelland and Tait in the opening chapter (II.) of their recently published work * have, we think, successfully avoided this element of discouragement. They tell us at once what a vector is, and how to add vectors, and they do this in a way which is quite as intelligible to those who are just beginning to learn geometry as to the most expert mathematician.

The subject, like all other subjects, becomes more intricate as the student advances in it; but at the same time his ideas are becoming clearer and more firmly established as he works out the numerous examples and exercises which are placed before him.

The technical terms of the method—Scalar, Vector, Tensor, Versor—are introduced in their proper places, and their meaning is sufficiently illustrated to the beginner by the examples which he is expected to work out. The pride of the accomplished mathematician, however (for whom this book is not written), might have been somewhat mollified if somewhere in the book a few pages had been devoted to explaining to him the differences between the Quaternion methods and those which he has spent his life in mastering, and of which he has now become the slave. He is apt to be startled by finding that when one vector is multiplied into another at right angles to it, the product is still a vector, but at right angles to both. His only idea of a vector had been that of a line, and he had expected that when one vector was multiplied into another the result would be something of a different kind from a line, such, for instance, as a surface. Now if it had been pointed out to him in the chapter on vector multiplication that a surface is a vector, he would be saved from a painful mental shock, for a mathematician is as sensitive about "dimensions" as an English schoolboy is about "quantities."

The fact is, that even in the purely geometrical applications of the Quaternion method we meet with three different kinds of directed quantities: the vector proper, which represents transference from A to B; the area or "aperture," which is always understood to have a positive and a negative aspect, according to the direction in which it is swept out by the generating vector; and the versor, which represents turning round an axis.

The Quaternion ideas of these three quantities differ from the old ideas of the line, the surface, and the angle only by giving more prominence to the fact that each of them has a determinate *direction* as well as a determinate magnitude. When Euclid tells us to draw the line A B, he supposes it to be done by the motion of a point from A to B or from B to A. But when the line is once generated he makes no distinction between the results of these two operations, which, on Hamilton's system, are each the opposite of the other.

Surfaces also, according to Euclid, are generated by the motion of lines, so that the idea of motion is an old one, and we have only to take special note of the direction of the motion in order to raise Euclid's idea to the level of Hamilton's.

With respect to angles, Euclid appears to treat them as if they arose from the fortuitous concourse of right lines;

* "Introduction to Quaternions, with numerous Examples." By P. Kelland, F.R.S., formerly Fellow of Queen's College, Cambridge; and P. G. Tait, formerly Fellow of St. Peter's College, Cambridge; Professors in the Department of Mathematics in the University of Edinburgh. (Macmillan, 1873.)

but the unsatisfactory nature of this mode of treatment is shown by the fact that in all modern books on trigonometry an angle is represented as generated by motion round an axis in a definite direction.

There are thus three geometrical quantities having direction, and the more than magical power of the method of Quaternions resides in the spell by which these three orders of quantities are brought under the sway of the same system of operators.

The secret of this spell is twofold, and is symbolised by the vine-tendril and the mason's rule and square. The tendril of the vine teaches us the relation which must be maintained between the positive direction of translation along a line and the positive direction of rotation about that line. When we have not a vine-tendril to guide us, a corkscrew will do as well, or we may use a hop-tendril, provided we look at it not directly, but by reflexion in a mirror.

The mason's rule teaches us that the symbol, as written on paper, is not a real line, but a mere injunction, commanding us to measure out in a certain direction a vector of a length so many times that of the rule. Without the rule the symbol would have no definite meaning. Thus the rule is the unit of the Quaternion system, while the square *reminds* us that the right angle is the unit versor.

The doctrine of the unit is a necessary part of every exact science, but in Quaternions the application of the same operators to versors, vectors, and areas is utterly unintelligible without a clear understanding of the function of the unit in the science of measurement.

Whether, however, it is better to insinuate the true doctrine into the mind of the student by a graduated series of exercises, or to inculcate it upon him at once by dogmatic statements, is a question which can only be determined by the experience of a new generation, who shall have been born with the extraspatial unit ever present to their consciousness, and whose thoughts, guided by the vine-tendril along the Quaternion path, shall turn always to the right hand, and never to the left.

Prof. Kelland tells us in the preface to the work to which we have alluded that, whereas Sir W. R. Hamilton and Prof. Tait have written treatises on Quaternions for mathematicians, the time has come when it behoves some one to write for those who desire to become mathematicians. Whatever, therefore, advanced mathematicians may think of this book, they ought to reserve their judgment as to its difficulty till they have ascertained how it is assimilated by those for whom it is written—those in whom the desire to become mathematicians has not yet become alloyed with the consciousness that they are mathematicians. For while Prof. Kelland—as he has elsewhere told us—finds but little difficulty in teaching the elements of the doctrine of Vectors to his junior classes, Hamilton himself, the great master of the spell, when addressing mathematicians of established reputation, found, for his Quaternions, but few to praise and fewer still to love.

Prof. Kelland, by the clearness and orderliness of his statements, and by boldly getting rid of everything which is unnecessarily abstruse, has done more than any other man towards rendering the subject easy to the student, and reconciling even the case-hardened mathematician to the new method, as applied to geometrical questions of old-established truth.

The other aspect of Quaternions, as a method which every mathematician *must* learn in order to deal with the questions which the progress of physics brings every day into greater prominence, is hinted at by Prof. Tait in the last chapter of the book. He there introduces us to the linear and vector function of the first degree under its kinematical aspect of a homogeneous strain. The importance of functions of this kind may be gathered from the fact that a knowledge of their properties supplies the key to the theory of the stresses as well as the strains in solid bodies, and to that of the conduction of heat and electricity in bodies whose properties are different in different directions, to the phenomena exhibited by crystals in the magnetic field, to the thermo-electric properties of crystals, and to other sets of natural phenomena, one or more of which the scientific progress of every year brings before us.

But as we believe that Prof. Tait is about to bring out a new edition of his treatise on Quaternions, in which this higher aspect of the subject will be brought more prominently forward, we reserve our remarks on Quaternions as an instrument of physical research till we have the subject presented to us by Prof. Tait in a form which adequately represents its latest developments.

MARKHAM'S "UNKNOWN REGION"

The Threshold of the Unknown Region. By Clements R. Markham, C.B., F.R.S., Secretary of the Royal Geographical Society, formerly of H.M. Arctic ship *Assistance.* (London: Sampson Low and Co., 1873).

HE must be a sorry story-teller who manages to make a traveller's tale uninteresting, especially if the traveller be a voyager, and still more if his voyages have led him into unknown regions. Of all forms of narrative we think it will be generally acknowledged that narratives of discovery are by far the most popular, as is testified by the abundance of this kind of literature, historical and fictitious, provided for the delectation of the young. No doubt this may be largely accounted for by the fact that a discoverer of new lands is continually unveiling the unknown to those who listen to his tale, thereby appealing to one of the strongest and most fruitful characteristics of the human mind, that of curiosity. Every step taken by a discoverer, every knot sailed by his "good ship," we know will lead him among fresh wonders. Once upon a time the Unknown Region—that is, the region unknown to those peoples who have had a thirst for knowledge to any fruitful extent—was in sooth wide enough, when first our Aryan forefathers left their eastern home, and had "all the world before them where to choose." Even four centuries ago the greater part of the earth waited the coming of the European descendants of those primitive discoverers who first turned their faces eagerly and inquisitively to the unknown west. But ever since then the boundary of the Unknown Region has been gradually pushed farther and farther back, until now there remains comparatively little to be found out in order to enable geographers to complete the configuration of the lands of the globe. The extent of our dwelling-place is now pretty well known, though there is yet abundance of

work for many generations of explorers ere the contents of land and water be anything like fully disclosed.

Of all narratives of discovery, those relating to Arctic regions bear, in our estimation, the palm for intensity of interest, and we are sure there are many who think along with us in this matter. It would be difficult to say briefly why this is so. It may be mainly that there the mystery of the unknown, so far as relates to the surface of our globe, is concentrated. No doubt, also, there is a weird fascination around those eerie, rugged, ice-bound regions of the far north, which have been the scene of a greater number of deeds of heroic daring for noble and disinterested purposes, than any other region of the globe of equal extent. There is also a general though perhaps vague, yet we believe, well-founded belief, that within these regions lie solutions to many of the yet mysterious problems of science; that if once all the phenomena that lie within the yet unlifted veil were exposed and understood, they would afford us the means of tracing with something like certainty the history of our earth through many geological ages. In more senses than one, we are there on the threshold of the unknown.

There is somehow not the same attractiveness about Antarctic exploration, though, as Dr. Neumayer has well shown, it is certainly calculated to yield valuable results to Science, and indeed has already done so. This may partly arise from the scarcity in these regions of land and of life of all kinds, which are abundant enough in certain regions of the known north. Indeed, the tract around which the interest of Arctic discovery is concentrated may be regarded as but a continuation of the great American Continent.

We are sure that all who read this immensely interesting volume of Mr. Markham's will agree with what we have said. No more attractive subject for a work exists than the history of Arctic discovery; no man knows this subject better than Mr. Markham; and few could have written a volume on the subject more full of interest and of valuable information clearly arranged than the one before us. The object of the volume, Mr. Markham tells us, "is to give the public a correct knowledge of the whole line of frontier separating the known from the unknown region round the North Pole, to recall the stories of early voyagers, to narrate the recent efforts of gallant adventurers of various nationalities to cross the threshold, to set forth the arguments in favour of a renewal of Arctic exploration by England, and to enumerate, in detail, the valuable and important results to be derived from North Polar discovery." Mr Markham's main design is evidently to show that the only certain gateway to the Pole is by the Smith Sound route, and this design he accomplishes in a way that cannot fail to convince any unprejudiced reader, by going over the whole story of Arctic discovery from the time that that hardy Norseman Lief, the son of Eric the Red, in 1001, made his abortive discovery of North America, down to the present year, when the world was astounded by the news of the discoveries and adventures of the ill-equipped but remarkably successful *Polaris* expedition. One's blood is once more stirred by the story of these fearless early English and Dutch adventurers, Burrough and Pett and Jackman and Barentz and Hudson and others, who dared to face the dangers of Arctic navigation in mere "cock-boats" of 20 and 40 and 80 and 100 tons. The story of Barentz and his companions especially is told with considerable fulness, and it is with a very strange kind of feeling that one reads of the discovery, in 1871, of the very hut in which these stout-hearted Dutchmen passed the winter of 1596-7, and goes over the long catalogue of "Barentz relics" found therein.

Mr. Markham recounts the principal attempts that have been made to pierce through the formidable barrier of ice that guards the North Pole. "There are three approaches by sea to this land-girt end of the earth: through the wide ocean between Norway and Greenland, through Davis' Strait, and through Behring's Strait—one wide portal and two narrow gates." At present no one seems to think of attempting the last-mentioned route, advocates of Arctic exploration being divided between the Spitzbergen route, as the wide sea between Greenland and Novaya Zemlya is called, and the Smith Sound route, the route through the winding passages that lie between Greenland and the American continent. Mr. Markham, in considerable detail, recounts the various expeditions which, from the days of Barentz down to our own time, have charged the barrier that hems the Pole between the east coast of Greenland and Novaya Zemlya. He states with perfect fairness and with all necessary fulness the progress made by each expedition, and the invariable result, so far as the attempt to approach the Pole is concerned, has been failure. The highest latitude attained by this route was that reached by the well-equipped sledge expedition of Parry in 1827, 82° 45′ N.; but the difficulties which the expedition had to encounter were so stupendous as, when combined with what is known of the conditions which influence the movements of the pack in this direction, to utterly forbid any hope of attaining the desired goal by the Spitzbergen route. The inevitable conclusion to be derived from the many fruitless attempts which have hitherto been made by this route is, "that by the Spitzbergen route, in a bad season, nothing whatever can be done; and in a favourable season a steamer may possibly press one or two, or even more degrees farther north than has hitherto been reached, and obtain some valuable deep-sea soundings and temperatures, but no other scientific results in the absence of land. The Spitzbergen route cannot be recommended, because there is no sure prospect of exploring an extensive unknown area, and because no valuable results in geology, botany, ethnology, or geodesy could be obtained under any circumstances." On this point Arctic authorities are all but unanimous, as they are also on the point that by the Smith Sound route a well-equipped Government expedition, if sent out next spring, would be almost certain to return within three years with the mystery of the "Polynia" cleared up, and with results in nearly all departments of Science not only invaluable from a purely scientific point of view, but of the highest practical importance. The very last attempt that has been made by the Smith Sound route seems to us to prove triumphantly that it would at present be folly to attempt to reach the pole by any other route, and that if the meagrely equipped and badly disciplined *Polaris* expedition accomplished so much in a very few days, an expedition such as Government will, we hope, feel bound to send out, will be sure to accomplish the remaining 400 or 500 miles

that lie between Hall's farthest north point and the Pole.

True, there are a few unhealthy croakers, as there always have been, and will be, we fear, for many generations to come, who ask What is the good of incurring so much danger and expense, for the mere gratification of curiosity, or, at best, to satisfy the wishes of a few men of science? But we feel confident that the great body of the English people will ask no such questions, but would hail with enthusiasm the decision of the Government to crown the glory which England has hitherto gained in Arctic exploration by sending out one more expedition whose task it would be to return with the long-sought-for secret in its keeping. It is beginning to dawn upon the ordinary English mind that, after all, the apparently unpractical researches of scientific men are frequently pregnant with results of the most important practical bearing on the welfare of the country and the race.

As for the element of danger, Mr. Markham convincingly shows by unimpeachable statistics, that the loss of men by the Smith Sound route, from causes connected with the climate and the peculiarities of the service, is almost incredibly small. One of the most distinguished medical officers who has served in the Arctic regions declares, that "of all seas visited by men-of-war the Arctic have proved the most healthy. . . . The risk by climate and disease which is run in a voyage to the Arctic seas—such as a Royal Expedition necessitates—is not greater than that which a ship like the *Challenger* will incur in her voyage of discovery." The dangers, or rather difficulties, which have to be faced are only such as brave men are eager to confront, and the service is one which our naval officers and men glory in in time of peace, and is certainly an infinitely better use to put them to than to keep them idling at home or on foreign stations. As to the question of expense, the article in a recent number will show that the less said by Government on this score the better.

All these and many other points in connection with Arctic exploration will be found fully and clearly discussed in Mr. Markham's volume, in which the invaluable results, scientific and practical, in nearly all departments of Science to be obtained from a Government Expedition are set forth with great fulness, clearness, and force. The volume concludes with an account of the interview that took place last year between the Arctic deputation and Mr. Lowe, the result of which was such as to give good grounds for expecting that this year Government will feel bound to organise an adequate expedition to leave our shores next spring to find its way to the Pole by the Smith Sound route.

The numerous maps by which the volume is illustrated are beautifully drawn, and are of the greatest assistance in enabling the reader to understand the interesting story of Arctic discovery so well told by Mr. Markham. As a mere story the work is a masterly one; and if anyone wants to know within short space what has already been done in the discovery of the Arctic regions, what still remains to be done, and what results are to be expected from further exploration, he could not do better than read Mr. Markham's "Threshold of the Unknown Region."

OUR BOOK SHELF

Annual Record of Science and Industry for 1872; edited by Spencer F. Baird, with the assistance of eminent men of Science. (New York: Harper and Brothers, 1873.)

THE praise which we were able to bestow on the first of Prof. Baird's Annual Records, that for 1871, can be fully repeated with regard to its successor. The only method of "reviewing" a work of this kind, is to refer in general terms to its scope, and to the degree to which the compiler appears to have fulfilled the promises of his programme. On these points we can speak in the most favourable terms. As far as a cursory glance through the pages of the volume enables us to speak, we believe that purchasers of the book will find it a most useful addition to their library shelves. The paragraphs refer to the most noteworthy additions to scientific knowledge or observation made during the year, and have been compiled with commendable terseness and perspicuity from a large range of English, American, and Continental sources. A carefully *raisonné* table of contents, and an alphabetical index, will enable the student to turn without difficulty to any desired subject. Although absolute freedom from errors, typical and otherwise, can hardly be expected in a work with so large a scope, the American "Record," contrasts most favourably in this respect with some similar volumes published in this country. We do not know where to find a more complete record of the science of the year; and we shall hope to see a long series of these useful volumes.

The Borderland of Science. By Richard A. Proctor. (London: Smith, Elder, and Co. 1873.)

THESE Essays are reprinted from the *Cornhill Magazine*. The titles are as follows:—"The Herschels and the Star-Depths;" "A Voyage to the Sun;" "A Voyage to the Ringed Planet;" "A Giant Planet;" "Life in Mars;" "A Whewellite Essay on the Planet Mars;" "Meteors—Seed-bearing, and otherwise;" "A Recent Star-shower, and Star-showers generally;" "News from the Moon;" "Earthquakes;" "The Antarctic Regions:" "A Few Words about Coal;" "Notes on Flying and Flying-Machines;" "Gambling Superstitions;" "Coincidences and Superstitions;" "Notes on Ghosts and Goblins."

Sommario delle Lezioni di Fisica, date dal Professore Enrico Dal Pozzo di Mombello, nella Libera Universita di Perugia. (Foligno: Pietro Spariglia, 1873.)

GANOT'S Treatise on Physics has been translated into Italian and is no doubt largely used in the country; also in 1870 Prof. Cantoni, of Milan, published a course of Physical Lectures. The work before us by Prof. Dal Pozzo is to some extent based upon that of Cantoni; it is a summary of two courses of lectures delivered in the free University of Perugia. The University (founded in 1307) is one of the oldest in Europe, and possesses a good library, botanical gardens, and mineralogical collections. We cannot at this moment call to mind any scientific associations connected with the place, as with Pisa, Bologna, and Pavia. The town itself has been mentioned any time for two and twenty centuries, and it is a noted school of music.

We can scarcely judge of the science of Perugia from the work before us. The students must be very clear-headed men if they can follow Prof. Pozzo's arrangement. It is certainly most novel. It may have its advantages. He begins cleverly enough with an account of the "Energy of the Universe," embracing some general properties of bodies, actual and potential energy, conservation and dissipation of energy. The author uses the terms *forza attiva* and *forza di posizione*, in place of our more usual terms. We are glad to find him acquainted with the works of Thomson, Balfour Stewart

and Rankine. The lecture on Energy is followed by one on the Dynamical Theory; which embraces to some extent the relations of different forces, and the "varied modality" of chemical, thermical, and electrical action. The next lecture relates to Molecular Dynamics. Then in succession:—Electromotive force produced by Chemical Action, by Heat, by mechanical means, and by Induction. Mutual action of Currents and Magnets, Terrestrial Magnetism, Polar Auroræ; Atmospheric Electricity; Diamagnetism; Rhumkorff's Coil; Winds; Marine Currents; the Sun; the Doctrine of La Place; the Doctrine of Lyell; Thermogenesis; Atmolysis and Osmosis; Capillarity; the Doctrine of Mayer. The second course treats of electricity, undulations, sonority, musical timbre, echoes, photometry, dispersion and the spectroscope, chromatism, vision, luminous undulations, diffraction, polarisation, radiant heat, action of electricity on organic bodies, the muscular current, electrical nervous phenomena, electrical fishes.

The arrangement is really wonderful. What can possibly warrant the following order for lectures:—diamagnetism, Rhumkorff's coil, winds, marine currents; or again—thermogenesis, atmolysis, capillarity? One lecture ends with "Che cosí mirabilmente si svolgono dall' evoluzione Darwinianæ;" and the next commences "E impossible proseguire un corso di Fisica e piu ancora quella parte, che tratta delle azioni senza prima definire le parole, atomo, molecula." The Prof. Pozzo can scarcely be expected to lecture on all science: to pass from the sun to an atom, from Darwinism to electro-dynamics, from geology to elliptical polarisation. If he is, the system is a bad one, and his students may get a smattering of many things, and know nothing well. Mechanical philosophy seems to be almost ignored. The book is devoid of mathematics, and without woodcuts; and we imagine the youth of Perugia must yawn over it; and, if the lectures are as dry as the book, spend much of the time which ought to be given to physics in saying "felicissima notte" to each other. G. F. R.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Proposed Alterations in the Medical Curriculum

The remarks made in your number of December 18 by my friend Prof. Balfour are founded on the mistake he has made in supposing that it is proposed to abolish the regulation requiring attendance on the courses of lectures on Botany and Zoology. There is no question raised between mere examining boards and teaching institutions, between compulsory and optional attendance on professors' lectures. It is simply that the candidate for medical degrees be allowed to take the examination in Zoology and Botany earlier than is at present permitted. At present the examination in these subjects in Edinburgh University is fixed by ordinance at the end of the second of the four years of medical study, and in this University, while the Botany comes at that time, the Zoology is actually not till the end of the third year, so that our case is even worse than that of Edinburgh. Prof. Balfour says, "The student might be encouraged to take his science examination at an early period of his curriculum, say at the end of his first year of study." That is exactly the result practically aimed at here, and I am quite at one with him on the subject. But why prevent the student from taking the examination in Botany and Zoology before entering on his medical curriculum proper, if he has attended the professor's class and is ready for it? Very few would at present do so, as it would imply a preliminary year of attendance at the Universities to obtain the courses of Zoology and Botany. But is it not a very desirable thing, from every point of view, to encourage this? So far from lowering the standard in these subjects, or promoting cramming, it would do exactly the reverse. It would enable real study to take the place of the cramming which is inevitable when these subjects are left over to be mixed up with medical studies proper.

For some time there has been a strong feeling here that the examination in Zoology and Botany should take place not later than the end of the first year, and the Lord Rector of our University in taking this matter up, instead of tinkering as to particular dates, has announced the sound general principle that the student should be encouraged to take the subjects of Botany and Zoology before beginning his medical curriculum proper, with the view both of promoting a more real study of these sciences, and of clearing the subsequent medical curriculum for a more real study of the subjects which belong to it. I see nothing in the resolutions which our distinguished Lord Rector has laid before the University Court either suggesting or implying abolition of compulsory attendance on the professors' courses of Zoology and Botany, and Prof. Balfour might well have taken it for granted that the mere fact of the proposal emanating from Prof. Huxley is security enough that the object could not possibly be to lower the position of the natural sciences or to promote cramming instead of real study. Our Lord Rector has as yet only intimated his resolutions, but when the oracle speaks we shall no doubt hear such good reasons for them that even so enthusiastic a botanist as Prof. Balfour will have his alarm turned into joy.

Will any of those who are so strong on the point of compulsory attendance on courses of Zoology and Botany tell us why they do not say a word for Natural Philosophy? Including such subjects as heat, light, electricity, hydrostatics, pneumatics, optics, acoustics, it is surely of more importance than either of the other two, whether regarded educationally or in its bearing on modern medicine. Yet in the Scotch Universities there is no compulsion to attend a course of lectures on Natural Philosophy, and it is relegated to the preliminary examination in general education. The day is past for laying on additional compulsory courses of lectures, but it is surely not too much to say that the student might be allowed to profess and be examined in Natural Philosophy instead of one of the other two.

Aberdeen University, Dec. 20 JOHN STRUTHERS

The Distribution of Volcanoes

Some of the correspondence in your paper has latterly been so caustic, that timid people may be pardoned for shrinking from writing letters which bring down upon them the hammers of scorn and contempt so vigorously.

Notwithstanding this, the discussion between Mr. Mallet and Dr. Forbes about volcanoes tempts me to write to you on a side issue of that controversy in which I have been interested for some time. What I have to say may not be new, although I believe it to be so. At all events it is not commented upon in the books accessible to me. I will premise that, caring little for laurels of any kind but a good deal for instruction, that if it be discovered that what I say is stale and old, I hope I may be treated as an ignorant scholar, willing to learn, and not as a rival to be crushed, and further, that my results having been obtained independently, they support and make more sure the position of my predecessors.

You were good enough, some months ago, to print some letters of mine on the current elevation of the circumpolar regions of the earth. I have since accumulated much new matter on this subject, which will be shortly published in part in the Journal of the Geographical Society. The general result of my inquiry is, that all the large land surfaces of the earth, the large continental and insular surfaces, are more or less in process of gradual or rapid elevation. There are a few small areas of depression on the outskirts and borders of the great land-masses, but these are very local and unimportant. And with this slight exception the continents of North and South America, Asia, Europe, Africa, and Australia, are all more or less rising. This rise of the land-surfaces necessitates a corresponding sinking, either an absolute or a relative sinking, in the surfaces covered with water. It is comparatively easy to test where a land surface is gradually protruding from the water. It is not such a simple matter always to know whether this rise is relative or absolute, for the same effect may be produced by the sinking of the sea-floor as by the actual rising of the land. One thing only we know, that when our measure is water, there must be a corresponding sinking either relative or absolute where there is a rising elsewhere. Direct evidence of the sinking of the sea-bottom is not very easy to find, but such does exist. Students are familiar with the facts collected by Darwin and others, showing from the growth of coral islands, &c., that the Pacific is an area of depression; other evidence consists in the disappearance of well-known rocks, the

vigias of navigators in different parts of the greater oceans. From this and other evidence, I am very well satisfied that not only the Pacific, but also the North and South Atlantic and the Indian Oceans, are areas of depression.

Having thus roughly mapped out the world, it becomes an interesting problem to correlate the distribution of volcanoes with that of the rising and sinking land. If the older theory of volcanoes be the true one, that they are the direct results of the eruptive forces of the interior of the earth, we ought surely to meet with them in profusion in those large areas where we know the earth to be relatively rising, where in fact the eruptive force of which volcanoes are the supposed violent proofs is concentrated. Is this so? On the contrary; and it is this that forms the burden of my present letter. The fact is that we shall search in vain among the large areas of upheaval except along their boundaries and fringes for any active volcanoes. Take the northern circumpolar region, the most typical area of rising land in the world, and there is absolutely no volcano in it. The Iceland volcanoes and Jan Mayen happen to be outside the area of upheaval, and in a part of the Atlantic which is notoriously sinking. North America, another large area of rising land, is similarly bare of volcanoes. So is South America, save on the very verge of the Pacific, and that part of the Pacific which I believe to be sinking most rapidly. Australia is probably now rising faster than any area in the world save Spitzbergen, and there we have no volcanoes. Europe is similarly free except in that part of it which is sinking, namely, the Mediterranean border. Lastly, there is the vast continent of Asia, a large part of whose northern surface seems, from all the evidence we can collect, to have been quite recently under water and to be still rising. About Asia I wish to enlarge somewhat.

It was one of the peculiar fancies of Alexander Humboldt, the great authority on the Physical Geography of Asia, that there was a large active volcanic region in the Altai Mountains, &c., and he brought together a great deal of plausible matter to support this view.

As this volcanic region would be in the midst of one of the largest areas of elevation on the earth's surface, it would conflict materially with the evidence elsewhere and with the theory of the distribution of volcanoes for which I am arguing. Luckily for me it has been recently shown, so far as the negative results of those who have been to find Humboldt's volcanoes and have not found them, goes, that is, so far as the only scientific witnesses who have surveyed the region may be allowed to dogmatise, that Humboldt was entirely mistaken. I will quote the accounts of the Russian surveyors as they have been translated for the Geographical Society.

"It now remained for me," says Semenof, "to prove by actual observation the existence or otherwise of volcanic phenomena in Djungaria and in the Celestial Mountains, to which Humboldt in his works so often alludes. I started on my journey, firmly persuaded that I should find the conjectured volcanoes, or at all events some volcanic forms, and sought diligently (as Schrenck did on Lake Ala-kul) to establish the correctness of Humboldt's surmises with respect to the existence of volcanic phenomena in Central Asia, by which confirmation I knew a traveller would gain greater credit than by any incomplete refutation of the supposition. I was even aware that Humboldt was rather displeased with the researches of Schrenck, who clearly showed that the island of Aral-Tübe on Lake Ala-kul was not of volcanic origin. The opinions entertained by Humboldt on the subject of the existence of volcanoes in Djungaria were favourite ones with him, and I regret that I was not able to confirm his cherished theory. Kullok Peak, another of Humboldt's mistaken volcanoes, was found to have no volcanic origin whatever. The hot springs and the non-congelation of Lake Issyk-kul were not accompanied by any volcanic forms in the Tian Shan; and furthermore, all the native accounts of phenomena which from their description might be supposed to be volcanic proved unfounded, and were at once disposed of on my examination of the localities where they were declared to occur. The result, therefore, of my researches on this point was that I became convinced of the complete absence of volcanoes, typical volcanic phenomena, or even volcanic forms, throughout the Celestial Mountains. It is true that there existed in Djungaria at one period some solfatara, or smoking apertures, from which there was a discharge and deposit of sulphur, and that some of these fissures, out of which the Chinese obtain sulphur, emit smoke even at the present day. But a careful inspection of one of the extinguished pits satisfied me that, at all events in that case, there was no volcanic affinity. In the neighbourhood of the pits discovered by me in the Kater Mountains and in the Ili Valley, I could trace no volcanic forms. . . . The whole process of the formation of sulphur can then in my opinion be reasonably explained by the combustion of some coal seams in this basin, which would at once set at rest the question of supposed volcanic agency. . . . The observation of a single portion of the Tian Shan visited by me cannot serve as positive evidence of the absence of volcanoes and volcanic forms in other parts of this mountain chain. My conclusions on this question generally have already been made public in the letter referred to, but I must likewise observe in addition that all Asiatic accounts of phenomena which might be volcanic in appearance should be treated by men of science with great circumspection, as many of these accounts have already proved fallacious. I would here also remark that the impression produced on me personally by Djungaria and the Tian Shan leaves great doubts in my mind as to the existence of volcanoes in this part of Asia; and as I am the only traveller who has visited the Tian Shan, I cannot accept the belief in their existence as an axiom requiring no proof or confirmation. My conclusion on this point, though only negative, is one of the most important results of my journey." ("Djungaria and the Celestial Mountains," by P. P. Semenof, Journal of the Royal Geographical Society, 35-213.) Again, I will quote a later traveller, Mr. Severkof. He says—"There are no volcanic formations in the western portions of the Tian Shan which I surveyed. From eastern sources, Humboldt refers to evidences of volcanic action farther south in the Ak-tan, but even these are doubtful. Fire may be produced in the mountains even by the ignition of the seams of coal as well as of the carburetted hydrogen gas filling the caverns of the seams. This conjecture is supported by the circumstance that Messrs. Bagaslouski and Lehmann discovered, on their journey to Bockhara, a burning seam of coal in the mountains of the upper Zaraphan, a little to the south of the Ak-tan. Speaking generally of volcanic action in the Tian Shan and the surrounding regions, the geological surveys hitherto made from Khantengir (east of Issyk-kul, near the sources of the Tonta, Djergalan, Tekes, and Kegen) to the extreme western limits of the system, have given only negative results. To the east of Khantengir there are again seams of coal—for instance, at Kuldja, and perhaps also at Urumchi—the ignition of which is quite sufficient to create explosive gases. Whether the seams of coal were ignited at Urumchi by volcanic agency, or accidentally at their denudations, is a question that cannot be settled without close observation. It can only be said that the demonstrations in favour of volcanic action adduced by Humboldt are not sufficient proof of the volcanic origin of the Tian Shan, excepting only as regards the lava which, according to Chinese records, flowed from the Peshan mountain during the 6th century. But a single crater—even if the fact of its existence in an extensive mountain system extending, as the Tian Shan does, for 3,000 versts, can be proved—does not make the whole of the range volcanic. (Severkof's "Journey to the western portion of the Tian Shan," Royal Geographical Journal, 40, 395-6.)

This evidence, to my mind, completely refutes Humboldt, and makes it very clear that his volcanic region is non-existent. With the disappearance of this, disappears the only exception I know to the rule that volcanoes, instead of being found chiefly on areas of elevation, are invariably found in areas of depression, or on or close to the boundary lines which separate them from the areas of elevation. The meaning of this lesson, as I read it, I will reserve for another letter.

In conclusion, I wish to thank one of your correspondents in Tasmania for the fact he communicated to you about the rise of that island. I shall be very grateful to anyone who will send me other facts about areas of upheaval and subsidence, and their communications shall be cheerfully acknowledged when I publish them.

Derby House, Eccles HENRY H. HOWORTH

Spectra of Shooting Stars

IT may interest observers of shooting stars who attempt to obtain views of their spectra by the use of suitably adapted meteor-spectroscopes to indicate a peculiarity which seems to distinguish the larger meteors of the December star-shower, radiating annually from the direction of a point near θ Geminorum on the nights of the 10th, 11th, and 12th of December. Two such small bolides of this stream which appeared to me on December 9th, 1864, and on Thursday night last, the 11th inst., were characterised by a beautiful pale-green colour, like that of

the thallium flame in purity of tint, but perhaps of a slightly paler or lighter hue, and it remained uniform like the brightness of these meteors as long as they remained in sight, strongly suggesting that either copper, barium, thallium, silver, or some other element giving, in some of its combinations, an intensely green spectrum, was undergoing vivid ignition in their flame. As each of these bright meteors presented a sensibly round disc (the first several times brighter, and the second a little brighter than the planet Jupiter), without visible sparks or train of any other colour than that of the head which could give rise to the green colour by the effect of contrast, and yet the green hue was much more distinct than I have noticed in any other meteors, not omitting some bright ones accompanied by very ruddy streaks in the principal displays of November 14, it appears to be a distinguishing feature of the brighter meteors of the annual star-shower of December, to which it would be very useful on occasions of its future return to direct particular attention. The meteors of this star-shower are, however, seldom of very considerable brightness, and the occurrence of one such during its recent appearance not improbably marked its return during the present year with somewhat more than ordinary intensity. The meteor was simultaneously observed at Glasgow and at Newcastle upon Tyne, and its apparent paths among the constellations at those places, directed from the usual radiant point in Gemini, with the duration of its flight, will enable the real height and the speed of motion of one of the principal meteors of the shower to be pretty exactly ascertained.

During many hours of repeated observations under the most favourable conditions of the sky on the nights between the 23rd and the 30th ult., and again on the 5th of this month, when observers for the return of the shower of meteors belonging to Biela's comet were on the watch for its appearance at different places in England, Scotland and Ireland, the reports of their observations which have hitherto been communicated to the Luminous Meteor Committee of the British Association have been entirely negative, scarcely a single meteor of the few which were observed being recognised as belonging to the well-known radiant-point of the shower, which was so conspicuous last year in Andromeda. At various times during the night of the 27th of November itself, when the sky was generally clear, no meteors of this description were visible, and their absence on all the other nights when the state of the sky permitted a watch to be kept for them scarcely leaves any reasonable grounds for the supposition that even a comparatively insignificant return of last year's meteor-showers of the 24th and 27th of November has this year been visible in England on the same or on any very nearly adjacent dates. A. S. HERSCHEL

Newcastle-on-Tyne

Meteor Shower

FROM the reported weather in England it seems improbable that the Geminid meteor shower was well observed in England, and as the return was rather above the average a few particulars of what was seen here may at least be interesting.

The nights of the 10th and 11th, when the watch was kept, were exceedingly clear. Except for a quarter of an hour at the commencement of the first watch there was only one observer, then there were two. The position taken was a window, N.E., whence all was visible from about 3° from the zenith to the hills opposite (perhaps 10° or 15°), behind which only one meteor disappeared, whilst only one was noticed whose course was part hidden by the roof. The average per hour on the $1\frac{1}{2}$ hours' watch on the 10th must have been about 38, and on the 2 hours' watch on the 11th, 60. But the rate in the second hour was much in excess of the first; taking the two thus the result is, from 10–11, about 30, from 11–12 about 88. In all probability the rate would have not been much below in the morning hours, but having a cold I did not stop longer.

The brightness was, I think, rather below the average, but as tabulated it was as follows:—

Bright as	Jupiter	1
,,	Sirius	2
,,	1 magn. *	9
,,	2 ,,	17
,,	3 ,,	10
,,	4 ,,	23
,,	5 ,,	2

A comparison with the radiant points in Mr. R. P. Grey's list makes it seem that the meteors were distributed over at least *nine*, and that two of these are ones not included by him. Of these one seems pretty certainly fixed about R.A. 57° N.S 6°, and to this I have assigned 14 on the two nights. The other is more doubtful, two nearly parallel meteors appeared on the 10th, opposite in direction to the others; their point may be about R.A. 275° N.δ. 60°.

An apparent discrepancy in the total seen and the tabulated numbers is explained by the fact that some meteors were not well enough seen to be entered. But on the regular watch of the 11th I had the unusual success of entering every one seen, in consequence I believe of the position I had assumed, *i.e.* seeing less than half the heavens and *lying* on my back. Several cases of almost, or perfectly, simultaneous meteors appeared, but of these only 4 pairs were from the same radiant.

J. EDMUND CLARK

Heidelberg, Dec. 16

THE LATE PROFESSOR DE LA RIVE

SWITZERLAND has in one month been shorn of two of her most distinguished ornaments. De La Rive and Agassiz have died within a fortnight of each other, and the "Académie des Sciences" has thus been deprived in the same month of a fourth of its Foreign Associates. Agassiz will no doubt find, both in Switzerland and America, more than one pen competent to describe his labours in the field of science; but a few lines on the life and researches of de la Rive are due to this distinguished philosopher, and will be read with interest in this country, which he has often visited, and in which he had many friends.

Born at Geneva in 1801, of an old family closely connected with Cavour, Auguste de la Rive inherited from his father the love of science in general, and more especially of electricity. After going through the usual course of studies with brilliant success, he was, at the early age of twenty-two, called to the Chair of Natural Philosophy in the Academy of Geneva, and took his seat amongst the distinguished men of that city.

Although de la Rive devoted his time principally to the study of the different branches of electricity and their numerous applications, his acquirements were not limited to that department of science. During the earlier part of his career the subject of specific heat, more particularly applied to gases, and a series of experiments on the temperature of the crust of the earth, were published by him conjointly with a friend and colleague. But electricity remained his favourite study to the end of his life. The treatise he published between the years 1853 and 1858, in three large octavo volumes on the subject of electricity, translated into English by Mr. C. Walker, F.R.S., and the numerous original articles which appeared in the well-known monthly journal, *Les Archives d'Electricité*, for many years under the direction of de la Rive, afford ample proof of the extent of his information on all subjects connected with his favourite pursuit. His original memoirs on electro-dynamics, magnetism, the connection of magnetism with electricity, the nature of the voltaic arc, and on the propagation of electricity in the interior of bodies, more especially through extremely rarefied media, and others too numerous to be quoted, ensured him a high European reputation, to which was soon added the title of Member or Correspondent of almost every scientific body in Europe. In 1840 he was named Correspondent of the French Académie des Sciences; in 1846, Foreign Member of the Royal Society, and finally in 1864 he was elected Foreign Associate of the Académie des Sciences, the highest honour to which a man of science can aspire.

It was de la Rive who first conceived the idea of applying the force of electricity, through the means of alkaline solutions, to the gilding of silver and brass, and

he thus laid down the groundwork of the principle by which thanks to the practical improvements introduced soon after by Messrs. Elkington and Ruolz, electric gilding has gradually superseded the deleterious process of gilding by mercury. It was on this occasion that the grand prize of 3,000 fr. was awarded to de la Rive by the French Academie des Sciences.

A long and patient study of the phenomena which accompany the aurora borealis, and of their apparent connection, both with the properties exhibited by the flame of the Voltaic arc when under the influence of a magnet, and with the passage of the electric fluid through extremely rarefied gases, gradually led de la Rive to a new theory on the electric origin of the aurora. His theory was illustrated, and to a certain extent rendered plausible, by a series of beautiful experiments, reproducing in the lecture-room, through artificial means, the varied phenomena which characterise the aurora. These experiments were made first at Geneva, and some time after repeated at Paris before some of the most distinguished members of the French Institute.

But de la Rive's acquirements were not limited to science. The noble use he made of his fortune, the well-known hospitality which rendered his country house near Geneva for nearly forty years a centre of attraction to the most distinguished scientific and literary society of Europe, the high tone of his character, and the many services he rendered his country, more particularly when called upon in 1860 to use the influence of his name and position in obtaining from the English Government an effectual support for Switzerland against the threatened danger of French aggression, have secured to his memory a popularity which will long survive him.

VIVISECTION

THE advance of culture has brought with it an increased tenderness, and a more solicitous regard for the feelings of others, a regard extending slowly but surely to the feelings of animals also. It is to Science that this advance is mainly due. Only by gaining clear conceptions of natural sequences can men be brought to repress their native tendency to inflict pain as an exertion of power, or to feel ashamed of their thoughtless indifference when they see pain inflicted by others. It is demonstrable that Ignorance has ever been the most potent ally of Cruelty—on the small scale of boys torturing animals, and on the large scale of priests torturing heretics. The boy can only be made to feel that his act is vicious by having a vivid imagination of the fact that the animal organism is constructed like his own, and that the animal suffers as he suffers. The holy inquisitor, or enthroned persecutor, can only be made to see that his attempt to combat heresy by an *auto-da-fé*, is flagrantly at variance with all psychological experience. If the vast cruelties of persecuting "fanatics" have become intolerable in modern society, it is assuredly from no dogmatic teaching, no insistence on charity and love, but wholly from a moral enlightenment coming with a larger and more accurate understanding of natural sequences.

Not only has Science been a great agent in evolving the sympathies, and creating the intense desire to avoid giving pain, it has also created the means of alleviating pain. Is not the whole skill of the surgeon and the physician devoted to this end? How comes it, then, that physiologists who have to supply the surgeon and physician with accurate data, which they can only reach through Experiment, are supposed to be less sympathetic, less careful of the feelings of animals, than other men? A candid person would at once admit that this was not so; would admit that physiologists are quite as unwilling to inflict *unnecessary* pain as men of other classes. But because Vivisection is one of the branches of physiological Experiment, and because when the details of such vivisections are reported, the public reading these, and wholly unacquainted both with the purpose and the procedure, is shocked at what seems needless cruelty, a cry of indignation naturally escapes, and the experimenter is regarded as indifferent to the sufferings of animals.

Every thinking man will admit that the feeling which prompts this indignant cry is highly laudable, and every man who understands the real case will declare that this feeling is misguided by ignorance. For what is the fact? The fact is, that in the vast majority of experiments no pain is inflicted, the operations that are painful being performed under chloroform, and thus the animal which has undergone an operation which would have killed it, had it not been insensible, awakens from the coma and begins tranquilly eating the food before it, as if nothing but a sleep had gone before! In some cases, indeed, pain *is* unavoidable; in some it is part of the phenomenon investigated. But this procedure is not chosen in wantonness, or the thoughtlessness of cruelty. The operation is justified by its purpose. If the tender surgeon inflicts pain, it is to save pain; if the physiologist inflicts pain, it is to widen knowledge, and thus alleviate pain on a wide scale. This is very different from the pain inflicted for the sake of *sport;* very different from the measureless misery of wars, inflicted to gratify national vanity or commercial greed. The physiologist does not inflict pain for his own pleasure; he overcomes his repugnance to it, as he overcomes his repugnance to the sights of the amphitheatre and hospital, nerved by a sense of ulterior good.

Here we meet the question raised by "X.," whether man is justified in inflicting pain on animals to secure the good of fellow-men? I unhesitatingly answer, Yes. It is quite certain that man does assume and assert supremacy, eating, subduing, and exterminating animals, according to his needs; and I would ask whether human life would be practicable on this globe on other conditions? Why, there is seldom a spade thrust into the earth that does not cut some worm into writhing halves. If this be excused as a painful necessity, then also must vivisection be excused as a painful necessity; if the one is necessary to food, the other is necessary to knowledge. The physiologist is the judge of the necessity; on him rests the responsibility.

And now a word on the particular experiments which called forth X.'s protest. Obviously, since testing sensibility was the very purpose in view, Prof. Goltz, Prof. Foster, and myself were forced either to forego the inquiry, or to inflict more or less pain, and (if need were) excessive pain. Perhaps X. will say that such an inquiry ought not to have been pursued at such a cost. We thought otherwise. The point cannot be argued now; but I would illustrate what has been just said, by informing X. that even here anæsthetics were used where they could be used—when I removed the skin from the legs or the body of the frogs, or took out their brains, the animals were wholly insensible; and dreadful as it may seem to read of their limbs being pricked, and burned, we are assured that no pain whatever, not even the feeling of contact, was felt by the frogs.

In conclusion, I would urge upon the opponents of Vivisection, that it would be but fair to credit physiologists with the same repugnance to the infliction of pain as animates all enlightened classes; and to consider that if the repugnance is overcome in the pursuit of physiological knowledge, it does not the less exist, nor the less guide their conduct in other cases. For myself, I may be permitted to add that so far from acknowledging indifference to the feelings of animals, my sympathies are unusually active in the direction of animals; and it was my inability to witness pain which prevented my pursuing the

profession of a surgeon. Nevertheless, I have performed hundreds of experiments; and in the very rare cases where great pain was inevitable, the performance has been very distressing; but in all cases I should vehemently protest against the accusation that it was indifference or cruelty which enabled the experiments to be performed.

It is but right that I should acknowledge that Prof. Foster's communication of December 11 has shown me the error of my interpretation of his hypothesis.

George Henry Lewes

I WISH briefly to point out the grounds upon which persons who are every bit as tender-hearted and as sympathetic with Nature as any ante-vivisectionist may claim to be, justify what X. condemns. In order that a part of the order of Nature may be ascertained, it is necessary that vivisection be largely practised. Those who practise it do so under a sense of solemn and even sacred responsibility. To suggest the word "cruelty" in connection with their proceedings is an injustice which only profound ignorance and inability to realise the motives of other men can excuse. There is no lack of sympathy with the probable sufferings of animals experimented upon in the mind of the physiologist. He suffers with them, and, as I know of one eminent experimenter, is sometimes disabled by emotion from continuing a research. But the recognition of a higher duty than regard to his own transient impulses or the brief sufferings of a lower animal usually completely controls the experimenter's thought and action, and the mutual suffering of both vivisector and vivisected becomes a sacrifice offered up on the altar of Science. My conviction is that, especially in dealing with such animals as the dog, the experimenter is no less constrained to inflict suffering at which his feelings revolt, by the presence of a noble ulterior motive, than is the surgeon who does not flinch from subjecting his brother-man to the certainty of the direst pain and the imminent risk of death.

No one has a right to *assume* that any other man, still less a whole body of men, is so fiendish as to take any pleasure in the evidences of an animal's sufferings, or so dull as not himself to feel distress when viewing those sufferings. If man is willing to suffer this mental pain for a high end, may he not exact some contribution from the animal world, who after all will benefit as well as he by the progress of Science. It is futile to bewail "the tremendous cost" at which such progress is made. Nature is inconceivably costly, if we choose to put things in that way, for no progress is made without endless suffering and immense destruction. Our very dinner-tables reek with the evidences of "the tremendous cost"—the pangs of slaughtered sheep, the groans of over-worked horses, the disfigurement of Nature's sacred face by agriculture—by which our corporeal means of progress is attained. And are we to be so inconsistent as to refuse to undertake the very highest occupation of humanity, the ascertainment of the order of Nature, because it adds to this "cost" of our existence?

The attempt to raise the question of the "rights" of the animal world in this connection seems to me to involve a very large assumption. I am not prepared to admit that animals have *any* "rights" in the sense that men have them. I could never subject a human being to vivisection for the purposes of scientific progress for much the same reason that, if starving among the Arctic snows, I should feel bound to starve with my companion, rather than kill and feed on him. The recognition of the inviolability of one's fellow-man except under conditions authorised by the community, is the very foundation of human society, and our relations to animals cannot in the remotest degree be assimilated to the relation thus established between man and man. Our conduct towards animals, as towards other living and even inanimate things, must be determined in quite a different way, and by very different reasons. It is, I am inclined to believe, solely the consideration of how we ourselves are affected—whether injuriously or beneficially—by any particular line of conduct towards beings other than men, that can be allowed to guide us in such matters. Anything of the nature of cruelty is obviously thus condemned, and all wanton disrespect to the persons of both living and inanimate things, no less so.

Whilst thus refusing to admit anything like the "right" claimed by man from man, for lower animals, we are not led to regard them with less affection, nor to treat them with diminished tenderness. The conviction that they are ours with which to do what seems good to us, must even increase our disposition to kindly treatment.

Let cases of cruelty, whether from man to man, to woman or child, to horse, fox, or dog, rabbit or frog, be searched out, exposed, and the perpetrator condemned; but unless such persons as X. are prepared to accuse such men as Michael Foster and George Henry Lewes of specific acts of cruelty, they are not justified in making physiology the text for heart-rending appeals to a public imperfectly acquainted with the facts.

E. R. L.

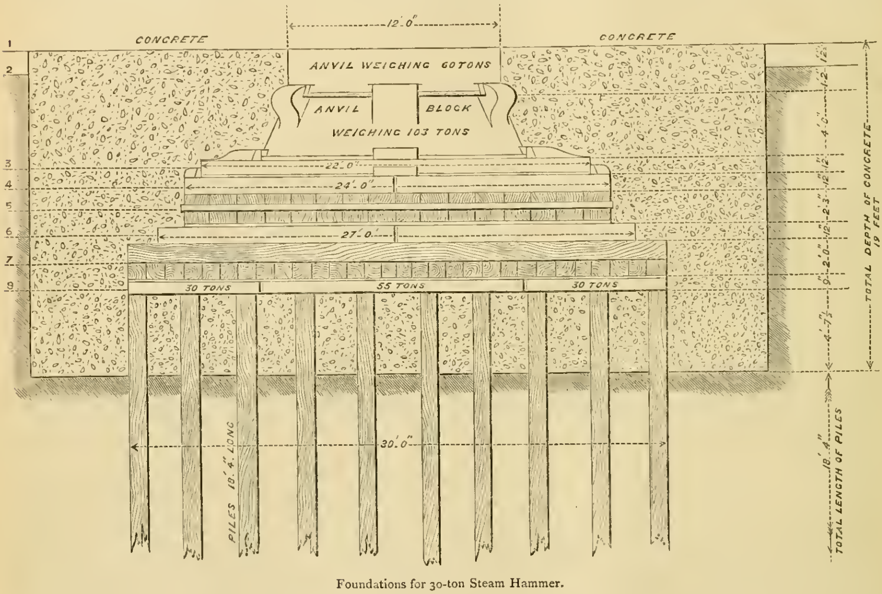
THE THIRTY-TON STEAM-HAMMER AT THE ROYAL ARSENAL, WOOLWICH

FOR the past two years a stupendous undertaking has been in course of development at the Royal Arsenal, Woolwich, which bids fair to rival in point of solidity and grandeur of dimensions the works of ancient Egypt itself. We allude to the gigantic steam-hammer which is being erected in the gun factories, for the purpose of welding more swiftly and efficaciously than can possibly be done at present the coils of which such massive pieces of ordnance as our modern "Woolwich Infants" consist. The first phase in this undertaking, viz. the laying of an appropriate foundation for the hammer, has now been accomplished, and will be the subject of the present paper. The hammer itself, which is still in an unfinished condition, although rapidly approaching completion, will be treated of subsequently. It is out of the question, in the compass of a brief sketch, to give an adequate idea of all the labour and thought that has been expended upon these foundations, but an endeavour will be made to condense as far as possible the most interesting part of their history into a few words.

The foundations were commenced in a soft, spongy soil, which is the substratum upon which all the Arsenal has been built. A hundred piles of pine-wood shod with iron a foot square each, were driven into the earth so as to form an area of thirty feet square; and when the heads were sawn off to an even surface, their average length was 18 feet 4 inches. Concrete was then filled in all round to the top of the piles, and three cast-iron plates, weighing respectively 30, 55, and 30 tons, were placed upon the heads of the piles. But before proceeding further with the building up of the foundations, we must describe the nature of the castings alluded to. They were all run in the foundry of the Royal Gun Factories, and consisted of about one-fifth of Calder pig-iron to four-fifths of scrap metal containing old broken-up shell, and shot, &c. The metal, after being taken from a number of cupolas in which it was melted, was collected in huge reservoirs, called "sows," and kept in a liquid state during the time necessarily occupied in filling the sows by a quantity of firewood being piled on top, which of course was continually in a state of ignition. This process occupied some eight or ten hours. At a given signal the sows were tapped, and the iron run out into open sand moulds in the floor of the foundry. The removal of these gigantic castings to their destination was a matter involving considerable difficulty. Two sets of worn-out gun-trucks were laid down upon either side of the road, and planks

of African oak, placed longitudinally upon these, thus forming a rude railway. Rollers consisting of the unworked tubes of guns were then obtained from the gun factories, and laid across the planks. A sleigh, composed of two massive bars of wrought-iron turned up in front, and attached together by baulks of timber, was then placed upon the rollers, and surmounted first by the cast-iron plate to be carried, then by a movable or revolving crane. The sleigh being drawn forwards by a crab-winch and tackling, as the rollers were successively passed over the crane lifted up those that were behind, and, swinging round, deposited them in front, presenting a fresh rolling surface upon each occasion. Thus the plates were each slowly moved from the foundry to the foundation pit. But there was another difficulty. As it was necessary to have "joggles," or projections npon the summit of several of the plates for the superincumbent ones to rest within, and in open castings it was impossible to cast them upon an upper surface, the joggles had to be formed upon the lower surface, and the plates to be reversed in position afterwards. This was done by casting trunnions upon the edges of the plates, nearer one end than the other, and then swinging the plates over the foundation pit by these trunnions, until the heavier half descended, drawing back the heavier portion by a crab-winch, and finally permitting the lighter portion gradually to descend, the trunnion supports being withdrawn, and the edge of the plate resting on the ground forming a fulcrum. The trunnions do not appear in our engraving, but the joggles may be seen upon the three upper sets of castings.

We will now revert to the laying of the foundations. Over the whole extent of the lower plates a thin layer of rock-elm planks was laid, this being the most indestructible kind of wood known, it being necessary to



Foundations for 30-ton Steam Hammer.

1, Proposed floor; 2, Present ground line; 3, Single block weighing 98 tons; 4, Two weighing 65 tons each; 5, Oak stumps on end with band; 6, Two blocks of 75 tons each; 7, Oak baulks crossed; 8, Three blocks.

produce a perfectly even surface for the baulks of timber which come next. These were of oak, thirty feet long, and a foot square. Upon the baulks of oak rest two more plates of cast-iron, twenty-seven feet long, and thirteen feet six inches wide, and weighing each seventy-five tons. They are connected by huge dove-tails cast into the metal itself, as are also the two lower ones, and all the other plates which are in the same horizontal plane. A liquid called "grouting," formed of very thin watery concrete, is poured in between the joints of the plates so as to fill up all interstices, and holes are made in several places through the castings, so as to admit of the grouting freely percolating everywhere. Upon the two plates are more planks of rock-elm, and then a layer of oak stumps two feet three inches long, placed upright, and surrounded by a band of wrought-iron, six inches wide by two inches thick. All the remainder of the foundation pit was filled in with concrete as the work gradually proceeded upwards. Upon the oak stumps are two plates, weighing each sixty-five tons, and forming a square of twenty-four feet. A thin layer of rock-elm planks separates them from a huge single casting, twenty-two feet square, and weighing very nearly 100 tons. Wedges within the joggles of the 65-ton plates fix firmly the single one above, and it in its turn supports the enormous anvil block weighing 103 tons, over which will come the anvil itself, but that is not yet in position. The anvil block was cast in a closed mould, which rested upon a substratum of coke and bricks with passages left filled with straw for the exit of the gas generated; it took, nevertheless, *six months* to cool, and could not be removed until after the manufacture and removal of several subsequent castings. Such is a short review of the principal features in the construction of these foundations; all other information as to details in dimensions, &c., may be obtained from the accompanying engraving. About 660 tons of metal have been made use of in completing them.

THE COMMON FROG *

VII.

THE skull of the frog presents numerous points of interest, but only four of these can be here referred to, as other matters demand our attention.

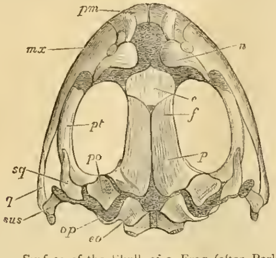


FIG. 37.—Upper Surface of the Skull of a Frog (after Parker). *e*, os en ceinture, or girdle-bone; *eo*, exoccipital; *f*, frontal part of frontoparietal bone; *mx*, maxillary bone; *n*, nasal; *op*, opisthotic; *p*, parietal part of fronto-parietal bone; *pm*, pre-maxilla; *po*, pro-otic; *pt*, pterygoid; *q*, quadrato-jugal; *sq*, squamosal; *sus*, suspensorium of lower jaw.

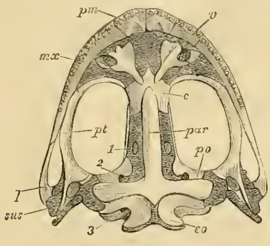


FIG. 38.—Under Surface of the Skull of a Frog (after Parker). *e*, girdle-bone; *eo*, exoccipital; *mx*, maxilla; *par*, parasphenoid; *pm*, pre-maxilla; *po*, pro-otic; *pt*, pterygoid; *q*, quadrato-jugal; *sus*, suspensorium of lower jaw, the lower end of which represents the quadrate bone; *v*, vomer; 1, optic foramen; 2, foramen ovale; 3, condyloid foramen.

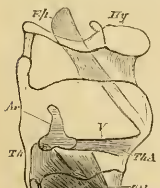


FIG. 39.

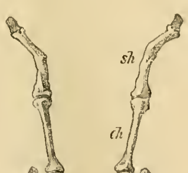


FIG. 40.

FIG. 39.—Diagram of the Larynx of Man, the thyroid cartilage being supposed to be transparent, and allowing the right arytenoid cartilage (*Ar*), vocal ligament (*V*), and thyro-arytenoid muscle (*Th A*), the upper part of the cricoid cartilage (*Cr*), and the attachment of the epiglottis (*Ep*), to be seen. *C th*, the right cricothyroid muscle; *Tr*, the trachea; *Hy*, the body of the hyoid bone. The right lesser cornu appears as a very small process, extending upwards and backwards from the body of the hyoid behind the letters *Hy*, and in front of the Epiglottis. The right great cornu is shown extending backwards from the body of the Hyoid and terminating beneath the letters *Ep*

FIG. 40—Extracranial portion of hyoidean apparatus of Dog, front views *sh*, stylohyal; *eh*, epihyal; *ch*, ceratohyal (these three constitute the "anterior cornu"); *bh*, basihyal, or "body" of hyoid; *th*, thyrohyal, or "posterior cornu." (From Flower's "Osteology.")

* Continued from p. 110

The first of these four relates to its mode of articulation with the vertebral column. As has been said the first vertebra presents a pair of concavities to the skull. The skull develops from its hinder (or occipital) region a cor-

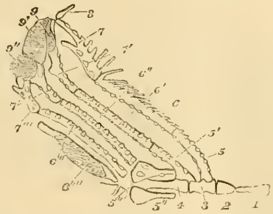


FIG. 41. FIG. 42.

FIG. 41.—Skeleton of left series of Branchial Arches of a Perch, seen from above. 1, glosso-hyal; 2, 3, and 4, basi-branchials; 5, hypo-branchials; 6, cerato-branchials; 7, epi-branchials; 8, styliform pharyngo-branchials; 9, pharyngo-branchials; 6'''', inferior pharyngeal bone; 9' and 9'', superior pharyngeal bones; 5, 6, 7, and 8, first branchial arch; 5', 6', 7', and 9, second branchial arch; 5'', 6'', 7'', and 9', third branchial arch: 5'', 6''', and 7''', fourth branchial arch; 6'''', fifth branchial arch.

FIG. 42.—First three Branchial Arches from the left side of a Perch. On the outer (convex) side of each branchial arch the series of closely-set gill filaments (or leaflets or lamellæ) are seen to be attached. On the inner (concave) side of the first branchial arch are the series of elongated processes (supporting minute denticles) which help to prevent particles of food, or other foreign bodies, passing from the mouth to the gill chamber.

responding pair of articular convexities or "condyles." Now in this matter the frog differs from both birds and

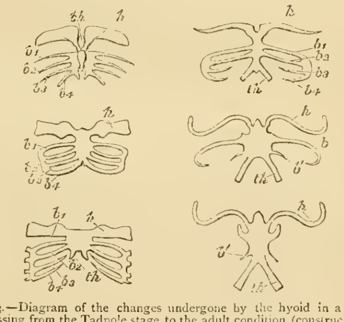


FIG. 43.—Diagram of the changes undergone by the hyoid in a Frog in passing from the Tadpole stage to the adult condition (constructed from Parker's Memoir). Uppermost left-hand figure, the youngest condition; lowest right-hand figure, the adult. *h*, the hyoidean arch, ultimately the corniculum; *b*1—*b*4, the four branchial arches which become gradually atrophied, the cornua (or thyro-hyal), *th* being their representative in the adult; *b'*, another branchial rudiment; *bh*, the body of the hyoid.

reptiles, every member of those classes possessing a single median (occipital) condyle for articulation with the vertebral column.

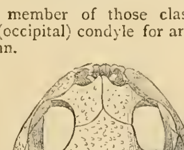


FIG. 44.—Dorsal view of skull of *Pelobates*, showing bony lamellæ behind the orbits.

Yet every member of the frog class, not only every toad and newt, but also every species of the Ophiomorpha, and even every one of the long extinct Labyrinthodons (with the doubtful exception of the probably immature and

larval *Archegosaurus*) has a similar pair of occipital condyles. The interesting matter is that man and all beasts have also two occipital condyles. Is this then a mark of affinity, and can we, as it were, reach beasts by a short cut through Batrachians, leaving all the reptiles and birds on one side, as a special outstanding and diverging development?

We shall presently see that other yet more striking facts may be brought forward in support of the latter view. Nevertheless it must be remembered that there are fishes, thongh very few and exceptional, which also possess a pair of occipital condyles, and that in one respect most fishes are more like mammals than are any Batrachians since they, like mammals, have a well ossified median bone at the base of the skull in the occipital region, a structure which all Batrachians, without a single exception, are destitute of.

The second point of interest concerns the lower part, or base, of the skull, which exhibits a striking agreement with the same part as developed in bony fishes.

This agreement consists in the fact that the middle of the floor of the skull is not formed as in all beasts, birds, and reptiles, by a deposition of bony substance in preexisting gristle (ossification of cartilage), to which name *Basi-sphenoid* is applied, but, as in bony fishes, by a great bone called *Parasphenoid*, which shoots forwards and also extends backwards to the hinder end of the skull floor, but is formed by the deposition of bony substance in preexisting membrane. (Fig. 38, *par.*)

Although this great membrane bone is constant in Batrachians and bony fishes, and is represented, if at all, only by minute rudiments in higher vertebrates; nevertheless in serpents we once more meet with a far-reaching and well-developed parasphenoid.

Yet it can hardly be conceived that serpents have carried off from Piscine ancestors and carefully preserved this peculiarity of structure which all their other class fellows have lost. It seems much more probable that this structure has independently appeared through the action of peculiar conditions, and hence that we have here again a remarkable instance of the independent origin of similar structures.

The third peculiarity of the frog's skull consists in the form and conditions of the bony supports of the tongue.

It would not be easy to find a better example of the need of widely extended observations in order duly to understand structures apparently very simple indeed.

The bone of the tongue in man—the *os hyoides**—is a small structure, and one to all appearance of little significance. It is placed at the root of the tongue and above the larynx, and consists of a body with a pair of processes on each side, one large (the posterior or great cornu), and one small (the anterior or lesser cornu, or corniculum).

Even in man's own class (mammalia) the relative development of the parts may vary greatly. Thus the cornicula may be large and may each be represented by two or three distinct applications as in the dog and horse.

The cornua also may take on a development very much greater than that existing in man as is the case in some other Mammals. These facts may prepare us to expect much greater divergences in lower forms; and yet throughout the two great classes of birds and reptiles (as well as beasts)—though varying conditions as to the proportions of the parts present themselves—the os hyoides continues essentially the same in structure, and even in the adult frog this bone exhibits nothing but a rather wide "body" with two long and slender "cornicula" and a pair of shorter "cornua."

Let us now pass for a moment to the other end of the vertebrate sub-kingdom. We find in fishes a complex framework for the support of the gills, or structures, by which they effect their aquatic respiration. This framework consists of a number of arches (placed in series one behind another) extending on each side of the throat upwards towards the backbone, and supporting on their outer sides the gills or branchia, cn which account they are called the *branchial arches*. In front of these arches and forming as it were the first of the series, is an arch which ascends and becomes connected with the skull.

Turning now to those Batrachians which breathe throughout their lives in the manner of fishes, we find a corresponding system of branchial arches. Thus in the Siren we find a series of gill-supporting branchial arches, placed behind another arch which is connected with the skull.

But the frog passes the first part of its life in a fish-like manner, and in the tadpole accordingly we find an apparatus similar to that of the Siren. There are, in fact, on each side of the throat, four branchial arches, placed behind another arch, which is connected with the skull. As development proceeds these *branchial* arches become gradually absorbed and all but disappear. Relics of them, however, exist even in the adult condition, and thus serve to indicate the true nature of parts which otherwise would be little understood.

The central portion of the structure—that from which arches diverge on each side—increases in relative as well as absolute size, and becomes the "body" of the *os hyoides*. That arch on each side which is connected with the skull and is placed immediately in front of the branchial arches, continues to be so connected and becomes one of the two "cornicula," while the rudimentary relics of the branchial arches which persist become what we have seen in the adult as the cornua of the *os hyoides*.

Thus the anatomy of the tongue-bone of the frog, studied in its progressive changes, reveals to us that otherwise unsuspected relations exist in certain parts of the tongue-bone of man. It exhibits to us the coruna of his *os hyoides* as related to those large and complex branchial arches which play so important a part in the fish and form so relatively large a portion of its skeleton.

The fourth circumstance (the last here to be noticed) connected with the frog's skull concerns the relative position and size of certain of its enveloping bones.

When the skull of the frog is viewed from above, a large vacuity is seen to exist on each side, between the brain-case and the great arch of the upper jaw. In the hinder part of this space is situate the temporal muscle, which by its contraction pulls up the lower jaw and closes the mouth; and the hollow in which this muscle lies is called the temporal fossa.

In a certain frog before noticed, called *Pelobates*, as also in *Calyptocephalus*, a similar view of the skull exhibits no such great vacuity. The reason of such absence is that the temporal fossa in these animals is roofed over and enclosed by the meeting together of bony lamellæ developed from the bones surrounding it, which thus bound the orbit posteriorly, and give to the cranium an altogether false appearance of great capacity.

This very singular structure is found to exist also in the marine turtles, amongst the Chelonians, and here we have another striking resemblance between the Chelonia and the Anoura, apparently reinforcing the argument for the existence of real affinity derived from the presence of such bony dorsal shields in both those two orders. The importance of this character might seem the more unquestionable, since no other reptiles and no birds or beasts whatever were known to exhibit a similar structure.

Quite recently, however, Prof Alphonse Milne-Edwards has described a beast from Africa (*Lophiomys*) belonging to the Rodent (rat, rabbit, and squirrel) order, which has a skull, the temporal fossa of which is similarly enclosed by bony plates.

This unexpected discovery completely destroys any weight which might be attached to this character as an evidence of genetic affinity. It does so because it is inconceivable this Rodent should have directly descended

* So named from its resemblance to the Greek letter υ.

from a common progenitor of frogs and of Chelonians through a line of ancestors which never lost this cranial shield, though the ancestors of all other beasts, all birds, and all reptiles, except turtles, *did* lose it. It is inconceivable, for if it were true a variety of the lowest mammals (Marsupials * and Monotremes †) must have less diverged from the ancient common stock than have the members of the Rodent order, and nevertheless these lowest mammals exhibit no trace whatever of such a cranial shield.

Here then we have an undoubted example of the independent origin of structures so similar that at first sight their similarity might well have been deemed a conclusive evidence of affinity.

Here, also, we have a memorable caution against hasty

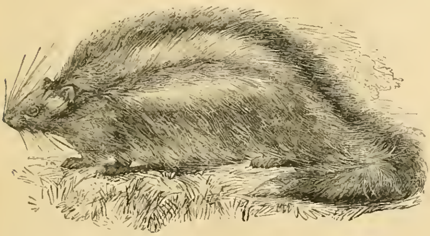


Fig. 45.—External form of *Lophiomys*.

inferences from structural similarities. If this resemblance and that of the dorsal shields are, when taken together, no signs whatever of special genetic affinity—it is difficult to say what structural likenesses are to be deemed unquestionable evidences of a common ancestry.

Passing now to the skeleton of the limbs, we come to a character of great significance, as it is one which serves to distinguish all the limbed species of the frog's class from lower vertebrates. The character is very significant, because all Batrachians, in spite of their numerous and important fish affinities, differ from all fishes, and agree with all higher classes in that they—if they have limbs at all—have them divided into those very typical segments which exist in man; namely, shoulder-bones, arm-bones, wrist-bones, and hand-bones; and into haunch-bones, leg-bones, ankle-bones, and foot-bones respectively. It is difficult, then, to avoid the belief that in the Batrachian

Fig. 46.—Lateral view of skull of *Lophiomys*, showing bony lamellæ behind the orbit.

class we come upon the first appearance of vertebrate limbs, differentiated in a fashion which thenceforward becomes universal.

The bones of the wrist in the frog, again, present a nearer resemblance to those in man than do those of most reptiles, and this is still more the case in some other members of the frog's class, *e.g. Salamandra* and other Efts. Nevertheless, there are certain reptiles, and, strange to say, they are once more Chelonians, which agree in this resemblance—as may be seen in the hand of the tortoise—*Chelydra serpentina*.

* *i.e.* opossums, kangaroos, &c.
† The Ornithorhynchus and Echidna.

The bones of the fingers show, moreover, a greater likeness, in certain respects, to those of beasts than to those of reptiles. No finger has a greater number of joints than three, while, in some lizards, the fourth digit may have as many as five joints.

In the frog the wrist-bones (called respectively the magnum and unciforme) which support the third, fourth, and the little fingers, are formed together into a single ossicle. The same condition, however, sometimes occurs even in the orang. On the other hand, the single bone which in man and beasts supports both the "ring" and the "little" fingers, may be represented by two ossicles in the frog's class (or *e.g.* in *Salamandra*) and in some reptiles (as in *e g. Chelydra*).

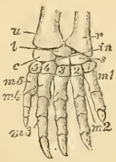


Fig. 47.

Fig. 48.

Fig. 47.—Dorsal surface of skeleton of right hand of the Tortoise, *Chelydra* (after Gegenbaur). *c*, cuneiforme; *in*, intermedium (or centrale); *l*, lunare; m^1-m^5, metacarpals; *r*, radius; *s*, scaphoides; *u*, ulna; 1—5, the five distal carpals, namely—1, trapezium; 2, trapezoides; 3, magnum; 4 and 5, divided unciforme.

Fig. 48.—Outer side of right os innominatum of Man. *a*, acetabulum; *ai*, anterior inferior spinous process of the ilium; *as*, anterior superior spinous process of the ilium; *c*, crest of the ilium; *ip*, ilio-pectineal eminence; *o*, obdurator foramen; *p*, pubis—its horizontal ramus; posterior inferior spinous process; *ps*, posterior superior spinous process; *s*, spine of the ischium; *t*, tuberosity of the ischium.

No member of the frog's class which has an arm at all, bears less than two fingers (as does *Proteus*) upon it. Thus we meet with a number as small as that which is developed amongst beasts in ruminants, but not so small a number as in the horse.

In the rudimentary condition of its thumb the frog participates in a very common defect, since this member

Fig. 49.

Fig. 50.

Fig. 49.—Right side of Pelvis of Frog. *il*, ilium; *is*, ischium; *p*, pubis The three bones meet at the uppper margin of the acetabulum.

Fig. 50.—Dorsal view of pelvis of Frog, showing the narrow ends of the ilia for attachment to the backbone, and also the close approximation of the acetabula.

is absent in very many forms. It is so even in creatures as highly organised and as like man in bodily structure as monkeys, since both the spider-monkeys of America and certain long-tailed monkeys (*Colobi*) of Africa, are thumbless.

In man, when standing, the weight of the body is transferred to the limbs by a large bony girdle, which, from its basin-like shape, is called the *pelvis*,

This basin consists of the two haunch bones which meet together in front, but behind are separated by the lower part of the backbone (called the sacrum), to which the haunch bones are attached, and which forms the hinder portion of the pelvis. The pelvis has a depression, or "socket," on each side, into which fits the head of one of the thigh bones. Each "haunch bone" consists of three parts, which are, in man, primitively distinct, but afterwards anchylose together, and all three elements (in each haunch bone) take a share in the formation of the bony thigh-socket, or *acetabulum*. These three elements are named—1, *ilium;* 2, *ischium;* and 3, *pubis*. It is the ilium which is adjoined to the sacrum. The pubis, in man, meets its fellow of the opposite side in the middle line in the front of the body. The two ischia (one to each haunch bone) support man's body when in a sitting posture.

The pelvis of man is often quoted as one of the most peculiar and characteristic parts of his skeleton, and its shape in him *is* very peculiar. Nevertheless the pelvis as it exists in frogs and toads is a far more exceptional structure. It is so in the extraordinary elongation, yet small vertebral attachment, of the haunch bones *ilia*, as also in the fact that these bones as well as the other pelvic elements (*ischia* and *pubes*) are all closely applied to each other in the middle line of the body. Thus these elements form a bony disc, and the two sockets (*acetabula*) destined, respectively, for the heads of the two thigh bones, come to be closely approximated one against the other. The great elongation and small attachments of the ilia allow the pelvis as a whole to be bent upon the backbone. Thus the hinder part of the body is moveable and forms as it were an additional common root segment for the two limbs.

St. George Mivart

(*To be continued.*)

SOUNDINGS IN THE NORTH PACIFIC

Over a year ago the United States Congress authorised preliminary measures for laying a submarine cable from the west coast of America to Japan. The United States steamer *Tuscarora*, then on duty off the Isthmus of Darien, was despatched on this business, and started September 22, 1873, from San Francisco for the Straits of Juan de Fuca. Reconnaissances off Victoria, Vancouver's Island, discovered a gradually shelving bottom in all respects suitable for a cable landing. The steamer coaled at Nanaimo. Coal is also found at Newcastle Island, which is not far distant. It may be mentioned that the coal of this region is semi-bituminous, and that recent discoveries have largely increased its product.

The line of soundings extended along a great circle drawn from Cape Flattery to Oonalaska Island. At lat. 53° 58′ N., long. 153° W., within about 400 miles of Oonalaska, the coal was exhausted, and the vessel returned to Victoria. The ocean bed sank rapidly from Cape Flattery to lat. 48° 54′ N., long. 126° 21′ W., then rapidly and steadily to lat. 49° 26′ N., long. 128° 37′ W., then more rapidly to lat. 49° 46′ N., long. 129° 27′ W., at which point the depression was 1,452 fathoms. Thence a peak rose in the sea bottom, with a summit at 1,007 fathoms depth, in lat 51° 40′ N. long, 137° 32′ W. Its rise was fully as rapid as the depression preceding it, and the depression beyond it, the side being equally steep, was somewhat greater. The slope after the western bottom of this submarine mountain was reached was exceedingly gradual, and somewhat undulating. Perhaps the following estimates, roughly made from a sketch, will give a clearer notion of the ground surveyed. At about 100 miles from Cape Flattery, depth about 400 fathoms; at 150 miles, 1,000 fathoms; 170 miles, 1,400 fathoms; 200 miles, 1,000 fathoms; 300 miles, 1,600 fathoms; 400, 1,900 fathoms; 500, 2,000 fathoms; 600, 2,000 fathoms; 700, 2,100 fathoms; 800, 2,200 fathoms; 900, 2,300 fathoms; 1,000, 2,300 fathoms; 1,100, 2,500 fathoms.

During soundings on the return voyage to San Francisco, another submarine mountain was discovered in lat. 41° 30′ N., long. 127° 11′ W., the depth at its summit, which the sounding instruments showed to be of a rocky character, being only 996 fathoms. Around it, at distances of 20 miles, the depth was between 1,600 and 1,700 fathoms.

The water temperatures along the line of soundings for the cable, at depths of over 1,000 fathoms, varied from 0° 45′ C. to 2° 43′ C.; surface, 10° 35′ C. to 14° 15′ C. In lat. 53° 58′ N., long. 153° 00′ W., the increase from 50 fathoms to surface, was gradual; but at 50, 100 and 200 fathoms the same temperature was found as at 2,500 fathoms.

The conclusion has been reached in the course of a series of observations made during the return voyage, and subsequently, that what is known as the "California coast current," is really a warm, and not as hitherto supposed, a cold stream. The observations determined the existence of a warm current, presumably a continuation of the "Great Japanese Circle Current," setting toward the south and east, of a surface temperature averaging 15° C., between the positions lat. 48° 36′ N., long. 126° 36′ W., and lat. 50° 34′ N., long. 131° 38′ W. Outside of this current the temperature was but 10° C. Its width, between what is known as "Fleurier's Whirlpool" and the coast of California, is about 700 miles; its depth in lat. 44° 54′ N., long. 125° 13′ W. is about 200 ft.; its speed, one to two knots per hour. Under-currents below this stream have been determined, setting to the north and west. The counter-current does not appear to extend more than 30 to 35 miles from shore, moving at a half to one knot per hour, with a depth of 200 to 300 fathoms.

The expedition was equipped with a great variety of sounding apparatus, of which only a few instruments gave perfect satisfaction, and several proved quite useless. The vessel carried 32,000 fathoms line, of which 21,000 were 1¼ in., carbonised. Among the satisfactory instruments, Prof. Thomson's is mentioned. This is worked by hand, winding No. 22 piano wire, capable of resisting a strain of 200 pounds. It has a registering indicator and a dynamometer attached. For bringing up material from the bottom, Belknap's cylinder, No. 2, gave the best results, the lower half of the cylinder being usually filled with about three ounces of sea-bottom material, and the upper half with water that had rested on the sea-bottom. The material is brought up secured in the case of a "Sand's cup" by a cylindrical sleeve. The latter is held by a spiral spring, in a position just covering a small orifice in the hollow cylindrical case. On striking bottom, the sleeve is forced up, permitting the material of the ocean bottom to enter the orifice. The instrument is driven into the bottom material by a weight which carries it down with great velocity. This weight, consisting of two hemispheres of iron attached just above the spring, is automatically detached when bottom is struck, by the slackening of the line. Upon drawing up the line, the spiral spring again forces the sleeve down, covering the orifice. The material drawn from the greatest depths was the usual chalky, pasty mud, smooth and homogeneous, rarely containing sand, chiefly composed of casings of diatoms and foraminifers, with here and there the spiculæ and siliceous skeletons of the smaller sponges and *polycystina*.

Although the expedition met for the most part with unsettled and unfavourable weather which interfered with its work, that which it has accomplished is regarded as eminently satisfactory. There is little doubt but that the route upon which the soundings have been made, will be the one selected for the cable; and next spring the work will be extended from the point at which it was discontinued.

NOTES

To the large number of his palæontological discoveries Prof. Owen has quite recently added that of a most peculiar bird from the London clay of Sheppey, which he has named *Odontopteryx toliapica*. This new form, known only from the skull, though perfectly ornithic in general structure, and exhibiting many of the characters of the Steganopodes (Gannets and Cormorants), presents a peculiarity not found in any existing bird. The trenchant margins of the bones of both jaws, instead of being simple, are provided with long conical bony processes, like the serrations in a coarse saw. The posterior of these serrations, which are alone preserved, are directed somewhat forwards; the anterior were probably less inclined, or even directed backwards like the homologous horny processes in the Goosander. The theoretical importance of this new form is great; for it is as good an example as can be brought forward of the loss in modern times, from a persistent type of animals, of a well-developed specialised structure. Many who criticise the evolution hypothesis appear to assume that progress, or what is the same thing, development in the individual of a maximum number of specialised organs, is an indispensable element of the Darwinian hypothesis. Such, however, is certainly not the case after a certain degree of elaboration has been reached. For, taking *Odontopteryx* as an example, it is evident that though this bird had in the struggle for existence acquired a dentigerous mouth, in which point it was in advance of all other members of the bird type, nevertheless its being thus able to obtain food which others could not hold, did not render it in the least less liable to be exterminated by many of the other accidents associated with existence. The upheaval of the sea-bottom, for instance, in its accustomed haunts, would have been destructive to it as to any other of its kind, and probably more so; for the specialisation of the jaws is certain to have been attended with a similar modification in the limbs, resulting in the loss of the power of flight, which would not allow of its removing to a new locality on the change in the physical geography of its home. So with the equally modified Moa, Dodo and Auk, the term of existence of the *Odontopteryx* was a short one, because the tendency of its development was too much towards a degree of uniformity in surrounding circumstances, which the human mind alone knows is not justified by facts.

THE autumn show of the larger fungi at the Royal Horticultural Society has so steadily increased in interest and popularity, that it is intended to considerably extend it next year (1874). The following extract from the recently issued official schedule states the classes which are admissible, and the number and value of the prizes, which are entirely open to all competitors:—Wednesday, Oct. 7.—Class 1, Collection of Fungi, arranged according to their botanical affinities. Neat arrangement and correct nomenclature will be taken into account in awarding the prizes. The edible and poisonous species are to be so marked on their respective labels; the edible species being named on white labels, the poisonous on red ditto, the rest on yellow ditto. Prizes: 5*l.*, 3*l.*, 2*l.* Class 2, Collection of Edible Fungi. These should be shown, when possible, in juxtaposition with specimens of similar but noxious species. Prizes: 3*l.*, 2*l.*, 1*l.* Class 3, Collection of New or Rare Fungi. Prizes: 3*l.*, 2*l.*, 1*l.* Class 4, Cultivated Edible Fungi. This class is intended for species likely to be useful as esculents, but which are not now known in the cultivated state. Prizes: 3*l.*, 2*l.*, 1*l.*

THE following has been announced as the Cambridge Natural Science Tripos:—First Class.—Martin, Christ's; Balfour, Trinity; (a) Bettany, Caius; (a) Hartog, Trinity; (a) Sollas, John's; Koch, John's—those marked (a) being equal in merit. Second Class.—(a) Balderston, Caius; (a) Davies, John's; (a) Jukes-Browne, John's; (a) Ogilvie, Trinity; (a) Salomons, Caius; Coe, Sidney; Ds. Fletcher, St. Peter's; Ds. Myers, Trinity: Symons, Trinity; Ds. Vinter, Caius; Ds. Yonge, Trinity Hall, the last six equal in merit as well as the first five Third Class.—Ds. Hawker, Trinity; Lighton, Trinity, equal. The undermentioned acquitted themselves so as to deserve an ordinary degree:—Crallen, Emmanuel; Mogg, Pembroke; Slater, St. Catharine's.

MR. ROBERT E. BAYNES, B.A., Wadham College, has been elected to a Lee's Readership in Physics at Christ Church, Oxford. Mr. Baynes gained a First-Class in Mathematical Moderations in Trinity Term 1871; and a First-Class in the School of Natural Science, Michaelmas Term 1872. The stipend of the Lee's Reader is 300*l.* per annum for the first four years after election, 400*l.* for the next three years, and 500*l.* after seventh year from election. He has also a right to occupy rooms in college rent free.

AMONG the more important of the numerous current publications of the United States Hydrographical Office, under Commodore Wyman, is the first volume of a "Coast Pilot" of the coast of Brazil, prepared by Lieutenant Gorringe, and covering the region from Cape Orange to Rio Janeiro, forming a volume of nearly 400 pages, in which the peculiarities of that portion of the coast are detailed with great minuteness, and accompanied by numerous profile sketches of the shores as observable from the vessel at sea. Another report of a very practical bearing is the result of the observations made by the United States steamer *Narraganset* during a cruise between Honolulu and Sidney, conducted between July 6 and September 7, 1872. The points visited were Christmas Island, the Gilbert group, Mulgrave Islands, the Disappointment and Duff Islands, and the Vanikoro Islands.

THE Council of the Society of Arts have given notice of their intention to provide a short course of lectures suitable for a juvenile auditory during the Christmas holidays. For this purpose arrangements have been made with Mr. Frank Buckland, M.A., Her Majesty's Iespector of Salmon Fisheries, to deliver two lectures "On the Structure and Habits of Beasts, Birds, and Fishes, as showing Beauty and Design," on Friday, January 2, and Friday, January 9, at 8 P.M. The lectures will be illustrated by specimens. It is intended to make every effort to obtain an entirely juvenile audience, and the notice in the Society's *Journal* impresses strongly upon the members the fact that only children, not adults, are wanted. The plan is, as far as the Society of Arts is concerned, quite a new one; though the Royal Institution have before now had courses of juvenile lectures.

WE are glad to hear that the course of lectures by Mr. J. E. Taylor, F.G.S., F.L.S., at Ipswich, on "Physical Geography and Geology," has been so successful that the place of meeting has had to be changed to a larger building. The average attendance, we believe, has been 500.

"THE Fifth Annual Report of the Trustees of the Peabody Academy of Science for the year 1872" (Salem, U.S.) is a very cheerful one. The collections in the museum of the Academy are mainly in Natural History and Archæology, and to both departments very large additions were made during the year 1872; the museum, indeed, promises to become one of the most valuable collections in the United States. By the indefatigable researches of Dr. C. C. Abbott a collection of 3,000 implements of the stone age has been brought together, all obtained from the immediate vicinity of Trenton, N.J., on the banks of the Delaware and adjoining fields and hills. The greater part of the present Report is occupied by a number of papers by Mr. A. S. Packard, jun., the Curator of the Articulates. These papers are:—"Synopsis of the Thysanura of the Essex County, Mass., with

descriptions of a few extralimital forms," "Descriptions of New American Phalænidæ," "Notes on North American Moths of the Families Phalænidæ and Pyralidæ in the British Museum," "On the Cave Fauna of Indiana," and "Record of American Entomology for 1872."

THE *Dundee Advertiser* is a daily paper of wide circulation and of considerable influence in the north, and is, therefore, we presume, able to keep a competent "London Correspondent." That gentleman, however, in writing in a recent number of the *Advertiser* about Mr. Prestwich's paper on tunnelling the Channel, is made to make the extraordinary statement that "in order to get under the chalk to the *Palæozoic* rocks the Company would have to go to a *depth of ten miles* on either side!" We had recently occasion to point out that science is at a discount in Dundee.

THE Bordeaux district branch of the French Association for the Promotion of Science has resolved to hold its meetings weekly on Mondays.

GOVERNMENT has sanctioned the appointment of a Professor of Physical Science at the Madras Presidency College, on a salary of 500 rs., rising to 700 rs. per month.

THE New York papers have lately contained quite a number of articles urging the propriety of establishing an Aquarium in Central Park, on the same scale as that at Brighton.

WE learn from *La Revue Scientifique* that two specimens of the Ibis, a bird found only in Egypt and at the mouths of the Danube, were recently shot by a hunter in the department of the Somme.

WE can only briefly refer to the following new books and new editions:—"Where there's a Will there's a Way; or, Science in the Cottage" (Hardwicke), is the title of a little volume by Mr. James Cash, containing an interesting collection of lives of persons in humble life who have to some purpose pursued the study of science, especially of Natural History.—"Mountain, Meadow, and Mere, a series of Outdoor Sketches of Sport, Scenery, Adventures, and Natural History," by Mr. G. C. Davies (Henry S. King & Co.), is a series of articles which originally appeared in the *Field* and some magazines. The sketches are generally graphic and racy, and contain information that, we should think, would be valuable to sportsmen of various kinds, with occasional observations on the natural history of the districts referred to by the author.—Mr. John Murray has just published third editions of Mr. H. W. Bates' "Naturalist on the River Amazons," and Mr. J. G. Bertram's interesting work, "The Harvest of the Sea, including Sketches of Fisheries and Fisher Folk." The latter work, which has been the means of doing good service to our fisheries, has been revised, and a considerable amount of new matter added.

A *Times* telegram dated Rome, Dec. 20, states that Colonel Gordon, who has accepted from the Khédive the leadership of a scientific expedition into Upper Egypt, is furnished by his Highness with a credit of 100,000*l*.

WE are glad to hear that a Section for Microscopical Investigation has been formed in connection with the Leeds Naturalists' Field Club and Scientific Association, one of the most efficient of local scientific societies. An excellent microscope has been purchased by liberal subscriptions among the members.

WE have received the Report of the 16th Session, 1872-3, of the Birkenhead Literary and Scientific Society, which numbers 134 members. The Report, among other papers, contains an address by the President, the Rev. G. H. Hopkins, on "the Insufficiency of Facts to establish a Scientific Law," characterised by considerable acuteness and knowledge. A paper read before this Society by Dr. Ricketts, F.G.S., on "Fissures, Faults, Contortions, and Slaty Cleavage," has been printed in a separate form.

THE Annual Report for 1872 of the Birmingham Natural History and Microscopical Society, is on the whole very satisfactory. Prefixed to the Report is a very able and extremely interesting address by the retiring President, the Rev. H. W. Crosskey, F.G.S., on some of the general principles on which geology as a science depends. Some of his illustrations are very forcible and ingenious.

THE Mining Commission, consisting of Savot Bey and Osman Bey, sent into the district of Lom, in the Danubian viceroyalty of Turkey in Europe, has been compelled, on account of the winter, to bring its labours to a close. It has, however, discovered two good coal mines, one ten and the other twenty miles from Lom. There are other mines of iron, copper, and bitumen.

ON November 26, at 11 P.M., a smart shock of earthquake was felt at Prevesa, in European Turkey. Though reported to have been violent, the shock only lasted a few seconds and did no damage. The earthquake of November 10, in Anatolia, extended to Ak Hissar, where it did some damage, and also in the village of Suleimanich. On October 11, there was a slight shock at Lima, in Peru.

THE following statistics relating to Swedish Universities are from the *Medical Record*:—In the University of Upsala there are 52 ordinary and 2 extraordinary professors, 24 ordinary and 2 extraordinary assistant-professors, and other teachers, making a total of 109 persons engaged in instruction. The number of pupils is 1,607, of whom 172 belong to the faculty of medicine. The University of Lund has 64 teachers, including 28 ordinary and 1 extraordinary professor, and 28 ordinary assistant-professors. There are 545 students, of whom 33 are medical.

THE *Journal of the Society of Arts* informs us that from a recent report to the Congress by the Inspector-general of Public Instruction in Chili, some idea of the educational condition of that republic may be formed. There are 1,190 schools in Chili, of which 726 are public and 464 private. It appears from the latest census that the population of the towns is 520,668, being at the rate of one school for every 1,769 inhabitants; and in the country, with a population of 1,298,560, there would be one school for every 3,020 inhabitants. In 1872 these schools were attended by 82,162 children and young persons of both sexes, and the amount expended by the Government for education purposes amounted to 414,127 piastres. The number of teachers in the primary schools was 1,544, of which 896 were male and 657 female teachers.

ACCORDING to the "Reports of the Mining Surveyors and Registrars," the yield of gold in the colony of Victoria for the quarter ending June 30, was:—from Alluviums 123,643 oz. 6 dwt.; from quartz reefs, 159,604 oz. 17 dwt; total 283,248 oz. 3 dwt.

WE have received No. 3 of Albert Muller's "Contributions to Entomological Bibliography," up to 1862.

THE additions to the Zoological Society's Gardens during the last week include an Alpaca (*Lama pacos*) from Peru, and a Pileated Parraket (*Platycercus pileatus*) from Australia, purchased; a Violaceous Plaintain-cutter (*Musophaga violacea*) from West Africa, received in exchange; a Puma (*Felis concolor*) from America, and two Tuberculated Iguanas (*Iguana tuberculata*) from the West Indies, deposited.

SCIENTIFIC SERIALS

THE *Journal of the Franklin Institute*, November 1873.—In this number Mr. Richards, mechanical engineer, communicates the first part of a treatise on "The Principles of Shop Manipulation for Engineering Apprentices;" the points dealt with being these: plans of studying (and here he advocates the order, first, machine functions, next, plans or adaptations of machines, third, construction of machines), nature of mechanical engineering, engineering as a calling, and the conditions of apprenticeship.—Dr. Coolley, in a lecture-extract, shows how convection may be usefully applied in detection of heat. He has an instrument somewhat like a Coulomb electrometer; in a glass case, a thin glass tube with black pith ball at one end is suspended horizontally by a silk fibre over a graduated disc. A heated body is introduced near the ball, which immediately swings towards it; while a cold body will repel the ball; these effects being due to air currents. The experiments Dr. Coolley makes, show that this forms a very sensitive thermoscope.—An account is furnished of the Cleveland Waterworks Tunnel, just completed, and which is similar to the one at Chicago. The shore section and lake section were carried on simultaneously, 40 ft. to 70 ft. below the bottom of the lake; the starting-points being a mile and a quarter apart. The work was somewhat disturbed by quicksands, but the sections met on an exact level. The capacity of the tunnel is 60 to 70 million gallons daily; though the average daily consumption is at present only about 6 million gallons.—A new process is described for utilising coal waste. The inventor uses, as a cement, only yellow clay with some milk of lime, but no bituminous or resinous matter; merely waterproofing the surface with a solution of rosin. From first to last no handling is required; and the lumps are delivered, in shape and size like hen's eggs. The process is highly commended.—We find notes on American machinery abroad, friction of screw propellers in water, &c., and, among other novelties of construction described, a planing bar, a compound beam engine, an antifriction journal, an irrigating machine, and a new optical toy (Prof. Dolbear).

Annalen der Chemie und Pharmacie. Band 169, Heft 1, u. 2. —We notice that in this number Liebig's name disappears from the list of editors, and the title is changed to *Justus Liebig's Annalen der Chemie und Pharmacie.* The following papers are published:—Hubner and Post on the constitution of bromtoluol in relation to its hydrogen atoms. The authors give a collection of minor papers by various authors, dealing with the substitution of different hydrogen atoms in the formula by various radicles.—On the estimation of nitrogen, by S. W. Johnson. The author finds that a mixture of sulphate or carbonate of sodium with slaked lime can be employed instead of the soda-lime usually used in Varrentrapp's and Will's processes. The mixture, when heated, of course, yields sodic hydrate and sulphate or carbonate of calcium. Experiments made with such mixtures are described.—On the nitro derivatives of naphthalin, by F. Beilstein and A. Kuhlberg. The mono-, di-, and tri-nitro compounds are described.—On atacamite, by E. Ludwig. The author proposes some alteration in the ideas of the constitution of this mineral advocated by Rammelsberg and others, his suggestions being based upon the way in which the substance gives up its water at different temperatures; he also makes some suggestions as to formula of brochantite.—On the action of sulphocarbonyl chloride on amidogen compounds, by B. Rathke and P. Schäfer.—Note on a polyacetone, by W. Heintz.—On the production of talanin by means of potassic cyanide, and on a by product of the reaction by W. Heintz. The author gives details of the preparation of alanin, the by product is lactyt-urea.—On the constitution of natural silicates, by Dr. K. Haushofer, is a lengthy paper dealing with the probable constitutional and graphic formulæ of these bodies.—On the polyolenes and on the change of ethylene into ethyl alcohol, by W. Goriainow and A. Butlerow.—On protein substances, by H. Hlasiwetz and J. Habermann.—On the compounds of the camphor group, by J. Kachler. The author describes pimelinic acid, $C_7H_{12}O_4$, and many of its salts. —On the isomers of amylene obtained from the amylic alcohol of fermentation, by F. Flavitzky.—On the synthesis of anthracene and dimethyl-anthracene, by W. A. van Dorp.—On cœrulignon and its derivatives, by C. Lieberman. The author regards cœrulignon as a quinone.—On pentabrom resorcin and pentabromorcin, by C. Lieberman and A. Dittler.—The number concludes with an abstract from M. L. d'Henry's late paper in the *Comptes Rendus*, on the use of the sodium flame for observing litmus tints in alkalimetry.

Verhandlungen der k. k. geologischen Reichsanstalt. Nos. 1 to 6. (1873.) Amongst many other papers of interest contained in these numbers of the Proceedings we note the following:—On the occurrence of a new genus and new species of palm seed-vessel (*Lepidocaryopsis Westphaleni*) in the cretaceous sandstone of Kaunitz in Bohemia, by D. Stur.—Notices of the earthquake at Vienna on the 3rd January, by Dr. G. Stache.—Hugo Rittler's sketches of the rothliegende in the environs of Rossitz, by D. Stur.—On the analogies of the three carboniferous resins, anthracox, middletonite, and tasmanite, and their probable origin, by O. Feistmantel.—On the geological position and distribution of the silicified woods in Bohemia, by the same author.—The usual literary notices and other matters accompany each part of the Proceedings.

Ocean Highways, December. This number commences with an appreciative memoir of the late Sir Robert Maclure. An article entitled "The Straits of Magellan" contains some very interesting information concerning the little known region in that quarter of the world, and what has been done recently for the settlement of the mainland-coast of the straits. The paper recommends to emigrants Sandy Point, the Chilian settlement at which most of the steamers touch on their way to and from the West Coast, and which "is admirably situated on Brunswick Peninsula, nearly on the line of demarcation between the dense forests which cover the whole western end of the Straits, and the naked, rolling Pampas, which spread uninterruptedly northward to the very shores of the river Plate."—H. H. Giglio sends a letter, with some remarks from Dr. Beccari, on the latter's Exploration of Papuasia. Three small maps of parts of New Guinea illustrate the discoveries of Beccari, D'Albertis, Moresby, Cerruti, and Meyer.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, Dec. 11.—"On the Action of Heat on Gravitating Masses," by William Crookes, F.R.S.

The experiments recorded in this paper have arisen from observations made when using the vacuum-balance, described by the author in his paper "On the Atomic Weight of Thallium,"* for weighing substances which were of a higher temperature than the surrounding air and the weights. There appeared to be a diminution of the force of gravitation, and experiments were instituted to render the action more sensible, and to eliminate sources of error.

After discussing the explanations which may be given of these actions, and showing that they cannot be due to air-currents, the author refers to evidences of this repulsive action of heat, and attractive action of cold, in nature. In that portion of the sun's radiation which is called heat, we have the radial repulsive force possessing successive propagation required to explain the phenomena of comets and the shape and changes of the nebulæ. To compare small things with great (to argue from pieces of straw up to heavenly bodies), it is not improbable that the attraction now shown to exist between a cold and a warm body will equally prevail when, for the temperature of melting ice is substituted the cold of space, for a pith ball a celestial sphere, and for an artificial vacuum a stellar void. In the radiant molecular energy of cosmical masses may at last be found that "agent acting constantly according to certain laws," which Newton held to be the cause of gravity.

Dec. 18.—"On Double Refraction in a Viscous Fluid in motion," by Prof. J. Clerk Maxwell, F.R.S.

According to Poisson's † theory of the internal friction of fluids, a viscous fluid behaves as an elastic solid would do if it were periodically liquefied for an instant and solidified again, so that at each fresh start it becomes for the moment like an elastic solid free from strain. The state of strain of certain transparent bodies may be investigated by means of their action on polarised light. This action was observed by Brewster, and was shown by Fresnel to be an instance of double refraction.

In 1866 I made some attempts to ascertain whether the state of strain in a viscous fluid in motion could be detected by its action on polarised light. I had a cylindrical box with a glass bottom. Within this box a solid cylinder could be made to rotate. The fluid to be examined was placed in the annular space

* Phil. Trans. 1873.

† Journal de l'Ecole Polytechnique, tome xiii. cah. xx (1829).

between this cylinder and the sides of the box. Polarised light was thrown up through the fluid parallel to the axis, and the inner cylinder was then made to rotate. I was unable to obtain any result with solution of gum or syrup of sugar, though I observed an effect on polarised light when I compressed some Canada balsam which had become very thick and almost solid in a bottle.

It is easy, however, to observe the effect in Canada balsam, which is so fluid that it very rapidly assumes a level surface after being disturbed. Put some Canada balsam in a wide-mouthed square bottle; let light, polarised in a vertical plane, be transmitted through the fluid; observe the light through a Nicol's prism, and turn the prism so as to cut off the light; insert a spatula into the Canada balsam in a vertical plane passing through the eye. Whenever the spatula is moved up or down in the fluid, the light reappears on both sides of the spatula; this continues only so long as the spatula is in motion. As soon as the motion stops, the light disappears, and that so quickly that I have hitherto been unable to determine the rate of relaxation of that state of strain which the light indicates.

If the motion of the spatula in its own plane, instead of being in the plane of polarisation, is inclined 45° to it, no effect is observed, showing that the axes of strain are inclined 45° to the plane of shearing, as indicated by the theory.

I am not aware that this method of rendering visible the state of strain of a viscous fluid has been hitherto employed; but it appears capable of furnishing important information as to the nature of viscosity in different substances.

Among transparent solids there is considerable diversity in their action on polarised light. If a small portion is cut from a piece of unannealed glass at a place where the strain is uniform, the effect on polarised light vanishes as soon as the glass is relieved from the stress caused by the unequal contraction of the parts surrounding it.

But if a plate of gelatine is allowed to dry under longitudinal tension, a small piece cut out of it exhibits the same effect on light as it did before, showing that a state of strain can exist without the action of stress. A film of gutta percha which has been stretched in one direction has a similar action on light. If a circular piece is cut out of such a stretched film and warmed, it contracts in the direction in which the stretching took place.

The body of a sea-nettle has all the appearance of a transparent jelly, and at one time I thought that the spontaneous contractions of the living animal might be rendered visible by means of polarised light transmitted through its body. But I found that even a very considerable pressure applied to the sides of the sea-nettle produced no effect on polarised light, and I thus found, what I might have learned by dissection, that the sea-nettle is not a true jelly, but consists of cells filled with fluid.

On the other hand, the crystalline lens of the eye, as Brewster observed, has a strong action on polarised light when strained, either by external pressure, or by the unequal contraction of its parts as it becomes dry.

I have enumerated these instances of the application of polarised light to the study of the structure of solid bodies as suggestions with respect to the application of the same method to liquids so as to determine whether a given liquid differs from a solid in having a very small "rigidity," or in having a small "time of relaxation,"* or in both ways. Those which, like Canada balsam, act strongly on polarised light, have probably a small "rigidity," but a sensible "time of relaxation." Those which do not show this action are probably much more "rigid," and owe their fluidity to the smallness of their "time of relaxation."

"On the Period of Hemispherical Excess of Sun-spots, and the 26-day Period of Terrestrial Magnetism." By J. A. Broun, F.R.S.

It appears from the interesting communication to the Royal Society, June 19, by Messrs. De La Rue, Stewart, and Loewy,† that the difference of the area of spots on the visible northern and southern quarter-spheres of the sun seems, during periods of considerable solar disturbance, to obey a law such that the difference is a maximum in the same quarter-sphere during several successive rotations of the sun, the difference being a maximum alternately in the northern and southern hemispheres; the time from maximum to maximum, for the same hemisphere, being variable between 18 and 32 days, but having a mean value of about 25·2 days.

It occurs at once that if the variations of the mean terrestrial magnetic force are connected in any way with the solar spots, or the causes which produce them, we might here find some explanation of the magnetic period of 26 days, the difference of spot area in one hemisphere from that in the other being related to a difference of the solar magnetic action.

In order to determine whether such a connection existed, I projected first the curves of excess of spot-area given in the paper of Messrs. De La Rue, Stewart, and Loewy, and below them the daily mean horizontal force of the earth's magnetism during the same periods. The conclusion from these projections is, that there is *no relation whatever between the two classes of curves.* The maxima and minima of the one agree in no ways with those of the other; the greatest excesses of sun-spot area in the one hemisphere over those in the other occur when the earth's magnetic force is the most constant; the greatest variations of the earth's magnetic force from the mean occur in several instances when the sun-spot area is equal in the two visible quarter-spheres.

It should be remembered, in considering the curves of sun-spot excess, that the minima and maxima are in some cases only relative; sometimes the one, sometimes the other being really cases in which there is neither maximum nor minimum; that is to say, cases in which the sun-spot area is equal, or nearly so in the two visible quarter-spheres.

It would be hasty to conclude from this comparison that the variations of the mean magnetic force are really unconnected with the mode of distribution of the sun-spots. Other methods of grouping the spots may perhaps be employed with advantage relatively to this and other questions, for example, were the position of the centre of gravity of the sun-spots determined for the visible quarter-spheres and hemisphere, giving each spot a spot-weight in proportion to its area, the variation of these positions in latitude and longitude and their weights, might give a more satisfactory base for this comparison and for other deductions.

It will be obvious also that this investigation refers only to one *visible* hemisphere of the sun; an approximation to the spot-distribution on the other hemisphere will, however, be frequently possible.

"On the Nervous System of *Actinia*," Part I., by Prof. P. Martin Duncan, F.R.S.

"On certain Discrepancies in the published numerical value of π," by William Shanks.

Mathematical Society, Dec. 11.—Prof. Cayley, F.R.S., V.P., in the chair.—Prof. Clifford gave an account of his paper on the graphic representation of the harmonic components of a periodic motion. The paper was an application of a theorem of Fourier's, which asserts that any motion having the period P may be decomposed into simple harmonic motions having periods P, $\frac{1}{2}$ P, $\frac{1}{3}$ P, &c., and assigns the amplitudes and phases of these motions by means of definite integrals.—Prof. Cayley next spoke on the subject of Steiner's surface. The author stated that he had constructed a model and drawings of the symmetrical form of Steiner's surface, viz. that wherein the four singular tangent planes form a regular tetrahedron, and consequently the three nodal lines (being the lines joining the middle points of opposite edges) a system of rectangular axes at the centre of the tetrahedron. He then described the general form of the surface, and finally discussed its analytical theory.—Lord Rayleigh, Mr. Roberts, Prof. Clifford, and Prof. Cayley made further extempore communications to the Society.

Linnean Society, Dec. 18.—G. Bentham, F.R.S., president, in the chair.—Dr. Hooker exhibited a magnificent zoophyte from Bermuda, sent by General Lefroy; also a six-lobed Seychelles cocoa-nut (*Lodoicea Seychellarum*) and two tazzas made from the shell of a Seychelles cocoa-nut sent from the Seychelles by Mr. Swinburne Ward to the Kew Museum; also some small boxes from Mauritius and Madagascar made from some grass-haulm; and two walking-sticks from Bermuda made of the "cedar-wood" of commerce (*Juniperus bermudiana*).—Mr. Bowring exhibited an inflorescence of an orchid with a remarkable smell, probably a *Bulbophyllum*.—The following papers were then read, viz.:—"Contributions to the Botany of the *Challenger* Expedition," No. 2, by H. N. Moseley, M.A. On the Vegetation of Bermuda and the surrounding sea. About 160 species of flower-

* The "time of relaxation" of a substance strained in a given manner is the time required for the complete relaxation of the strain, supposing the rate of relaxation to remain the same as at the beginning of this time.

† Proc. Royal Soc. vol. xxi. p. 399.

ing plants were gathered on the island; but of these, not more than 100 were certainly native. Those of West-Indian origin were probably brought, as Grisebach had suggested, by the Gulf-stream or by cyclones, there being no winds blowing directly from the American coast which would be likely to carry seeds, which might, however, be conveyed from the Continent by migratory birds. A note by Prof. Thiselton Dyer appended to the paper stated that 162 species sent over by Mr. Moseley had been determined at the Kew Herbarium, of which 71 belong to the Old World, while 2, an *Erythræa* and a *Spiranthes*, were plants hitherto known as confined to single localities in the United States.—"Changes in the Vegetation of South Africa, caused by the introduction of the Merino Sheep," by Dr. Shaw. The original vegetation of the colony is being in many places destroyed or rapidly deteriorated by over-stocking and by the accidental introduction of various weeds. Among the most important of the latter is the *Xanthium spinosum*, introduced from Europe, the achenes of which cling to the wool with such tenacity that it is almost impossible to detach them, and render it almost unsaleable. It spreads with such rapidity that in some parts legislative enactments have been passed for its extirpation; and where this is not done, it almost usurps the place of the more useful vegetation. The president stated that the *Xanthium* has in the same manner deteriorated the pastures in Queensland; whilst in the south of Europe, where it is equally abundant, it does not appear to cause such injurious results. Though generally distributed through Europe, the plant is probably of Chilian origin.—Extract from a letter from Osbert Salvin, F.R.S., to Dr. Hooker, dated Guatemala, Oct. 6. Mr. Salvin is engaged in collecting plants on the slopes of the Volcan de Fuego, 5,000 ft. in elevation, and within an easy ride of a volcano 13,000 ft. above the level of the sea. He hopes to secure all the plants between the elevations of 3,500 and 8,500 ft. Many of the species appear to have a vertical range of as much as from 2,000 to 3,000 ft.

Meteorological Society, Dec. 19.—Dr. R. J. Mann, president, in the chair.—The following papers were read:—"On an improved form of aneroid for determining heights with a means of adjusting the altitude scale for various temperatures," by Mr. Rogers Field. In this aneroid the scale is adjustable for different temperatures. The principle of the adjustment depends on the fact that when the scale is shifted it becomes inaccurate for the temperature for which it was laid down, and therefore practically accurate for some other temperature, so that the scale has only to be shifted into certain different fixed positions to obtain a series of different scales suitable for different temperatures of the air.—"On the North Atlantic hurricane of August 20 to 24, 1873, which did much damage at Halifax, Nova Scotia, and elsewhere," by Capt. H. Toynbee, F.R.A.S. The author alluded to various data which had come into the Meteorological Office respecting this gale, especially to a chart of its track, and important remarks from Mr. J. R. H. Macfarlane, R.N., Naval Sub-Lieut. H.M.S. *Plover*. This data proved that it was a hurricane, and its route was traced from a position to the south-east of Bermuda to Halifax, showing its probable track for four days. The author then went on to say that if the circular theory for hurricanes were correct, little more could be done, though it would be very interesting to trace so hard a gale from its formation to its breaking up. But he said if Mr. Meldrum's "Notes on the form of Cyclones in the Southern Indian Ocean"* were correct, then it was incumbent on the meteorologists of the northern hemisphere to institute a similar inquiry, as the form of cyclones in the southern hemisphere worked out from facts by Mr. Meldrum, made it necessary to modify the rules in use amongst seamen for avoiding their centres. An enlarged copy of Meldrum's diagram (reversed to adapt it to the northern hemisphere) was exhibited. The paper concluded with a suggestion that the August gale of 1873 would afford the means for inquiry into the shape of the northern hemisphere cyclones, and that data for that month should be collected from all parts of the North Atlantic, and worked up into daily synoptic charts, which suggestion the author hoped would be carried out either by America or England.—On a mercurial barometer for the use of travellers, filled by the spiral-cord method, by Staff-Commander C. George, R.N.

Geologists' Association, Dec. 5.—Henry Woodward, F.R.S., president, in the chair.—"On the Yorkshire Oolites," by W. T. Hudleston, F.G.S. The district occupied by beds of Oolitic age in north-east Yorkshire, constitutes a mass of elevated land divided into two very unequal lobes by a triangular depressed area known as the Vale of Pickering, towards which the beds incline. A diagonal of thirty-one miles, from N.E. to S.W., exhibits the beds of the Moorland range resting on the Lias of Robin Hood's Bay, whence they incline towards the Vale of Pickering, newer beds being continually met with as far as the "Kimmeridge Clay" of the vale. Crossing this vale towards the Howardian Hills, the previous beds or their equivalents are repeated in inverse order, until the Lias of the Vale of York is reached. Dealing with the Lower Oolites only, the group is essentially arenaceous. At the eastern termination of the moorland range (coast section) these beds have a thickness of 700 ft., mostly sands and shales, nearly devoid of marine mollusca, but rich in plant remains. There are, however, four distinct zones of marine life (well pointed out by Dr. Wright in 1859) which may be made out on the coast and identified in the transverse valleys of the moorland range. (1) The Dogger and its associated Land-rock, magnificently developed at Blue Wyke a sandy oolite, altered into an iron-stone, calcic carbonate being replaced by ferrous carbonate in the case of the shells, the original material being now replaced by siderite, very unequally developed, sometimes resting on 40 ft. of "striatulus beds," sometimes directly on the Upper Lias. (2) "The Millepore Bed." At the point of their maximum development 300 ft. of sands and shales intervene between the Dogger and this bed, which, north of Scarborough, is usually an arenaceous ironstone, but a few miles south of that town becomes the most important calcareous member of the Lower Oolites. (3) 100 ft. of sands succeed and then we have the "Scarborough Limestone" series, consisting of grey marly limestones alternating with marly shales and varying in thickness from 50 ft. at Mundall to 3 ft. at Gristhorp (distance 9 miles). Above the Scarborough Limestone series occurs 160 feet of shales and sandstones; some of these beds exhibit casts of myaciform shells. (4) The fourth fossiliferous zone is usually referred to the cornbrash. More complete marine conditions are apparent. Brachiopoda are abundant. *Ammonites Herveyi* plentiful in this bed, which yielded a fine suite of fossils. It forms the last of the Lower Oolites. In the inland chain south-west of the Vale of Pickering, the Lower Oolites are much attenuated, amounting to no more than 150 feet in the Derwent Valley, The types, too, are much altered.

Chemical Society, Dec. 18.—Dr. Odling, F.R.S., president, in the chair.—A paper on the preparation of standard trial plates to be used in verifying the composition of the coinage was read by the author, Mr. W. C. Roberts, Chemist of the Royal Mint. After giving a sketch of the variation in composition of the English gold and silver coins from the earliest times, he noticed the various trial plates which had been prepared since 1660, showing that they sometimes varied considerably from the standard of 916·66 parts in 1,000 for the gold and 925·0 for the silver. He then proceeded to describe the process employed and the difficulties to be overcome in the preparation of the new standard trial plates. These were exhibited at the meeting, and also a magnificent specimen of pure crystallised gold.—Researches on the action of the couple on organic bodies, Part iv., on iodide of allyl, by Dr. G. H. Gladstone and Mr. A. Tribe, being a continuation of their investigations on this subject.—On tetranickelous phosphide, by Dr. R. Schenck.—On ferrous anhydrosulphate, by Mr. T. Bolas. The compound, which is crystalline, is precipitated on mixing an aqueous solution of green vitriol with about nine times its volume of concentrated sulphuric acid.—On the hydrochloride of narceine, by Dr. C. R. A. Wright.

Royal Horticultural Sociey, Dec. 3.—Scientific Committee.—A. Smee, F.R.S., in the chair.—Dr. Masters, F.R.S., exhibited part of a poplar (sent by Mr. G. T. Saul), which, while apparently healthy, had during the past summer, within twenty-four hours, shed the whole of its leaves and never recovered. The Rev. M. J. Berkeley pointed out that the specimen was visibly attacked by fungus mycelium. No doubt, the tree had long been diseased unsuspected; the healthy bark would probably be reduced to a narrow strip, and when this failed the tree would die apparently quite suddenly.—Prof. Thiselton Dyer exhibited a drawing of a luminous *Didymium* from St. Kitt's.—Mr. McLachlan, F.L.S., inquired as to the possibility of introducing humble-bees into New Zealand; the red clover, which had also been introduced, was not fertilised for the want of them

* Mr. Meldrum's paper has been published as "Non-official, No. 7" by the Committee of the Royal Society who manage the Meteorological Office.

The chairman thought there could be no difficulty about it; the Rev. Mr. Cotton had taken bees out to New Zealand by keeping them at a low temperature, and consequently in a dormant condition, by means of ice.—Mr. McLachlan further wished the opinion of the committee with respect to another New Zealand inquiry by Captain Hutton; Aphides were now becoming very common in New Zealand, but were probably not indigenous. Could the golden-winged fly (*Chrysopa*) be advantageously introduced to check them. The chairman thought that it would be far better to send out dormant lady-birds (*Coccinella*). Mr. Wilson, F.R.S., pointed out the necessity of caution in these introductions; sparrows and hares were far from a boon in Australia.—Prof. Thiselton Dyer read a letter from Mr. Scott, F.R.S., Director of the Meteorological Office, with respect to a change in the climate of Scotland recently insisted on by Mr. McNab. He stated that it was an opinion too general to be lightly disregarded that our winters are warmer and summers cooler, on an average, than in the last century, but did not know where to find records which could be quoted with confidence in a discussion of the question.—Dr. Voelcker, F.R.S., mentioned that there was no doubt that it was quite possible to make wine from grapes ripened in this country; the often-repeated argument that our summers must be cooler because wine was not now made was manifestly fallacious.—Mr. A. W. Bennett, F.L.S., communicated a paper on pollen-eating flies of the group *Syrphidæ*.—Mr. Baker, F.L.S., sent capsules of *Lilium auratum* and *L. speciosum*.

Anthropological Institute, Dec. 9.—Mr. F. G. H. Price, F.G.S., in the chair.—Mr. J Park Harrison gave a detailed description of two incised tablets, from Easter Island in the South Pacific, discovered by the French missionaries in one of the stone houses supposed to be formerly occupied by the chiefs. The signs appeared to be principally iconographic and to represent forms of life and incidents connected with islands several thousand miles to the west.—Prof. T. McK. Hughes described the results of his exploration of the rock-shelter known as Cave Ha, near Giggleswick, Settle, Yorkshire. In the upper deposits flakes and scrapers of chert and flint and other ancient remains in stone and iron were mixed up with the most recent works of art by the operations of badgers, rabbits, &c. In these beds the bones were found by Prof. Busk to be all of recent species, still, or till quite lately, common in the district. In the older deposits, which were composed chiefly of angular fragments of limestone, and, therefore, were not disturbed by burrowing animals, the remains of bear occurred associated with ox, goat or sheep, and dog; but as yet no traces of men. A point to which the author called special attention was the explanation found here of the occurrence in many ossiferous caves of such immense quantities of the bones of mice. The floor was in places strewn with broken up pellets of owls with here and there a few retaining their form, which, when the hair had decomposed away would exactly correspond to the layers and little bunches of the bones of mice in the underlying beds.—Prof. Hughes also read a joint paper by himself and Rev. D. R. Thomas, "On the occurrence of Felstone implements, of the Le Moustier type, in Pontnewydd Cave near St. Asaph, North Wales," After explaining by reference to sections, the position of the cave and of the deposits in it, the authors described a series of implements of felstone as similar to the common forms of Le Moustier as would be expected, allowing for the difference of material. They exhibited also a collection of bones from the same deposit which were referred by Prof. Busk to *Ursus spelæus*, *U. ferox*, *Hyæna spelæa*, *Rhinoceros hemitæchus*, and others, including a human molar which Prof. Busk pointed out was remarkable for its large size. As the rock, of which the implements were manufactured, occurred in that river basin in the boulder clay only, as the implements seemed to have been made from fragments such as occur in the drift, and are found associated with remanié drift mixed with tumble from the roof of the cave, the authors inferred that the deposit was post-glacial, while the forms of the implements, and the animal remains found with them would refer the beds to the earliest cave deposit in which human remains have been found.—A communication was made by Prof. Busk on a human fibula of unusual formation discovered in Victoria Cave, Settle, Yorkshire. The fragment lay at a considerable depth in the cave and beneath a thick layer of Boulder Clay, and was associated with bones of the two large species of cave Bear, *Hyæna*, *Rhinoceros tichorhinus*, *Bison* and *Cervus*. From its position, accompaniments, and other considerations, the deposit in which the specimen was found, had been regarded as of pre-glacial age.

The London Anthropological Society, Dec. 2.—Dr. R. S. Charnock, president, in the chair.—Causes which determine the Rise and Fall of Nations, by T. Inman, M.D. The paper embraced the whole historical range.—Western Anthropologists and Extra Western Communities, by J. Kaines, D.Sc. The paper shows what should be the moral attitude of the more civilised to the less civilised—what the latter has to teach the former—and the evils of western contact with the backward races.

Photographic Society, Dec. 9.—J. Spiller, F.C.S., V.P., in the chair.—On photo-collotype printing, by Capt. J. Waterhouse. The author recommended the use of citric acid as a clearing agent.—Lieut. Chermside, R.E., read a paper on photography in the Arctic Regions. Mr. Chermside accompanied Mr. Leigh Smith in his Arctic expedition last summer. The temperature at which pictures were actually taken was rarely less than 32° Fahr., but much difficulty was experienced in maintaining the solutions in proper order during excessive cold. The author gave some practical advice on the subject of overcoming actual difficulties inherent to photographic manipulations in high latitudes.

PARIS

Academy of Sciences, Dec. 15.—M. de Quatrefages, president, in the chair.—The following papers were read:—On the laws of the magnetisation of steel by currents, by M. Jamin.—An answer to a note read by M. Trécul at the meeting of the Dec. 8, by M. Pasteur. This was a reply to M. Trécul's criticism on the author's note on beer and displayed considerable acrimony, M. Pasteur of course sustained his well-known views of the nature of ferments.—M. Berthelot presented some new remarks on the nature of the chemical elements, which however could not be read on account of want of time. The author, it may be stated, admits the possibility of the elements being modifications of a fundamental substance, and stated that nothing renders it improbable that a discovery like that of the voltaic current might not give us power to still further simplify matter. His paper concluded thus:—We shall only be too happy if Mr. Lockyer, guided by stellar spectral analysis, can shed a new light upon these questions, and continue to investigate problems raised now forty years ago by M. Dumas in a work (*Leçons de Philosophie Chimique*) which has contributed so much to our scientific education.—Researches on new butyl derivatives by M. A. Cahours. The author dealt with the aluminium silicon tin and mercury compounds of butyl.—On the propagation of the *Phylloxera*, by M. H. Marès.—Report on Mr. Douglas Galton's paper "On the Construction of Hospitals," by M. Larrey, and General Morin:—Valuation in mechanical units of the quantity of electricity produced by an element in a battery, by M. Branly.—Hybernation of the *Phylloxera* on the branches and leaves of the vine, by M. Max. Cornu.—Action of the volcanic earth of the solfatara of Pouzzoles on the diseases of the vine, by M. S. De Luca.—On certain morphological changes observed in the genus *Cypripedium*, by M. R. Guérin.

BOOKS RECEIVED

AMERICAN.—Catalogue of Stars observed in the United States Observatory, 1845–71: Rear-Admiral Sands (Washington).—Daily Bulletin of Weather Reports for September 1872: War Department (Washington).—Annual Record of Science and Industry: Dr. Spencer F. Baird (Harper, New York).—Elements of Logarithms: Pierce (Ginn Bros.).

FOREIGN.—Annalen der Sternwarte in Leiden: Dr. F. Kaiser (Nijkoff).—Somario delle Lezioni di Fisica: Prof. Mombello (Foligno).—Zoologische Studien auf Capri; Dr. Theodore Eimer (Engelmann, Leipzig).

CONTENTS

PAGE

THURSDAY, JANUARY 1, 1874

THE YORKSHIRE COLLEGE OF SCIENCE

NOW that a scheme for a College of Science at Leeds has been all but completed, under the chairmanship of Lord F. C. Cavendish, M.P., it seems somewhat surprising that such an institution in connection with Yorkshire has not been thought of long ere now. It is the largest county in England, carries on a greater variety of industries all more or less dependent for success on the results of scientific research, and boasts of a larger number of local scientific societies and field-clubs than any other county in the three kingdoms, as we have shown in our articles on that subject. However, "better late than never;" and to judge from the prospectus and subscription lists, a very fair start is likely to be made. The scheme proposed by the committee formed at Leeds in 1869 involved an expenditure of 100,000*l*., but it is not intended at present to carry out the whole of this scheme, but to commence on a smaller scale in temporary premises and with a limited number of professors. We have no doubt, from the hearty way in which the proposal has so far been met, that the college will be a success, and that ere long it will be possessed of a handsome building of its own, with a full staff of professors.

From what follows, it will be seen that the teaching will have a practical or technical aspect, having regard to the processes connected with the multifarious arts and manufactures which occupy the large population of Yorkshire. In the midst of an eminently practical people, there can be no fear of this consideration being neglected, but we hope that in the long run the claims of pure science will not be overlooked, for it is every day being more and more clearly proved that a preliminary training in pure scientific research is the best introduction to a "technical" education; and very many of the industrial applications of science have been found out by students who took no thought of the practical issues of their investigations. There is more than one institution in America which might, in this respect, be taken as models for a technical college.

The Yorkshire College of Science, the Prospectus tells us, is intended to supply an urgent and recognised want, viz.:—Instruction in those Sciences which are applicable to the Industrial Arts, particularly in their relation to Manufactures, Engineering, Mining, and Agriculture. It is designed for the use of persons who will afterwards be engaged in those callings as foremen, managers, or employers; and also for the training of teachers for ordinary Science Schools and Classes.

To carry out the object of the College, it is proposed to establish Professorships in (1) Chemistry and its application to Metallurgy, Manufactures, and Agriculture; (2) Civil and Mechanical Engineering; (3) Physics and Mathematics; (4) Geology and Mining.

The Provisional Committee seem to have right notions as to how scientific men ought to be treated. To obtain the services of eminent scientific men, they say, the payment to each Professor cannot be less than 300*l*. per annum, in addition to a proportion of the students' fees. A precarious income, if raised by annual subscriptions, would not secure Professors of high scientific qualifications, to whom the permanency of the scheme has to be assured. Besides the stipends of the Professors, sundry annual expenses for working and maintenance will be required, and these will be paid out of the general fund. The Committee therefore appeal for contributions upon a generous scale commensurate with the importance of the proposed scheme. This appeal has been well answered already; but we hope that the Committee will not rest until the whole of the original scheme has been realised.

The Committee refer to the sum raised for the Newcastle College of Science, 22,025*l*., with an annual contribution of 1,000*l*. from the University of Durham, and say with justice, that, considering that the wealth of the district over which the benefits conferred by the Yorkshire College of Science will extend is at least equal to the Newcastle district, it is to be hoped that the public spirit of Yorkshiremen in behalf of the College will be as freely expressed.

To the Owens College, Manchester, the sum of 13,500*l*. has been contributed by the engineering profession towards the endowment of the chair for Engineering; and the hope is entertained that towards the endowment of the Professorship in that subject in the Yorkshire College of Science, aid may be forthcoming from a similar source. The chair for Chemistry has also peculiar claims for support upon the manufacturers of the county whose business requires the aid of chemical science.

Arrangements will be made for the establishment of scholarships at the College. All donors of 500*l*. and upwards towards the College funds will be entitled to nominate to a free studentship for a term of years.

It is proposed to vest the government of the College in a board of governors, consisting of (*a*) all subscribers of 250*l*. and upwards; (*b*) fifty governors elected by the general body of subscribers; (*c*) two professors elected by the professorial staff. The governors shall hold two meetings in the year, shall appoint trustees, shall audit the accounts, shall receive the annual report from the council of the College, and shall constitute a court of appeal in certain cases. The ordinary administration shall be in the hands of a body called the council. This shall consist of fifteen members, including a chairman, to be elected out of and by the governors.

One of our wealthy City Companies, the Clothworkers' Company, we are glad to see, has generously come forward in the interests of the College as well as in the interests of the particular branch of manufacture with which the Company is connected, by endowing a Professorship of Textile Fabrics with 300*l*. a year. The subscription of the coal-owners alone amounts to some thousands of pounds, and we have no doubt, when the time comes to extend the sphere of the College and to give it a permanent building of its own, this wealthy class will see it to be their duty largely to add to this subscription. We hope also that others of our City Companies will see it to be their interest to lend a helping hand to the young institution. There are several such technical institutions on the Continent, and it is on this account that in several respects Continental manufactures are much superior to those of Britain. Let us hope that this may not be much longer the case, but that by the establishment of the Yorkshire

College of Science, and similar institutions in other districts, all who are in any way connected with our arts and manufactures may be trained to work on a method so really scientific that Britain shall in this, as she certainly is in some other respects, be foremost among the nations.

REFRACTION OF LIGHT MECHANICALLY ILLUSTRATED

IN preparing an elementary lecture on Light, intended to be given at the Taunton College School, I have had to consider how best to explain the somewhat abstruse principle of optical refraction. It is true that Sir John Herschel, in the sixth of his "Familiar Lectures on Scientific Subjects," giving the explanation of refraction on the undulatory theory, describes it as being "exceedingly simple." The fact is, however, that it involves conceptions of wave-motion, difficult for any but advanced students, and even they feel grateful to the eminent physicist for the help afforded by a familiar illustration with which he follows it. He desires his readers to imagine a line of soldiers marching across a tract of country divided at a straight boundary into two regions, the one level ground suited for marching, the other rough and difficult to walk over. Now if the line of soldiers march with their line of front oblique to the boundary, the men on the side just engaged in the heavy ground

Fig. 1

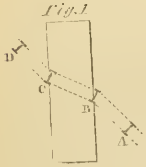
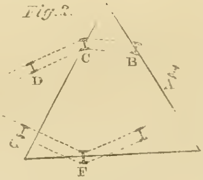


Fig. 2



will be retarded as soon as they cross into it, so that if the line be kept unbroken, the consequence must be a change of front, which will leave the whole body of men marching across the heavy ground in a new direction—in a word, their direction of march will have been refracted. Now the light-waves emitted from a radiant point being compared to the circles spreading from a stone thrown into a pond, it is easily understood how a sensibly straight portion of such a light-wave, passing obliquely from one medium to another of different resistance, will be refracted in a new direction. This simple conception of change of front is at once apprehended by the learner, to whom refraction thenceforth ceases to be a molecular mystery, and becomes an intelligible mechanical act dependent on the resistance of the two media and the form of their limiting surface. Probably no point in all Herschel's lectures has fixed itself in the memory of so many intelligent readers.

In following up the train of thought started by Sir John Herschel's comparison, it occurred to me that an instrument made to perform refraction mechanically would be useful in teaching optics, and that such a contrivance would only require a pair of wheels running on a table, into and out of a resisting medium. After a number of trials, made with the help of Mr. R. Knight, a simple arrangement has been completed, which answers satisfactorily in showing the behaviour of a ray of light under the various circumstances of ordinary refraction. Pieces of a thick-piled velvety plush known as "imitation sealskin" are cut out to represent the sections of a thick plate, a prism, a convex and a concave lens, and glued on to smooth boards. The runner consists of a pair of boxwood wheels mounted loosely on a stout iron axle, and is trundled across the board, or still better, the board itself

Fig. 3

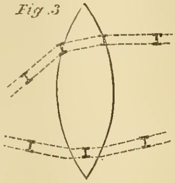
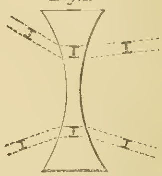


Fig. 4

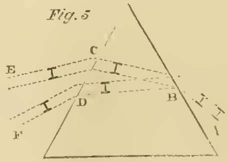


is tilted up, and the runner let go in the proper starting direction. The following figures show the path of the wheels, always from right to left of the page.

In Fig. 1, the runner starting from A, enters the rectangle of velvet at B, where its left wheel being first retarded, it shifts round into the direction BC, till it reaches C, where the left wheel first emerging gains on the right, so as to bring back the runner to the ultimate direction CD. This illustrates the refraction of a ray of light in entering and quitting parallel plane surfaces of a resisting medium, such as a plate of glass. When the runner enters at right angles to the boundary, its direction is of course unchanged, as with the ray of light.

Fig. 2 shows the path ABCD of the runner across a triangle, corresponding with the course of a ray traversing a prism. Also, by causing the runner to enter at about a right angle near E, a direction is given to it which, if the surface of the board and the triangle were similar as to resistance, would make it emerge near F, at a small angle

Fig. 5



to the side. But the left wheel passing on to the smooth surface gains so much on the right wheel still in the velvet, that the axle slews round, the left wheel re-enters th velvet, and the runner goes off in the direction FG, thus illustrating the total reflexion which takes place when a ray of light is directed to emerge very obliquely from a more into a less resisting medium, as from a glass prism or a surface of water into air.

The action of the double-convex lens in causing parallel or divergent rays to converge is shown by the path of the runner in Fig. 3, which requires no further explanation, nor does that corresponding to the divergent action of the double-concave lens, Fig. 4. By starting two runners

at once from the right-hand side of the board, so as to traverse the upper and lower parts of the convex lens, they are made to run into one another, thus illustrating the meeting of rays in a focus.

Lastly, by using two runners with wheels of different diameters, as the refraction depends on the resistance to the wheels by the velvet, the apparatus may be so inclined as to show plainly their consequent difference of refractive angles. The courses of the two are seen in Fig. 5. This experiment, however, requires some nicety of arrangement

Now the separation of rays of different refrangibilities by a prism being due to a like cause, this experiment serves to illustrate mechanically the decomposition of white light. Let the large-wheeled runner represent the red ray, and the small-wheeled runner the violet ray, the principle of the prismatic spectrum becomes at once evident.

For the information of any who may wish to reproduce this simple apparatus, I may state the dimensions I have found convenient. The wheels may be $1\frac{3}{4}$ in. and 2 in., with rounded edges, mounted on a nearly half-inch iron axle, turned down to $\frac{1}{8}$ in. at the ends. The boards may be 2 ft. 6 in. by 1 ft. 6 in., with velvet on each side. It is convenient to place the velvet nearer to one end of the board to leave room at the other for starting the runner; and care must be taken to cut the velvet so as to present a good resisting surface, as this varies with the direction of the pile. In using the apparatus for teaching, care in manipulation is required to neutralise the defects of the texture. Some kinds of "Utrecht velvet," to be had from the upholsterers, are more uniform than the "imitation seal-skin," and thus work more equally, but their effect is not so striking. Wet sand will answer equally well with the velvet, if metal wheels be used.

EDWARD B. TYLOR

THE FRESHWATER FISH OF INDIA AND BURMAH

Report on the Freshwater Fish and Fisheries of India and Burmah. By Surgeon-Major Francis Day, F.L.S. and F.Z.S., Inspector-General of Fisheries in India. 8vo. (Calcutta, 1873.)

IN the introductory part the author states that the present report is the result of investigations commenced by him in the year 1868, into whether a wasteful destruction of the freshwater fisheries is or is not occurring in India and Burmah. He comes to the conclusion that a wasteful destruction of fish is going on to a very great extent, that these fisheries are more and more deteriorating, and that immediate legislation is called for, to prevent the entire failure of a most important article of food.

The steps taken by the Inspector-General to ascertain the facts on which he bases his report were twofold. He personally inspected districts of various parts of the Indian Empire, and supplemented his own observations by collecting the opinions of European and Native officials, to whom he addressed a series of questions bearing upon the subject. Accordingly the book before us is divided into two parts :—(1) The report proper, pp. 1-118; and (2) A *résumé* of the answers returned, with marginal notes by the reporter, pp. i.-ccxxxvi. An article on "Fish as Food, or the reputed Origin of Disease," an Enumeration of the Indian freshwater fishes, and Notes on preserving specimens of fish, conclude the volume.

Europeans who have formed favourable ideas respecting Indian rivers and their abundance of fishes from the accounts which so frequently enliven the sporting papers of the day, will find them rudely dispelled by this report. It is true that not a few of the resident officials deny the decrease of fishes, and deprecate legislative interference altogether. Thus, for instance, the Commissioner of the Agra Division writes that there is no reason to apprehend that any wholesale destruction of fish goes on in these parts. A close-time might no doubt be introduced by law for the protection of fish during the breeding season, but it does not appear to him that it would be easy to carry out such a measure, or that there is any compensating object to be gained; that "it is a useful maxim—*de minimis non curat lex*—minute legislation is unbefitting our position in this country, and more likely to expose our Government to ridicule than to any results of important benefits to the people;" "it is in the highest degree undesirable that the public mind should be disturbed by gratuitous interference on the part of an alien administration, enforced by not very trustworthy agency." On the other hand, the Inspector adduces such incontrovertible evidence in favour of the conclusion he has arrived at, that we can but agree with him that in numerous districts the freshwater fisheries are in danger of being utterly destroyed, and this must appear to call for speedy interference by the Government all the more, as those districts are among the most populous, in which this article of food can be least spared.

Naturally one looks first for the causes by which the Indian fisheries are said to have been thus reduced; and it is not very flattering to be told by the author that this disastrous effect has been caused by the change from the Native to the British rule. He states that, under the former rule, fisheries formed royalties mostly let out to contractors, who alone in the district possessed the right to sell fish, and that they permitted the people, on payment, to capture fish for their own consumption; that the men who followed the occupation of fishing formed distinct crafts or castes, exercising their calling with certain restrictions and regulations. Under British rule the renting system was abolished; with the most philanthropic intentions, the British gave to the people liberty to fish when and where they pleased; where everybody could fish, fishing ceased to be a distinct calling; breedingfish were captured without regard to season; and when the supply of larger fish commenced to fail, it became the practice to catch undersized fish and fry. Add to this, that a number of irrigation weirs and dams were erected, preventing the fish from resorting to suitable spawning-beds, that fixed engines for the capture of fish are now used, where previously they were never permitted, and the natural result is the lamentable state as represented by the Inspector.

We need not enter at present into the remedial measures provisionally proposed by Mr. Day. His proposals, as well as the opinions of his opponents, will no doubt find due consideration on the part of the Indian Government. But I will not conclude this notice, without

alluding to one or two of the reports of European officials, which will show that, however weighty their evidence may be as regards the practical side of the question, their opinions in scientific matters are open to criticism. Mr. Day had drawn attention to the destruction of fish by various kinds of crocodiles, very properly recommending that rewards should be paid for their eggs. To this one of the officials replies :—" Waging war against such fish-destroying animals as crocodiles appears to me absurd. I have no doubt at all but that a general destruction of crocodiles would directly frustrate the end hoped for by their destruction. Their very presence in numbers, it being given that they live on fish, shows that the supply of fish is abundant, which is all that anyone requires, and nature in these matters, if left alone, keeps the balance even, and resents interference." This is exactly the same view as that held by the modern advocates of a general preservation of birds, who would preserve even such as the sparrow-hawk and cormorant, and who forget that nature itself, in distributing animal life, does not always consult the convenience of man. In India, the presence of tigers, poisonous snakes and crocodiles, would appear to prevent this doctrine from being generally adopted by the European community. Another official refers to a "very exhaustive and carefully drawn up report" from a Civil Surgeon in his district ; this report is accompanied by a list of the freshwater fishes, in which occur some species with Buchanan-Hamilton designations, others with Latin terms derived from a dictionary, a cod-fish, a john dory, and "a very common fish, the scientific name of which is supposed to be *Lacerta scincus !*" Can anyone doubt after this that a comprehensive and well-illustrated hand-book of Indian Freshwater Fishes with an introductory treatise on the elements of Ichthyology is called for?

ALBERT GÜNTHER

KOHLRAUSCH'S "PHYSICAL MEASUREMENTS"

An Introduction to Physical Measurements, with Appendices on Absolute Electrical Measurement, &c. By Dr. F. Kohlrausch. Translated from the Second German Edition by T. H. Waller, B.A., B.Sc., and H. R. Procter, F.C.S. (London: J. and A. Churchill, New Burlington Street, 1873.)

MESSRS. T. H. WALLER and H. R. Procter have furnished us with a translation of the second edition of Dr. Kohlrausch's "Physical Measurements," to which they have added several useful Appendices and Tables.

Their work is intended to serve as a text-book for students in experimental physics, and consists mainly of a collection of the formulæ used in correcting and applying the results of the simpler experiments in weighing and measuring, heat, light, electricity, and magnetism, accompanied in each case by such an account of the method of observation employed as may suffice to render them intelligible.

The limits which the author assigned to himself are very clearly laid down in the Translators' preface, in which we are informed that "descriptions of apparatus are but rarely given, as students mostly have instruments provided for them," and also that "the mathematical knowledge required is but very elementary, as the proofs of the formulæ are only given when they present no complex arguments," but it should perhaps have been added that, even in cases where the apparatus is simple, outlines of the mode of performing an experiment are generally alone supplied, the teacher being left to explain to his pupils the niceties of arrangement and manipulation.

Regarded as a syllabus of a course of physics, the book is incomplete, no account, for instance, being given of Favre and Silberman's Calorimeter, or, with the exception of saccharimetry, of experiments on polarised light ; and if the author's plan be thought to justify the exclusion of these, the same reason can hardly account for the omission of methods for determining melting points, or the specific gravity of substances whose constitution is altered by exposure to the atmosphere, or the ratio of the intensities of the illuminations produced by two sources of light, or of all experiments relating to the capillary elevation of liquids in fine tubes.

It is, however, as a collection of formulæ that "Physical Measurements" is likely to prove most useful, and from this point of view the "Introduction" seems to us one of the best parts of the book. It contains the rules for finding the mean and probable errors of a set of observations, and for determining empirical constants by the method of least squares, together with hints as to how to shorten the labour often wasted in the calculation of corrections ; points on which a short practical treatise like that here provided will afford great assistance to those who are not mathematicians.

The sections devoted to weighing and measuring are full and good, especially those which relate to the use of the balance, but heat and light are not treated of in an equally satisfactory manner.

The experiments on these subjects which are described are not numerous enough to satisfy the requirements of large laboratories. Moreover, sufficient attention seems scarcely to have been paid to the fact that students should be encouraged to apply corrections to the results of experiments which they perform, not so much on account of the more accurate numerical values thereby obtained, as for the sake of the excellent practice the necessary observations often afford, and the insight gained into the theoretical principles on which they are founded. A case in point is the omission in the article on the Determination of Specific Heats by the Method of Mixtures of any account of the correction employed by Regnault for the loss of heat by radiation.

We miss all mention of the optical bank, and the mathematical expressions for results involving the determination of distance in terms of differential measures on that instrument. In the article on the spherometer, which is in other respects incomplete, we see no instructions for finding the radius of a spherical surface too small to permit the instrument to be placed upon it ; and omissions are made in the pages devoted to the spectrometer, the goniometer, and elsewhere, which combine to render the section on Light very imperfect.

Nearly one half of the book is given up to Electricity and Magnetism, subjects in the study of which assistance can be more readily rendered by the method of treatment here adopted than in those we have been discussing, as numerous mathematical formulæ are required which are

in many cases obtained by calculations beyond the grasp of the less advanced pupils; and the Translators have considerably improved what was already good by several Appendices, among which one of the most important is that on Thomson's electrometer. Some preliminary sections are devoted to the reduction of observations made with the mirror and scale to angular measure, to the determination of the position of equilibrium and time of oscillation of a magnetic needle and similar topics, while the methods of reading the various magnetometers and galvanometers, and the measurement of resistance and electromotive force, are afterwards discussed.

On the whole the principal fault we have to find with the book is a want of fulness, especially in the earlier portions. It aims at supplying a want already felt, and which will become still more pressing as the number of those who make some progress in the study of Natural Science increases, and we are not aware of the existence of any manual which gives the information contained in it in an equally compact and handy form; while the tables, thirty in number, which fill the concluding pages, will often save time and trouble to those engaged in laboratory work. Although, then, as we have already pointed out, we consider it capable of very considerable improvement, yet probably most teachers of Experimental Physics will obtain some useful hints from its perusal, even if they do not adopt it as a text-book for their pupils. A. R.

OUR BOOK SHELF

Pheasants for Coverts and Aviaries. By W. B. Tegetmeier, F.Z.S. (London: Horace Cox. 1873.)

ANY work on animals which appeals to so many different human weaknesses as the Pheasants, must be popular if the least effort has been made to do the subject justice. The one before us has merits which make it peculiarly acceptable. It is by the hand of an author who has devoted his life to the careful study of the natures and habits of the Gallinaceous birds and Pigeons, and who has long since made himself well known by works on some of the genera, which have become the standard literature of the points on which they treat. In the handsome volume before us Mr. J. W. Wood's excellent and truthful illustrations add greatly to its value, though the absence of coloration has made it more than difficult in some cases to produce an approach to the gorgeous appearance of some of the species depicted. Among those that suffer most from this deficiency, are the Japanese Pheasant (*Phasianus versicolor*), whose chief beauty consists in the richness and delicacy of the shades of its plumage, and the Golden Pheasant (*Thaumelia picta*), with its ally, the Amherst Pheasant (*T. amherstiæ*), whose resplendent hues even the best artist finds it difficult to represent. The Reeves' Pheasant (*P. reevesii*), and the Eared Pheasant (*Crossoptilon mantchuricum*), however, form excellent and most truthful pictures, colours in them not being such important features. Mr. Tegetmeier, besides describing each of those species which are the love of the sportsman and the pride of the aviary, devotes the earlier part of his work to the discussion of points of great practical interest. After a short history of the Pheasants as a family, from which it is clear that they were introduced into this country from Asia Minor, the native home of the common Pheasant (*P. colchicus*), as early as the reign of King Harold, and probably by the Romans, a series of chapters is given on the management of the bird in preserves and in confinement, together with an account of the diseases to which it is most liable. These are replete with practical detail that must be most valuable to the many who spend such large sums on preserving game, and to those who have the actual superintendence of the coverts themselves. Particular attention is drawn to the great difference between birds, like the common Fowl (*Gallus bankiva*), which are capable of domestication in the true sense of the word, and the Pheasants, which, though individuals are frequently known to become tame, can never be really domesticated; even the young ones taking to the woods on the earliest opportunity, whilst the opposite inherent peculiarities of the poultry have given rise to the proverb—"Curses, like chickens, come home to roost." Altogether this work supplies a long-felt want, and its perusal will well repay anyone who takes it up.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Wasps

PERHAPS it may be of interest to some of your readers, who make entomology their study, to know that the wasps in a nest about a mile from this were still tolerably active on the 13th of this month, when my attention was attracted by the loud buzzing of three or four wasps at the entrance, apparently ventilating it with their wings after the manner of bees. I again visited the place on the 23rd. There were at first no signs of life outside; but stamping on the ground above caused a considerable number to come out after a minute or a minute and a half and hover in the air above the entrance. I attribute this unusual circumstance to the mildness of the season (the minimum temperatures having been 26° in October, 25° in November, and 29° on the 10th and 11th of December, and the 13th having been mild, and so also the 23rd) and the bad conducting power of the nearly cut out peat bog in which the nest was situated.

Birr Castle, Parsonstown, Dec. 24, 1873 ROSSE

The Potato Disease and Lord Cathcart's Prize

NO one acquainted with botanists and botanical science can feel surprised at the decision of the committee in this matter, and it must be confessed that, however well meant, the offer of the 100*l.* prize was a great mistake which has only ended in producing ninety-four unsatisfactory essays and the loss of a year.

Little else could have been expected, for the Council of the Royal Agricultural Society must surely be aware that the men (in this country at least) who are competent to write anything *new* on the subject could certainly be counted in units, and these men could not enter into the competition for more reasons than one, not the least being the loss of status such a proceeding would entail.

It appears to me that the committee have even now hardly hit the right nail upon the head in recommending a grant of money to "some competent mycologist" to investigate the life history of the fungus during a certain period of its life. If the investigation is carried on by any *one man* it is sure to end in failure. It would be far better for the committee to recommend that *five or six* competent botanists should each write an essay on the subject from his own point of view, each essay to be published in the Society's journal. There are many reasons why this would be best. I will give one. Payen has figured and described certain ciliated bodies found in spent potatoes, and which Berkeley and other botanists have looked upon as the probable resting-spores of the *Peronospora*. Montagne has referred these same bodies to the *Sepedoniei*, whilst I am by no means sure that the objects do not belong to the *Stilbacei*, and are no other than *Volutella ciliata*. However this may be, I have met with the last in spent potatoes in immediate connection with the *Peronospora* itself. Where competent observers differ in opinion it is better to get the views of all. It would be very unwise to restrict the observations to any particular period of the growth of the plant, and very little would be added to our knowledge were the resting spores themselves found; for, resting spores or no resting spores, it is an ascertained fact that the living

fungus has a season of rest underground, and whether in the condition of resting spores, a sclerotioid mass or a number of mycelioid threads, the principal fact remains that the fungus lives through the winter in a state of rest. As to certain potatoes being able to resist the disease, I shall shortly be able to show that whilst certain breeds of potatoes *entirely resist* it in one place, they fall a *ready prey* to it in another.

Hence any experiments carried on in one place by one person, though valuable in themselves, must be inconclusive and imperfect.

The great question is, "How can the disease be evaded or destroyed?" and this can only be answered, if answered at all, by men who thoroughly know the fungus and its allies.

WORTHINGTON G. SMITH

The Denudation of Limestone Hills of Sarawak

THERE is an agency in the denudation of the limestone rocks of Saràwak which I do not think has been noted, but which is very efficient locally in its operation.

The limestone in question is a dark-blue compact rock (probably the oldest stratified formation in this part of Borneo) full of fissures and joints, and forming hilly tracts in Saràwak proper and Samarahan. It is a not uncommon occurrence during periods of unusual drought for the jungle clothing these hills to take fire in some unascertained way, and for large tracts of the vegetation to be destroyed before the conflagration dies out or is extinguished by rains. Such an accident took place two years ago on the Jambusan hill, and a short time previously on Gunong Añgus (whence the present name, "Burnt Hill"), and on Marajah, a large hill near Bidi; and I have been informed by natives that similar fires are known at the head of the Undup, where I have observed from a distance extensive masses of limestone.

When such a fire takes place, not only may we take for granted that a great deal of surface-rock is more or less calcined, so as to be easily removable by the heavy tropical rains; but, there being no covering of soil to speak of, and the exterior rock having been merely bound together by a matted network of roots and creepers, large masses of rock—long loosened by weathering, or freshly detached by the expansion of air and water in the fissures—keep falling from the higher parts of the hill as their supports are burnt away; whilst groups of burning trees go crashing down the scarps, assisting the work of degradation by collision with the inequalities in their paths.

It is, however, subsequently to the fire that its most important effects become apparent. For the next year or two fresh dislodgments of rock will be continually taking place, particularly when, after the almost daily rains, the sun shines out, striking on the bared rock with rays of tropical fervour. Many years elapse before sufficient soil collects in the crevices of the rock to support vegetation; and until the whitened face of the hill is once more shrouded in jungle, it remains immediately exposed to steady sub-aërial denudation; so that, bearing in mind the immense rainfall, the abundance of fissures and joints in the stone, and its solubility, I am inclined to believe that the degradation of these hills which goes on during the interval before they again become efficiently shielded with vegetation, is comparable to centuries of waste of the same rock under ordinary conditions.

Were the limestone hills of Saràwak more gently rounded and less scarped, their destruction through the agencies above described might not be noteworthy; but, owing to the frequency of lines of old sea-cliffs and mural precipices, nearly the whole of the detached rock passes at once to the bases of the hills, where it is again attacked by the rains, assisted now by running streams or standing water.

Saràwak, July 1 A. HART EVERETT

An Appeal to our Provincial Scientific Societies

NOW that our provincial museums are yearly increasing in number, it appears desirable to draw the attention of the provincial scientific societies to their importance as the centres for the private collections illustrative of the local geology, natural history, and archæology which from time to time come into the market. We are entirely indebted to private energy for any British collections which we possess. How lamentable then is it that there is no public system for centralising them in our public museums, and thus saving them from dispersion by their passing into the hands of dealers or private collectors, or into the possession of foreign or metropolitan museums. Every year witnesses such losses, which are regarded with complete indifference by our local representatives of Science. It is unaccountable that not one of our provincial Societies has as yet had the public spirit, energy, or foresight to see the importance of this work and of raising a fund for the purpose of ultimately securing such collections for the district.

It is a question of national scientific importance. The collections which are formed during the present century may be said to represent the "pick" of the country. By-and-by, when localities are worked out, and the rarity and value of specimens greatly increased, we may awaken to a sense of the mistake we have made in not devoting our energies less to palæontological literature, and more to the formation of complete and exhaustive local series and collections, and thus smoothing the path of, and providing interest for, the investigators of our fossil and recent flora and fauna.

Such is the lack of originality displayed in this country, and precedent is so blindly followed, that everywhere we find narrow scientific cliques, so-called "Societies," apparently formed merely for the sake of having social gatherings and by means of a local periodical facilitating the cheap publication of the papers of such as contribute.

The energy thus expended is almost entirely thrown away. Indeed, so far as the journals of these "societies" are concerned, these societies are mere hindrances to the progress of Science, for, did they not exist, the papers which appear in their obscure journals (or "napkins," in which the "talents" of these societies lie hid) might be contributed to such as have a general circulation, and thus benefit the world at large. I would most earnestly impress on our scientific Societies the great importance of devoting their energies more to the formation and preservation of complete and exhaustive local collections. With such division of labour how much more accurate and rapid would be the progress of the sciences of Geology and Biology.

S. G. P.

The Killing of Entomological Specimens

A NOTE in a recent number of NATURE, reminds me of some experiments I made about 15 years ago upon the action of the vapours of volatile liquids (hydrocarbons, chloroform, &c.) on insects, my object being to find an expeditious and painless method of killing entomological specimens. Several vapours produced insensibility from which the insects recovered more or less rapidly, but bisulphide of carbon vapour killed them effectually.

My method of applying it was to place a few layers of blotting paper, lint, or cotton wool, on the bottom of a wide-mouthed bottle, pill box, or other convenient place of execution; then to pour a few drops of the liquid upon this and confine the insect in the receptacle, which on account of the great density of the vapour need not be very accurately closed. The action of the vapour must be continued a few minutes after signs of life have disappeared, or the insect will recover.

The most obstinate of beetles succumb without a struggle, and the most delicate of moths or butterflies are uninjured, provided the liquid itself does not touch them. Butterflies may be killed after they are pinned out, by simply placing a little cotton wool soaked with the bisulphide in a box near to them.

W. MATTIEU WILLIAMS

Lecture Experiments

THE result of convection in a liquid, tending to cause the upper part of the mass to be constantly at a higher temperature than the lower, may be well illustrated by the two following experiments:—

Two large glass beakers are placed in front of a sheet of white paper, one of them filled with cold the other with boiling water. A boiling-tube filled with freshly prepared starch solution which has been coloured deep blue by gradual addition of aqueous solution of iodine, and has then been heated until the colour just disappears, is plunged into the beaker of cold water; the blue colour, caused to return by the cooling of the solution, will appear first at the bottom of the tube and then gradually creep upwards, showing that the lower part of the heated liquid first becomes sufficiently cooled to cause the return of the colour. In order to insure the disappearance of this colour by heat, an excess of iodine must be carefully avoided.

In the boiling water contained in the other beaker is immersed a boiling-tube filled with the blue liquid obtained by adding

caustic soda in excess to a solution of copper sulphate and tartaric acid, with which has been mixed a little grape sugar (a small quantity of "set" honey): the formation of yellow cuprous oxide commences at the surface of the liquid, and is seen gradually to extend to the lower parts, showing hat the upper parts first attain the temperature requisite to cause the reaction to occur which precipitates cuprous oxide.

These experiments are easy of execution, and by the above arrangement, or still better by being projected on the screen, may be rendered visible at a considerable distance.

Queenwood College FRANK CLOWES

Mr. Garrod's Theory of Nerve-Force

THE thermo-electric theory of nerve-force propounded by Mr. Garrod (NATURE, vol. viii. p. 265) seems capable of extension. If a pole of metal, cased in a non-conducting sheath, were sunk in an artesian boring so as to reach from the level of constant temperature to the greatest depth attainable, how far would such pole fulfil the conditions of a sheathed nerve penetrating from the cool surface of an animal to the warmer interior? And with so little difference of temperature in so great a length, would its dynamic effect be at all appreciable?

A quarter of a mile of submarine cable let down the shaft of our Carnbrea mine might represent a sheathed nerve; and any existing nerve-force might there be tested. Abandoned mine-shafts are the terrors of our Cornish moorlands. Is it within the power of Science to convert them into earth-nerves, say by lining their sides with non-conducting material, and then packing them tight with conductive slag or some kind of metallic refuse? And is it possible, even in theory, to make such earth-nerves work some kind of earth-muscle? For ignorant me to speak of this subject is ultracrepidism (NATURE, vol. vii. p. 262). Yet it seems a fair extension of Mr. Garrod's ingenious theory.

AUGUSTINE CHUDLEIGH

Carnbrea, Cornwall

Genesis in Borneo

MR. CAMERON's paper read at the Society of Biblical Archæology, testifies to the early diffusion of Semitic traditions by the agency, it may be inferred, of Moslem converts.

The same traditional coincidences recorded of Borneo are found in New Zealand and elsewhere, and would naturally accompany the diffusion of Malayan dialects throughout Polynesia, an influence the duration of which may be counted by centuries. A. HALL

Dec. 11

Indian Snakes

IN a small treatise on Indian snakes by Dr. Nicholson, R.A., the author states his belief that cobras will not feed in captivity unless forced to, starving themselves voluntarily to death. He thinks, also, that jugglers in this country either "feed their cobras with liquid nourishment, or else let them loose when their lives are in danger," recapturing them at a future time.

To test the correctness of this, I questioned a snake-charmer a few days ago, and he informed me that he fed his cobra every week with frogs. His snake had then been recently fed, so he was told to bring it to the bungalow again in a few days. A frog (*R. tigrina*) was procured, and placed in the small basket in which the cobra was kept. The latter seized it at once; but as I was anxious to see the whole process, which could not be done whilst the snake was coiled up in the basket, I requested the man to place the frog on the ground. As it struggled away (the hind limbs of the poor reptile had been broken) the cobra followed it eagerly, and again and again seized it. The want of fangs, and the size of the frog, which in its inflated state exceeded considerably the circumference of its enemy, rendered these attempts ineffectual; so a smaller frog was caught, and placed with the cobra in the basket. This was swallowed in a short time, the snake pushing its victim against its coils, and working down the hind limbs by a lateral motion of the lower jaw, very similar to that of a cow chewing the cud.

The large frog was now placed in the basket, and the cover put on, and in about half an hour had followed its companion. The cobra's appetite was now appeased, for after seizing a third frog it let it go, on its croaking a remonstrance.

A laughable incident occurred whilst the snake was following the frog over the gravel path. A performing monkey belonging to the juggler, in a spirit of mischief, or perhaps fearing that its master's property was escaping, stepped gravely after the snake and laid hold of it by the tail. As a natural consequence, round came the cobra and menaced the monkey, which, retreating with sundry grimaces, took refuge with the juggler, in great alarm at the turn events had taken.

This cobra is a small one, and as it is one of those very pale, almost cream-coloured varieties, that finds no mention in Günther's able work, I am anxious to examine it thoroughly. The owner, however, affirms that he has to draw its fangs about once a month, and as he is most cautious in handling the reptile, it is probable that the fang matrix has not been destroyed, and examination will be safest just after the operation of extracting the fangs.

Mangalore, Sept. 12 E. H. PRINGLE

CLASSIFICATION OF CLOUDS*

IN an essay on the "Modifications of Clouds, read to the Askesian Society in 1802, Howard first proposed his classification of clouds, which has since been the generally received authority on the subject. His system has thus stood its ground for more than half a century, in spite of its defects and of the misconstruction not unfrequently put on the two terms, "stratus" and "nimbus" since the publication of Kaemtz's Meteorology. These misapprehensions and the obscurity and confusion arising from them are pointed out by Prof. Poey, but the errors have not been followed so generally as is asserted, at least by British meteorologists. In a series of papers issued at intervals during the past eleven years, Prof. Poey has endeavoured to develop a new classification of clouds, of which the volume before us is the result.

The following is Poey's classification compared with that of Howard:—

POEY'S CLASSIFICATION.

		Cloud composed of
First type:	cirrus	spicules of ice.
Derived:	cirro-stratus	spicules of ice.
	cirro-cumulus	snow.
	pallio-cirrus	snow.
Second type:	cumulus	vesicular aqueous vapour.
Derived:	pallio cumulus	vesicular aqueous vapour.
	fracto-cumulus	vesicular aqueous vapour.

HOWARD'S CLASSIFICATION.

First type:	cirrus.
Derived:	cirro-stratus.
	cirro-cumulus.
Second type:	cumulus.
Derived:	cumulo-stratus.
Third type	stratus.
Derived from the three types:	nimbus.

In forming his system, Prof. Poey first strikes out the "stratus" as being from Howard's own definition not a true cloud, but only "mist;" the "cumulo-stratus" as not differing really from the cumulus; and the "nimbus" as being not a single cloud, but rather a system of clouds. He retains the word "stratus" as part-descriptive of the "cirro-stratus," but in this case it is exclusively restricted to those instances where the cirrus arranges itself in a stratified form, and is not applied when the arrangement is an extended sheet or continuous layer of considerable thickness totally impervious to the sun's rays. To this latter condition, the new term "pallium" is applied.

In his classification Poey arranges the clouds in the order in which they severally appear, from the cirrus, the most elevated, its height being from 30,000 to 50,000 feet, to the fracto-cumulus, the lowest of all; and groups them into three divisions according as they are composed of ice-crystals, snowy particles, or vesicular vapour.

But the most fundamental change which he has introduced into the system is the *pallium* or *sheet-cloud*, in its two distinct forms of *pallio-cirrus*, and *pallio cumulus*, according as it is formed from the cirrus or the cumulus. The pallium is the greyish, or ash-coloured cloud which overspreads the whole sky, and from which rain falls continually for hours or days together. On the approach of rain the pallio-cirrus is formed by the rapid increase and thickening of the cirrus downwards from the enormous

* "Nouvelle Classification des Nuages suivie d'Instructions pour servir à l'Observation des Nuages et des Courants Atmosphériques.' Par André Poey, Havane. (Extrait des Annales hydrographiques, 1872.) Paris, 1873. (17 Planches).

accessions of moisture that take place, by which this high ice-cold region of the atmosphere over a great extent and thickness, is brought to the point of saturation and condensation. Underneath this leaden-hued mass of cloud which uniformly covers the sky, but separated from it by a clear space, is extended the dense cloud covering of the *pallio-cumulus*, which is formed by the watery vapour of the atmosphere reduced to the points of condensation and precipitation. This is the true *rain-cloud*, and it is fed and increased by the rapid drifting in from below of torn masses of cumulus constituting the *fracto-cumulus* or *wind-cloud*. The fracto-cumulus may be of all sizes, has no determinate shape, is the lowest and swiftest moving of the clouds, and is whitish, greyish, or slate-coloured, as may be determined by the hygrometric condition of the air. On the return of fine weather accessions of vapour by the fracto-cumulus slacken and then cease, the pallio-cumulus diminishes in thickness and gradually clears away, showing through its intervals the pallio-cirrus above it, which in its turn is broken up, revealing still higher up the delicate tracery of the cirrus. The pallio-cirrus is negatively electrical, whilst the pallio-cumulus is positively electrical, the clear stratum between being neutral; and between these oppositely electrified strata, discharges frequently take place in thunderstorms.

The merits of Prof. Poey's work are very considerable, whether they be regarded as expository of Howard, or as a contribution to this difficult branch of meteorology; and it is just those meteorologists who have paid particular attention to the observation of the clouds who will be readiest to recognise its merits. It must, however, be conceded that, as a descriptive classification of clouds, as well as explanatory of the phenomena they present, Prof. Poey's work leaves the subject in a state still too incomplete to warrant us in recommending his system for general introduction. It is a step in the right direction, and will materially contribute to place this vitally important department of atmospheric physics on a satisfactory footing.

Toward this end, what is now urgently wanted is an extensive collection of the data of cloud-phenomena in all countries, particularly of those clouds interesting in themselves or from their known relations to weather changes. We have more than enough of unmistakeably pure typical forms scattered through the pages of weather-literature, but such do not greatly assist us, in describing and classifying many of the forms of clouds which occur. Hence what is required is faithfully accurate delineations of these forms in their different aspects, and systematic inquiries set on foot into the relations of the forms of clouds to the mode of their formation, to the states of the aqueous vapour which compose them, and to the varying elasticity, temperature, and electricity of the atmosphere.

In connection with this part of the subject, Prof. Poey investigated in 1862-64, by means of the thermo-electric pile, the temperature of different parts of the sky under different conditions, and of the clouds which passed across it. Among other highly interesting results, he has shown that the cumulus, properly so called, and the cumulo-stratus of summer are the clouds of highest temperature; then follows the fracto-cumulus, except when it comes after the rain which accompanies a thunderstorm, in which case it is of a whitish colour, very rapid in its motion, much torn at the edges, and partakes of the low temperature prevailing on such occasions. The cirro-cumulus is colder than the cumulus and the cirrus the coldest of all the clouds. These are very suggestive results. We are convinced that the key to the position in meteorology is a better knowledge of the vapour of the atmosphere in its various states and changes; and the science will not make the advances it is destined to make till meteorologists generally recognise the necessity of equipping their first-class observatories with the requisite appliances for carrying on those physical researches which are intimately allied to meteorology.

FERTILISATION OF FLOWERS BY INSECTS

V.

More conspicuous flowers adapted to cross-fertilisation, and less conspicuous ones adapted to self-fertilisation, occurring in different species of the same genus.

WHAT has been described in the two last articles as occurring in varieties of the same species (using the term "species" in its widest sense) we propose now to investigate as existing likewise in species of the same genus.

Malva sylvestris and *rotundifolia*

are two closely allied, but, as acknowledged by all botanists, undoubtedly good and distinct species, differing in their flowers in a manner similar to the two varieties of *Lysimachia vulgaris* and the other species previously considered. In both these species of Malva an oval mass of anthers in the first place occupies the middle of the flower, enclosing the stigmatic branches as yet undeveloped and lying close together (Fig. 23). At a later period the stigmatic branches, growing out of and overtopping the mass of anthers, spread and bend outwards and downwards so as to occupy nearly the same place as was before occupied by the anthers (Figs. 24, 25). Insects, therefore, seeking for the honey which is secreted and contained in five cavities between the lowest parts of the petals (*n*, Fig. 23) and covered by a fringe of hairs (*pr*), carry away on their hairy bodies the large prickly pollen-grains from younger flowers, leaving many of them on the stigmatic papillæ of the branches of the style of older flowers, which they can scarcely avoid grazing in seeking for the honey. Hence, in both species, whenever insects frequently visit these flowers, cross-fertilisation in the manner described is largely effected, whereas self-fertilisation can scarcely take place, neither spontaneously nor by means of insects, nearly all the pollen-grains having been removed before the unfolding of the stigmatic branches. Since, however, *Malva sylvestris* and *rotundifolia* grow for the most part in the same locality, and flower during several months at the same time, insects flying about and seeking for honey are much more likely to find out and visit the highly conspicuous flowers of *M. sylvestris* than the far less conspicuous ones of *M. rotundifolia*; the former, when fully opened, presenting bright rose-coloured bells of from 40 to 50 mm. diameter, the latter, on the contrary, light rose-coloured bells of only from 20 to 25 mm.

Direct observation, indeed, fully confirms this supposition, the flowers of *M. sylvestris* being always found in sunny weather visited by a variety of insects, whereas those of *M. rotundifolia*, especially when growing intermixed with *M. sylvestris*, are commonly overlooked by them all. Thus, during the six last summers, I have observed on the flowers of *M. sylvestris* and collected more than 50 species of insects, many of them very frequently (2 Lepidoptera, 3 Diptera, 5 Coleoptera, 40 Apidæ, some Ichneumonidæ); while in the same space of time I found on the flowers of *M. rotundifolia* but 5 species (4 Apidæ, 1 Hemipter), and those only in single or a few cases.

It is evident from these facts, that wherever our two species of Malva grow together in the same locality, *M. rotundifolia* would be rapidly extinguished, unless it were enabled to produce seed by self-fertilisation; *M. sylvestris*, on the other hand, is so commonly visited and cross-fertilised by insects that self-fertilisation, if it were possible, would never be effected, or only exceptionally. Accordingly natural selection must have preserved and accumulated those slight individual variations of *M. rotundifolia*, which afford facility for self-fertilisation, whereas in *M. sylvestris* the possibility of self-fertilisation being quite useless, might be lost, and, indeed, has been, completely or nearly lost. Thus in the flowers of *M. sylvestris*, when precluded from the visits of insects by covering them with

a net, the anthers remain filled with pollen-grains, and never, or only exceptionally, come spontaneously into contact with the stigmatic branches, the free ends of their filaments at a later period bending downwards, and the branches of the styles remaining considerably above them (Fig. 24). Conversely in the flowers of *M. rotundifolia*, when the visits of insects are prevented, the anthers, filled with pollen-grains, remain in so high a position, and the stigmatic branches bend so far downwards as to come abundantly into contact with the pollen-grains, self-fertilisation being thus inevitable (Fig. 26).

Epilobium angustifolium and *parviflorum*

differ most strikingly in a similar manner. The flower of *E. angustifolium*, being of larger size, brighter colour, grouped in long splendid clusters, and exciting attention at a great distance, are so largely visited and cross-fertilised by insects* as never to have need of self-fertilisation, which has actually become impossible; the four stigmatic branches unfolding so long after the maturity of the eight anthers, and so far overtopping them, as to be completely shut out from the pollen of the same flower. The flowers of *E. parviflorum*, on the other hand, being of smaller size, lighter colour, and single, are so inconspicuous that insects but very rarely visit them. Accordingly, its four upper anthers so closely surround the four-lobed stigma, which is mature at the same time, as to cover it largely with their pollen, whilst the pollen-grains of the four lower anthers lying on the way to the honey, cannot reach the stigma of the same or of another flower unless transferred by insects.

Polygonum

Among the many species of the genus Polygonum which grow in our country there are two, *P. Fagopyrum* and *Bistorta*, most distinguished by their attractiveness for insects, which is due not only to the size and colour of the single flowers and to their collection into handsome spikes, but also, and even more perhaps, to their abundance of honey secreted by eight globular nectaries at the base of the filaments (n_1 Figs. 26, 27). With reference also to the frequent visits paid them by insects,† these two species have been adapted to inevitable cross-fertilisation by their visitors, self-fertilisation having at the same time become difficult or almost impossible. The manner in which this advantage has been attained being very different in the two species, it is evident that in this case the adaptation to cross-fertilisation by the visits of insects cannot have been inherited from the common parents of the genus, but must have been acquired by the single species during their evolution.

P. Fagopyrum has acquired, as shown in Figs. 26 and 27, the same kind of dimorphism which has been so fully explained by Darwin in Primula‡ and Linum.§ In both of the two kinds of flowers (which occur only on different plants) there are three styles and eight stamens, three of the stamens closely surrounding the styles and opening outwards, the five others inserted more outwards, alternating with the leaves of the perianth and opening inwards. An insect, therefore, visiting a flower for honey and pushing its head or proboscis between the inner and outer stamens into the base of the flower, cannot avoid being charged with pollen, especially in those parts of its body which, whilst it is sucking the honey, are pressed against the anthers. Now, the place occupied in one of the two kinds of flowers by the anthers, is occupied in the other kind by the stigmas, the same parts of the body of the insect which in the long-styled form were pressed against the anthers, come into contact in the short-styled with the stigmas, and conversely. Thus it is inevitable that insects effect chiefly what is called legitimate fertilisation, *i.e.* transmission of the pollen of the long-styled flowers to the stigmas of the short-styled, and of the pollen of the short-styled to the stigmas of the long-styled form. Fertilisation by pollen of the same form, however, and even of the same flower, is not impossible, and in the short-styled flowers even spontaneous self-fertilisation may happen, by pollen-grains falling down from the anthers upon the stigmas.

The same advantage which *P. Fagopyrum* has attained by dimorphism (Darwin) or heterostyly (Hildebrand), has been gained in the flowers of *P. Bistorta* by protandrous dichogamy, *i.e.* by the anthers so far preceding in their development the stigmas that in the first period of the flower (Fig. 28) only mature anthers, at a later period (Fig. 29) only mature stigmas are present, the anthers having then commonly fallen off. It is readily seen that such flowers also, when perseveringly visited by insects, are always inevitably intercrossed, no other mode of the transmission of pollen being possible than from younger flowers to the stigmas of older ones. It is only when the visits of insects are completely wanting during the first period and the anthers remain clothed with pollen while the stigmas attain their maturity, that self-fertilisation by insects or even spontaneous self-fertilisation is possible.

The least attractiveness for insects, on the contrary, among all native species of Polygonum is possessed by *P. aviculare*, its flowers (Figs. 30 and 31) being of small size, of greenish and white or reddish colour, standing singly on procumbent plants and offering only a small quantity of pollen to insects, but, as far as I have been able to see, no honey. No wonder that insects are induced only in very rare cases to visit and fertilise them,* and that, in compensation for the loss of cross-fertilisation, these little flowers regularly experience spontaneous self-fertilisation, the three inner anthers lying so close to the stigmas that their pollen-grains inevitably come into contact with them (Figs. 30 and 31).

Of the many other native species of Polygonum, which are all intermediate, as to their attractiveness for insects, between those now described, I will only remark briefly upon *P. Persicaria*, which is of more especial interest because of its flowers presenting great differences of structure. In this species, instead of eight nectaries there are only five developed, and these secrete a much smaller quantity of honey than those of *P. Fagopyrum* and *Bistorta*. Its spikes of flower, moreover, being less conspicuous than in those species, the visits of insects are somewhat rare, even in sunny weather, although far more frequent than in *P. aviculare*.† Fertilisation by insects, consequently, is by no means secured. Corresponding to this uncertain agency of insects the sexual organs of the flower are in a remarkably fluctuating condition, undecided, as it were, between adaptation to cross-fertilisation by the visits of insects, and to self-fertilisation. Thus, of the eight stamens, sometimes only the five outer ones are developed, the three others being reduced to rudimentary filaments; and this condition is apparently the most favourable to cross-fertilisation, as any honey-seeking insect must touch the anthers in every flower with one side of its proboscis, the stigma with the opposite side, to which it thus cannot fail to transfer pollen-grains

* On the flowers of *Epilobium angustifolium* I have hitherto observed 26 species of insects, 14 of them belonging to the family of bees, many of them very frequently; on those of *E. parviflorum* I found only once Meligethes, and once a butterfly (*Pieris rapæ* L.) repeatedly sucking the honey of its flowers.

† On the flowers of *P. Fagopyrum* I have observed 41 species of insects, among them 21 Diptera and 12 Apidæ; on the flowers of *P. Bistorta* 18 species of insects, among them 9 Diptera and 3 Apidæ; many of the visitors of each species very frequently.

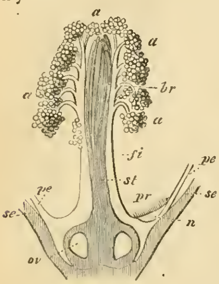
‡ On the two forms or dimorphic condition in the species of Primula and their remarkable sexual relations (Proc. of the Linn. Soc. vi. (1862); Bot. pp. 77–79.

§ On the existence of two forms and their reciprocal sexual relation in several species of the genus Linum, Ibid. 1863, pp. 69–83.

* After having repeatedly in vain watched *P. aviculare* in very hot sunny noons of the month of August 1871, I succeeded in observing some small Syrphidæ (*Ascia podagrica* F., *Syritta pipiens* L., and *Melithreptus menthastri* L.) visiting its flowers.

† I have observed in the flowers of *P. Persicaria* altogether 11 species of insects, among them 7 Diptera, and these as the most frequent visitors.

from the flowers previously visited. Sometimes, also, the three inner anthers are developed, and, completely filled with pollen, closely surround and spontaneously self-fertilise the two (in rarer cases three) stigmas, cross-fertilisation being thus almost prevented. But most of the flowers show an intermediate condition, having only one or two of the three inner anthers developed.

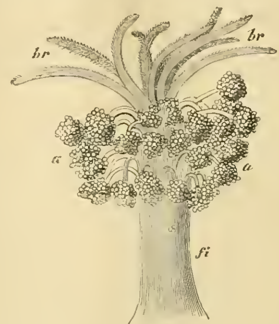


23

24

FIG. 23.—Sexual organs of *Malva rotundifolia*, in their first period, longitudinally bisected, seven times natural size. *a*, anthers; *br*, branches of the style (*st*); *pe*, petals; *n*, nectary; *pr*, protecting hairs; *se*, sepals; *ov*, ovary; *fi*, filament-cylinder.
FIG. 24.—Side view of the same organs in their second period.

Without referring to many other genera which I have ascertained to contain species quite analogous to those just described,* we may, I think, admit as a summary of the recorded facts, the following propositions:—In many species the flowers vary and have always varied in size, colour, the quantity of secreted honey, and consequently in their attractiveness for insects. Whenever in such a varying species the one variety possesses such a degree of attractiveness for insects as to receive sufficiently frequent visits from them, those variations which afford



25

FIG. 25.—Side view of the sexual organs of *M. sylvestris*, seven times natural size.

facility for cross-fertilisation by insects have always been preserved and accumulated by natural selection, whereas the possibility of self-fertilisation has at the same time frequently been lost. Hence we may infer that cross-fertilisation is more advantageous to a plant than self-

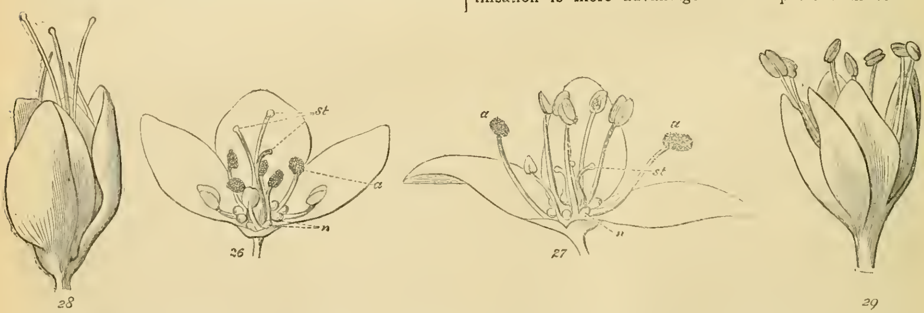
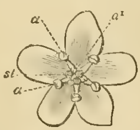
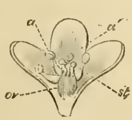


FIG. 26.—Side view of the long-styled flower of *Polygonum Fagopyrum*, two leaves of the perianth having been removed. *n*, nectaries; *a*, anthers; *st*, stigmas. FIG. 27.—Side view of the short-styled flower. FIG. 28.—Side view of the flower of *Polygonum Bistorta* in its first period. FIG. 29.—Side view in its second period.

fertilisation. Whenever, on the contrary, another variety of the same species presents so little attraction for insects as to remain commonly overlooked by them, only



30



31

FIG. 30.—Flower of *Polygonum aviculare* viewed from above. *a*, outer anthers; *a'*, inner anthers; *st*, stigmas. FIG. 31.—The same flower viewed laterally, two leaves of the perianth having been removed.

such individual peculiarities as induce self-fertilisation have been preserved and accumulated by natural selection, whereas cross-fertilisation by insects has frequently become very difficult, although perhaps never quite impossible. Hence we may infer that self-fertilisation is by no means absolutely disadvantageous to a plant, but only when the offspring of self-fertilisation has to struggle for existence with the offspring of cross-fertilisation.

There is another curious point about the recorded facts. We have seen that more and less attractive flowers adapted to cross- or to self-fertilisation sometimes occur in slightly differing, sometimes in well-marked varieties, sometimes in doubtful, sometimes in good and distinct species.

If we believe the principle of evolution, and view species as originated from varieties, varieties as originated from slight individual differences, we may consider the recorded facts as presenting and explaining one of the many ways in which previously varying forms have been transformed by natural selection into different and diverging species.

HERMANN MULLER

* Geranium, Stellaria, Cerastium, Rubus, Veronica, Carduus, Hieracium, and others.

POLARISATION OF LIGHT*

II.

THE experiment described in the previous article, in which the rays reflected from the pile of glass plates are extinguished by the analyser when in one position, while those which have been transmitted are extinguished when the analyser is in a position at right angles to the former, shows that the vibrations of the reflected and refracted rays, so far as they become polarised, are at right angles to one another. And further, if these rays be severally examined with a plate of tourmalin, it will be found that the vibrations of the reflected ray are executed in a direction perpendicular to the plane of incidence, and those of the refracted ray in a direction parallel to that plane.

The same general reasoning as that used in the case of tourmalin plates will serve, if not as actual proof, at all events as illustration in this case. Thus, suppose that a ray whose vibrations are perpendicular to the plane of incidence, that is, parallel to the reflecting surface, fall upon a plate of glass; then there is no apparent reason why a change in the angle of incidence should modify the reflection and refraction, so far as they depend directly upon the direction of the vibrations. The vibrations cannot undergo any change of direction on one side rather than on the other by incidence on a surface to which they are parallel, and will consequently remain parallel to themselves even when the incidence has taken place. And since the reflected and refracted rays both lie in the plane of incidence, the vibrations (which are perpendicular to that plane and consequently to every line in it) will fulfil the optical condition of being perpen-

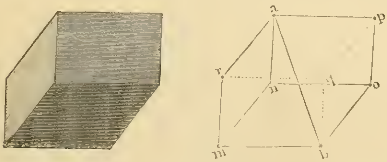


FIG. 9.

dicular to the rays in question. But if the vibrations of the incident ray take place in the plane of incidence, it is difficult to conceive that the results of reflection and refraction should be unaffected by a change in the angle of incidence. There are two mathematical and mechanical principles which, when applied to the case of vibrations in the plane of incidence, lead to the conclusion that if the ray be incident at such an angle that the reflected and refracted rays are perpendicular to one another, there can be no reflected ray.

A general explanation of this very curious result seems difficult; but the following considerations may perhaps tend to elucidate the subject. Reflexion is generally, perhaps always, accompanied by refraction. Bodies are visible in virtue of rays which, after reflexion from their surface, meet the eye. But the natural colours of bodies so seen are due to rays which are not reflected until they have penetrated to some, although inconsiderable, depth below the actual surface. During this penetration the light has been deprived of certain of its component rays, and emerges as a reflected beam covered with the remaining or complementary tint. And although the colourless reflexion from polished surfaces is an apparent exception to the rule, it may still be the fact that this is only a limiting case in which the penetration is a minimum. If this be so, we may fairly conclude that refraction is the ruling feature of the phenomenon, and that it in some sense precedes reflexion. With the change of direction of the ray involved in refraction it is in the highest degree probable that a change of direction of the vibrations (supposed always to be in the plane of incidence) will be also involved. The simplest supposition would be that the vibrations within the medium are perpendicular to the refracted ray; and that the intensity of the reflected light is due to that part of them which can be resolved in a direction perpendicular to that of the reflected ray. If, therefore, the refracted and the reflected rays be perpendicular, so also will be their vibrations, and consequently

FIG. 10.

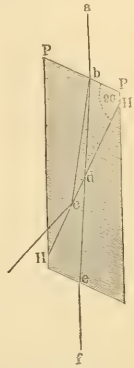


FIG. 11.

no part of the vibrations constituting the former can be resolved in the direction requisite for the latter. In other words there will be no reflected ray.

The above remarks give, it must be admitted, no mechanical theory of reflexions, nor indeed do they pretend to be even a rough explanation of the facts. They merely amount to this: If reflexion depends primarily upon refraction, and the known law of reflexion obtains independently of all questions of polarisation, then when the incident vibrations take place in the plane of incidence no reflected ray, whose direction is perpendicular to that of the refracted ray, can be produced.

We next come to the subject of polarisation by double refraction. There are a large number of crystals which have the property of generally dividing every ray which passes through them into two. But the extent of separation of the two rays varies with the direction of the incident ray in reference to the natural figure of the crystal.

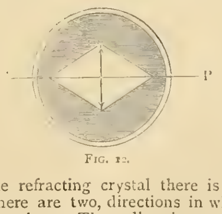


FIG. 12.

In every double refracting crystal there is at least one, and in many there are two, directions in which no such separation takes place. These directions are called optic axes. The relations between the forms of crystals and their optic axes, and optical properties arising therefrom, will be explained later.

Of such crystals Iceland spar is the most notable instance. If we take a block of such spar split into its natural shape, a rhombohedron, Fig. 9, and for convenience cut off the blunt angles by planes perpendicular to the line joining them, a b, it will be seen that a ray of light, transmitted perpendicularly to these planes, that is

* Continued from p. 129.

parallel to the line joining the blunt angles, is not divided. In fact, the image either of the aperture of the lantern projected on a screen, or of an object seen by the eye in the direction in question, appears single, as if passed through a block of glass. The direction in question (viz., the line a b itself, and all lines passing through any part of the crystal parallel to a b), is called the optic axis of the crystal. If, however, the crystal be tilted out of this position in any direction, it will be seen by the appearance of two images instead of one, that the rays are divided into two. The angular divergence of the two sets of rays, or what comes to the same thing, the separation of the two images, depends upon the angle through which the crystal has been turned; or, as it may also be expressed, upon the angle between the directions of the incident ray and the optic axis of the crystal. When this angle amounts to a right angle, the separation is at its greatest; and if the crystal be still further turned, the images begin to come together again until, when it has turned through another right angle, they coincide.

This process of separation, or doubling the rays, is called double refraction. And the following experiment will show that one set of rays follows the ordinary law of refraction, while the other follows a different law. The image produced by the first set of rays is, in consequence, called the ordinary, and that produced by the second the extraordinary image. Let us now take a sphere of Iceland spar, which will act upon the rays issuing from the lamp as a powerful lens. In every position in which it is placed it produces two images on the screen; but in that in which I now place it the two images are concentric, differing only in this, that one is larger than the other. The direction in which the light is now passing is that of the optic axis; and it is to be observed that, although there is a difference in the magnifying of the two images, there is still no divergence of rays, or separation of images in the sense used before. In fact, if we suppose the curvature of the lens to be gradually diminished, we should find the difference of the sizes of the two images, as well as the absolute size of both, diminish; until when the surfaces of the lens became flat, the difference would vanish, and the two images would absolutely coincide.

This difference in the size of the images shows, moreover, a very important property of double refracting crystals. The amount of refraction produced by a transparent medium standing in air depends, as is well known, upon the velocity with which a ray of light traverses the medium compared with that with which it traverses air. The smaller the velocity in the medium, the greater the refraction. The greater the refraction, the greater the magnifying power of a lens constructed of that medium. Hence in the two concentric images we can at once point to the system of rays which has traversed the crystal at a lower velocity than the other.

Let us now turn the crystal round into some other position, so that the direction of the optic axis shall no longer coincide with that of the rays from the lamp or from the object. During this process one of the images, the larger, remains stationary, as would be the case with the single image, if we had used a sphere of glass. This, therefore, is the ordinary image. The other shifts about, separating itself from the first, until the crystal has been turned through half a right angle, and then drawing back again until the crystal has swept round through a complete right angle. This is, consequently, the extraordinary image.

It will be noticed that when the sphere has been turned through a right angle, the extraordinary image is no longer circular, but elliptical, and that the major axis of the ellipse lies in the direction in which the motion has taken place, that is, perpendicular to the axis about which the sphere has been turned. This is due to the fact, shown above, that the nearer the direction of the incident rays to that of the optic axis, the less the divergence between the ordinary and the extraordinary rays. The distortion of the image when the sphere has turned through half a right angle is due to the difference of angles between the optic axis and the rays which enter the crystal on one side and on the other of the central ray of the beam coming from the lamp.

That the rays forming each of the images are polarised, and that the direction of their polarisation is different, is easily shown by interposing a plate of tourmalin or other polarising instrument between the lamp and the sphere of spar. But inasmuch as the polarisation in many positions of the sphere is far from uniform, the phenomenon becomes rather complicated; and the character of the polarisation of the two images is better studied by using flat instead of curved surfaces for separating the rays.

For the purpose in question there is, perhaps, no better instrument than the double-image prism. This consists of a combination of two prisms, one of Iceland spar, so cut that the optic axis is parallel to the refracting edge; the other of glass, and usually having a refracting angle equal to that of the spar. The rays passing through the crystal prism being perpendicular to the optic axis, undergo the greatest separation possible. And the chromatic dispersion caused by that prism is corrected or neutralised entirely in the case of the extraordinary, and nearly so in that of the ordinary ray, by the glass prism which is placed in a reversed position. In this arrangement the extraordinary image occupies the centre of the field, and remains fixed while the double-image prism is made to revolve in a plane perpendicular to the incident rays; while the ordinary image is diverted to a distance from the centre, and revolves in a circle about that centre, when the prism revolves.

If the nature of the light in the two images thus formed be examined by any polarising instrument, it will be found to be polarised in both cases; but that the vibrations in the one image are always perpendicular to those in the other. And in particular the vibrations in the extraordinary image are parallel, and those in the ordinary are perpendicular to the optic axis.

On these principles polarising and analysing instruments have been constructed by various combinations of wedges or prisms of Iceland spar, the details of which it is not necessary to describe in full. But the general problem, and object proposed, in all of them has been to cause such a separation of ordinary and extraordinary rays, that one set of rays may, by reflexion or other methods, be further diverted and afterwards thrown altogether out of the field of view. This done, we have a single beam of completely polarised light and a single image produced from it.

One such instrument, however, the Nicol's prism, on account of its great utility and its very extensive use, deserves description. A rhombohedron of Iceland spar double of its natural length is taken (see Fig. 10); and one of its terminal faces P, which naturally makes an angle of 71° with the blunt edges K, is cut off obliquely so as to give the new face, say P′ (not given in the figure), an inclination of 68° to the edges K. The whole block is then divided into two by a cut through the angle E in a direction at right angles to the new face P′; the faces of this cut are then carefully polished, and cemented together again in their original position with Canada balsam. Fig. 11 represents a section of such a prism made by a plane passing through the edges K (Fig. 10). A ray entering as a b is divided into two, viz., b c the ordinary, and b d the extraordinary. But the refractive index of the Canada balsam is 1·54, *i.e.* intermediate between that of the spar for the ordinary (1·65) and the extraordinary (1·48) rays respectively; and in virtue of this the ordinary ray undergoes total reflexion at the surface of the balsam, while the extraordinary passes through and emerges ulti-

mately parallel to the incident ray. Fig. 12 shows an end view of a Nicol's prism, the shorter diagonal in the direction of vibration of the emergent polarised ray.

Two such instruments, when used together, are respectively called the "polariser" and the "analyser," on account of the purposes to which they are put. These, when placed in the path of a beam of light, give rise to the following phenomena, which are, in fact, merely a reproduction in a simplified form of what has gone before.

When polariser and analyser are placed in front of one another, with their shorter diagonals parallel, that is, when the vibrations in the image transmitted by the one are parallel to those in the image transmitted by the other, the light will be projected on the screen exactly as if only one instrument existed. If, however, one instrument, say the analyser, be turned round, the light will be seen to fade in the same way as in the case of the tourmalin plates; until, when it has been turned through a right angle, or as it is usually expressed, when the polariser and analyser are crossed, the light is totally extinguished.

In the complete apparatus or polariscope, we may incorporate any system of lenses, so that we may

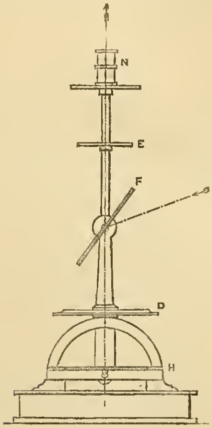


Fig. 13.

make use of either parallel or convergent light, and finally focus the image produced upon the screen or upon the retina. At present we shall speak only of the phenomena of colour produced by crystal plates in a parallel beam of polarised light—chromatic polarisation, as it is called, with parallel light.

Various forms of polariscopes have been devised, whereof the three described below may be regarded as the most important.

Fig. 13 is an elevation of one of them. When used in its simplest form, the frame F carries a plate of black glass which is capable of revolving about pivots in the uprights. The positions of the source of light and of the frame must be adjusted so that the plate will receive the incident light at the polarising angle, and reflect it in the direction of the eye-piece which contains a Nicol or other analyser. The objects to be examined are to be placed on the diaphragm E.

This instrument may be converted into another form, due to Norremberg, by placing a silvered mirror horizontally at H. The plate of black glass must be removed from the frame F, and a plate of transparent glass substituted for it, which must be so inclined that the light falling upon it shall be reflected at the polarising angle perpendicularly towards the horizontal mirror. The object may be placed on the diaphragm E as before. But it may also be placed on the diaphragm D below the polarising plate F, and in that case the eye will receive the polarised ray reflected from the mirror; and the polarised ray will have passed, before it reaches the eye, twice through the crystalline plate placed between the mirror and the polariser. The result is the same as if, in the ordinary apparatus, the polarised ray had passed through a plate of double the thickness. If the plate does not fill the entire field of view two images of the plate will be seen, the one larger, as viewed directly, the other smaller, as viewed after reflection from the horizontal mirror; the first will show the tint due to the actual thickness of the crystal, the other that due to a plate of the same crystal, but of double the thickness.

A further modification of this instrument will be described hereafter.

W. SPOTTISWOODE

(To be continued.)

GALILEO'S WORK IN ACOUSTICS

IN looking through the "Dialoghi delle Nuove Scienze" of Galileo, I came unexpectedly on a passage * containing two remarkable discoveries in acoustics, which I should have confidently referrred to a much later age. For the sake of such of your readers as may share the same erroneous impression, I hope you will allow me to give, in NATURE, a short account of these results.

The first is a perfectly accurate explanation of the phenomenon called "resonance." Every pendulum has a fixed period of oscillation peculiar to itself. Even when the "bob" is of considerable weight it is possible to set it swinging through a large arc by merely blowing against it with the mouth, provided the successive puffs are properly timed with reference to the pendulum's period of vibration. In the same way a single ringer can, by regular pulling, throw the heaviest bell into oscillations of such extent as to be capable of lifting half-a-dozen men who should hang on to its rope, off the ground all together. When a string of a musical instrument is struck, its vibrations set the air in its vicinity trembling, and the tremors thus set up spread themselves out through space. If they fall on a second wire in unison with the first, and therefore prepared to execute its vibrations in the same period, the effects of the successive impulses are accumulated, and the wire's oscillations can be distinctly seen to go on dilating until they have attained an extent equal to those of the wire originally struck.

Anyone who looks into the chapter on resonance in the "Tonempfindungen" will see that the account of the phenomenon given by the greatest living acoustician is, in principle, identical with that of Galileo.

The second point to which I wish to draw attention is an experiment involving the earliest direct determination of a vibration-ratio for a known musical interval. Galileo relates that he was one day engaged in scraping a brass plate with an iron chisel, in order to remove some spots from it, and noticed that the passage of the chisel across the plate was sometimes accompanied by a shrill whistling sound. On looking closely at the plate, he found that the chisel had left on its surface a long row of indentations parallel to each other and separated by exactly equal intervals. This occurred only when the sound was heard: if the chisel traversed the surface silently, not a trace of the markings remained. It was found that a rapid passage of the chisel gave rise to a more acute, a slower to a less acute, sound, and that, in the former case, the resulting indentations were closer together than they were in the latter. After repeated trials two sets of markings were obtained which corresponded to a pair of notes making

* Opere complete di Galileo Galilei. Vol. xiii. pp. 97-110. (Firenze.)

an exact fifth with each other; and, on counting the number of indentations contained in a given length of each series, it appeared that for 30 of the lower sound there were 45 of the higher, which numbers are in the exact proportion (2 : 3), which connects the lengths of two equally tense wires, giving that interval. Galileo, who had felt a tremor pass from the chisel to his hand at each experiment, inferred that what really determined a musical interval was the ratio of the numbers of vibrations performed in equal times by its constituent notes, and that that ratio was inversely as that of the lengths of the wires producing them. In order to bring out the crucial nature of his experiment, he goes on to remark, with extreme acuteness, that there was, prior to it, no reason for regarding the relations known to connect musical intervals with the *lengths* of wires as in any exclusive sense *representing* such intervals. With equal propriety might the ratio of the *tensions* under which two wires of equal lengths emitted sounds forming an interval be taken as its representative. In this case we should obtain the inverse square root of the ratio resulting from the former mode of comparison. Thus Galileo's experiment alone supplied decisive ground for concluding that the relations of *length* between similarly circumstanced wires, likewise governed those of *period* between corresponding aërial vibrations.

Prof. Tyndall, in referring to the above experiment, has described it as performed "by passing a knife over the edge of a piastre" ("Sound," 2nd ed., p. 51). This is an obvious mistake caused by incorrect translation. Galileo was scraping "una piastra d'ottone," *i.e.*, not "a piastre," but "a plate of brass." An excellent numismatist assures me that the *material* mentioned is alone decisive of the point, the piastre in Galileo's time being invariably made of *silver*. SEDLEY TAYLOR

THE HOOSAC TUNNEL

THE following facts respecting the Hoosac tunnel, in which the borings from east and west communicated on Nov. 28, may prove of interest. The mountain penetrated is part of the chain of mountains that skirts, at a distance of two or three hundred miles inland, the Atlantic coast of the United States; of which the Blue Ridge in Virginia, the Alleghanies in Pennsylvania, the Catskills and Adirondacks in New York, the Green Mountains in Vermont, and the White Mountains in New Hampshire, are prominent examples. Hoosac Mountain has two summits, the eastern being 2,210, and the western 2,508 ft. above tide-water.

The enterprise has been the subject of various undertakings by different contractors, and the greater part of the earlier work during the years from 1848 to 1863, in length but one-twelfth of the whole distance, was on a smaller scale than the subsequent plan adopted, and had to be much enlarged and strengthened. The present contract requires a clear width of bore of 24 ft. and a height of 20 ft.; the total length of the tunnel is 25,031 ft. A central shaft pierces it from above, at a distance of 12,837 ft. from the eastern, and 12,194 ft. from the western portal. The shaft has a depth of 1,038 ft., and is of elliptical form, its major axis is 27 ft. being coincident with the line of the tunnel; its minor axis is 15 ft. The grade of the tunnel slopes up to the shaft from both ends, with a rise of $26\frac{4}{10}$ per mile. The shaft is not placed at the lowest point between the two summits of the mountains, as the exigencies of the work at the western extremity, and the presence of a stream of water at the point of lowest depression, made a site half a mile nearer the western portal preferable. The tunnel is 767 ft. above tide-water at its extremities. The temperature within averages 58° F.

The total excavation is about 1,000,000 tons of rock, requiring somewhat over 1,450,000 days' work. The boring was principally through mica schist, similar to that of the surface. The miners found it lying on the edge of the foliations and disposed to hang together after the blast. They compared the operation of working in it to pulling boards endwise from a pile of lumber. Rock of this character was found continuous until a point was reached within about 5,000 feet west of the central shaft. At that point the proportion of mica was diminished and the rock began to lose its foliated structure, becoming more homogeneous or granitic. In fact it might be characterised in general terms as granite with the ingredients differently proportioned at different localities, in some places feldspar, in some mica, and in others quartz predominating. This rock was harder to penetrate with the drills, but broke out more satisfactorily with the blast than the mica schist.

The chief trouble was occasioned by what received the name of "demoralised rock." This was rock saturated with water, which, exposed to air, disintegrated into mere mud, rendering the support of masonry absolutely necessary. The tunnel will not probably be ready for railway traffic before next July, as there is yet much work to be done, the total cost at that date, it is estimated, will not fall short of 12,500,000 dols.

NOTES

ON Monday last the French Academy of Sciences named Mr. J. Norman Lockyer, F.R.S., one of its Correspondents, to fill the place rendered vacant in the Astronomical Section by the death of Encke. We believe that the following is a complete list of the English scientific members of the French Institute at the present time:—Foreign Members—Prof. Owen, Sir C. Wheatstone. Correspondents: Geometry—Prof. Sylvester. Mechanics—Sir Wm. Fairbairn. Astronomy—Sir G. Airy, Mr. Hind, Prof. Adams, Prof. Cayley, Sir Thomas MacLear, Mr. Lockyer. Geography and Navigation—Admiral Richards, Dr. Livingstone. Physics—Dr. Joule. Chemistry—Dr. Frankland, Dr. Williamson. Mineralogy—Sir C. Lyell, Prof. W. H. Miller. Botany—Dr. Hooker. Anatomy and Zoology—Dr. Carpenter.

AT the meeting of the Paris Academy of Sciences, which took place on December 22, the places of Correspondents in the Physical Section, vacant by the death of M. Hansteen, and the election of Sir C. Wheatstone to a foreign' associateship, were filled up by the election of MM. Angström and Billet.

HER MAJESTY'S Commissioners have resolved to commence, in connection with the series of international exhibitions, permanent collections which shall illustrate the ethnology and geography of the different portions of the British dominions, and ultimately form a great national museum of the empire upon which the sun never sets. They will be arranged for the present in the galleries of the Royal Albert Hall. Many portions of the empire are inhabited by aboriginal races, most of which are undergoing rapid changes, and some of which are disappearing altogether. These races are fast losing their primitive characteristics and distinguishing traits. The collections would embrace life-size and other figures representing the aboriginal inhabitants in their ordinary and gala costumes, models of their dwellings, samples of their domestic utensils, idols, weapons of war, boats and canoes, agricultural, musical, and manufacturing instruments and implements, samples of their industries, and in general all objects tending to show their present ethnological position and state of civilisation. It is proposed to receive for the Exhibition of 1874 any suitable collections, which will be grouped and classified hereafter in their strict ethnological and geographical relations. As, however, there is at present great public interest in the various tribes inhabiting the West Coast of

Africa, including the Ashantees, with whom this country is at war, all objects relating to the Ashantees, Fantees, Dahomeys, Houssas, and the neighbouring tribes are especially desired. The Indian Empire, the Eastern Archipelago, and the islands of the southern hemisphere, are also able to afford abundant and valuable materials for the proposed museum, of which it is believed that the nucleus can be formed at once from materials in private collections. Her Majesty's Commissioners confidently appeal to the civil, military, and naval officers of the British service throughout the Queen's dominions to assist them in these collections. Her Majesty's Commissioners have secured the services of eminent gentlemen to advise them from time to time in giving effect to these intentions. It is requested that offers of gifts and loans of objects should be made known at once to the Secretary of Her Majesty's Commissioners, Upper Kensington Gore, London, S.W.

IN reference to recent communications on the rate of stalagmitic deposit, Mr. Thomas K. Callard writes to say that he thinks the probability is that the rate of deposit in Kent's Cavern was not uniform, "for, when the thick forest (the habitat of the animals whose bones are found in the cave) left an accumulation of decayed vegetation on the soil, we had the natural laboratory where the rain would find the carbonic acid, to act as a solvent upon the calcareous earth, and as this acidulous liquid percolated through the soil and dripped into the cave, we have the origin of the stalagmite; but as, by the axe of man, the forest decreased, in that proportion the chemicals lessened, and as a consequence the deposit diminished. Besides the diminution of the solvent, every year that the operation was going on the material that composed the stalagmite must have been decreasing in the superjacent soil, so that the bicarbonate of lime which now takes two centuries to cover one-eighth of an inch, might have been, in days gone by, the work of much shorter time." Mr. W. Bruce Clarke writes that he visited, about ten years ago, a cavern near Buxton, commonly known as "Poole's Hole," and observed some stalagmite, probably $\frac{1}{8}$ in. in the back, had become deposited upon the gas-pipes, which were used to light the cave, and had been laid down six months before. At this rate, granting that the deposit had been six months in acquiring a thickness of $\frac{1}{8}$ in., 1 in. would be deposited in four years, a rate of deposit even more rapid than that (viz. $\frac{3}{4}$ in. in fifteen years) mentioned by Mr. Curry in the number of NATURE for December 18. It must be remembered, however, that though at one particular spot in "Poole's Hole," 1 in. of stalagmite might be deposited in four years, the same rate would probably not be maintained all over the cave.

THE Sub-Wealden Exploration has proved far more expensive than was at first anticipated, and additional funds will be required to complete the desired depth of 1,000 ft. A third sum of 1,000*l*. has now been promised, and this will form the basis for future operations. This amount includes 200*l*. from the Duke of Devonshire, 100*l*. from Lord Leconfield, 50*l*. from the Earl of Ashburnham, 50*l*. from the Royal Society, and 25*l*. from the Duke of Norfolk. These sums will be collected as the work proceeds, and additional contributions are solicited. The importance attributed to the enterprise by Professor Phillips in the Geological Section, during the last meeting of the British Association at Bradford, is an additional proof, if any were needed, of the expediency of completing the investigation.

PROF. OWEN, who is suffering from a troublesome bronchial affection, is spending the winter in Egypt.

MR. J. ALLEN, of Clifton College, has been elected to the Natural Science Exhibition at St. John's College, Cambridge (50*l*. per annum tenable for three years). The examiners reported that the merits of Mr. Lodge were very nearly equal to those of the successful candidate. There were ten candidates.

THE Caspian Sea is extremely rich in various species of fish, many of these occurring in prodigious numbers. Indeed, according to Alexander Schultz, the yield is very much greater than that of the Great Bank of Newfoundland. Thus in one single district 15,000 sturgeon are frequently taken in a day, and when the fishing is interrupted for twenty-four hours the waters become almost choked by the abundance of fish, which are so numerous as to press each other out upon the shore. The total yield of the Caspian Sea for one year in fish and fish products has been estimated at 13,000,000 *pouds* (about 469,430,000 pounds avoirdupois), worth about 12,000,000 dols. There are several varieties of sturgeon among the fish taken, including the sterlet, as well as the carp and other cyprinoids, the salmon, the *Coregonus* (similar to the white-fish of the American lakes), several kinds of herring, &c. A peculiar phenomenon observed especially among the sturgeon is that of a kind of winter sleep. At the approach of cold weather they seek the deep portion of the rivers, and remain there in a state of torpor, during which they secrete a viscid matter which forms a coating over the entire body, called by the fishermen a *pelisse*. During this period they appear to eat nothing, their stomachs always being found entirely empty.

MR. DALL, of whose movements as a surveyor and explorer in the Aleutian Islands in behalf of the Coast Survey we have advised our readers from time to time, returned on the 8th Nov. to San Francisco, where he will spend the winter in preparing his report to Prof. Peirce. Part of his labours had special reference to the selection of a suitable locality for an intermediate land station for the proposed Pacific cable between the United States and Japan. Mr. Dall expects to return in the spring to finish his explorations on the islands.

AMONG recent discoveries of valuable minerals in Australia is that of iron in the form of magnetic iron, and brown hematite at Wallerawang, Victoria, in close proximity to limestone, fire-clay, coal, and a railway station.

THE Italian Scientific Commission, appointed to examine, from an anthropological point of view, the remains of the Italian poet Petrarch, and to publish the result of its observations at the centenary of the great poet, proceeded, we learn from *La Nature*, in the beginning of December to open the urn of red granite, amid a large gathering of people. The bones, instead of being contained in a coffin of wood or metal, were spread upon a simple plank, and were of an amber colour, moist, and partly mouldered. The cranium, of medium size, was intact, the frontal bone much developed. The jaws still contained many teeth, among which were a number of molars and incisors very well preserved. The orbits were very large. Nearly all the vertebræ and ribs were found. The bones of the pelvis were in good condition, as also the scapula, the humerus, and the other bones of the arms; the apophyses of the femurs were very prominent. There was discovered also a quantity of small bones which probably composed the hands and the feet. The vestments were reduced to a dark powder. From the size and length of the bones, we may conclude that Petrarch was a man of middle height and robust constitution.

AT one of the last sittings of the French Academy of Medicine, says *La Nature*, M. Devergie read a remarkable report on the prize of the Marquis d'Ourches, a prize of 25,000 francs, to be given to the man who should discover an infallible method of recognising certain death. The method must be so simple as to be at the command of the most illiterate and rude. Besides this prize, the testator instituted another of 5,000 francs for the discovery of a scientific method of arriving at the same result. The value of the prize of 25,000 francs has tempted people of all classes and all conditions; thus the Academy has received 102 memoirs, not counting those which arrived after the expiration

of the time announced for their reception. Of these 102 memoirs, only 32 were judged worthy of serious examination. But no one has gained the famous prize of 25,000 francs, which therefore reverts to the testator's family. As to the prize of 5,000 francs, it will probably be divided among various competitors who have presented interesting memoirs.

AT the Annual Meeting of the Institution of Civil Engineers, held on December 23, it was stated that on the 30th November last, the number of members and associates was 1,994. On the subject of finance, it was stated that during the last fourteen years the savings had amounted to something like 2,000*l*. per annum, on the average. The receipts are now nearly 9,000*l*. per annum, while the ordinary expenditure was only 6,000*l*. per annum. What with trust funds, investments, and cash balance, the Institution has 30,233*l*. 8*s*. 6*d*. at its disposal. The library numbers 10,443 volumes.

WE would draw the attention of our London readers to the advertisement in this week's NATURE with regard to the Junior Philosophical Society, meeting at 6A, Victoria Street, S.W. We believe we have had occasion to speak of it before, as one whose object and method of work are commendable.

THE January number of Petermann's *Geographisches Mittheilungen*, contains a contribution by Dr. Nachtigal giving valuable details concerning the various Pagan tributaries to the kingdom of Baghirmi. Dr. Meyer gives some statistics of the inhabitants of the Philippine Islands, whose number he estimates at 7,451,352. In the same number is a communication from Dr. Miklucho-Maclay, dated Batavia, October 25, 1873, in which he maintains that the Papuas and Negritos belong to the same race, notwithstanding that the former are dolichocephalic, and the latter brachycephalic.

THE principal article in Guido Cora's excellent Italian Geographical Journal *Cosmos*, is on "Recent Expeditions to New Guinea."

THE "Second Report of the Committee on Boulders appointed by the Royal Society of Edinburgh," contains much interesting information which will no doubt be ultimately of service to geologists.

WE have received the first number of *The Argonaut* (Hodder and Stoughton), a journal started by "a number of young fellows who are just entering on the bolder thoughts or the more active duties of manhood," for the purpose of discussing questions in which all earnest young men take an interest. It professes to be devoted to no party either in religion, politics, or philosophy. It is edited by Mr. George Gladstone, F.C.S., and this first number contains an Introduction by Dr. Gladstone, F.R.S. The contents are varied and mostly interesting.

THE Opening Address to the Geological Association, by the president, Mr. Henry Woodward, F.R.S., has been printed as a supplemental number of the Proceedings. The Address is a survey of what has been done in geology during the past twelve months.

"THE Glaciation of the Northern Part of the Lake District," is the title of a paper by Mr. J. Clifton Ward, reprinted from the *Quarterly Journal of the Geological Society*.

THE *Mémorial Diplomatique* states that the Italian Consul at the Piræus has informed his Government that M. Théodore Tubini, banker, at Athens, has obtained a concession for cutting a canal through the Isthmus of Corinth. The principal clauses of the concession are that the canal shall have a *minimum* depth of 8½ metres (27 ft.), and a width of 12 metres (39 ft.) at the bottom. Half-way through the canal is to be a dock of 30,000 square metres in extent, and of sufficient depth to receive the largest vessels. The canal is to be completed in six years. The concession is for 99 years, and a deposit of 12,000*l*. is to be paid immediately after the Greek Parliament has approved the concession. The estimated cost of the undertaking is 800,000*l*.

THE principal papers in No. 39 of the *Journal of the Scottish Meteorological Society*, are "The Report of the Committee appointed to investigate the Relation of the Herring Fishery to Meteorology," an abstract of which has been given in our report of the Society's meeting, and a valuable paper by the Rev. W. Clement Ley, "On the Mean Inclination of Winds towards the Lower Isobarics." The Journal contains, as usual, the admirably compiled quarterly Meteorological returns from the Society's numerous stations.

WE have received a reprint from the "Proceedings of the Geologists' Association" of Mr. Henry Hick's paper on the "Classification of the Cambrian and Silurian Rocks.

PART III. of vol. xxii. of the "Transactions of the North of England Institute of Mining and Mechanical Engineers" consists entirely of an elaborate and valuable paper on the geology of the Redesdale ironstone district, by Mr. G. A. Lebour, of the Geological Survey. It is accompanied by two useful maps of the district.

AN aerolite, *Iron* says, weighing about twelve pounds fell in the vicinity of Marysville, Cal., on the 24th of August, which was so hot that it could not be handled for some time. It came crashing through the tree tops with a bright flash, and was found buried eight feet in the ground.

THE additions to the Zoological Society's Gardens during the past week include an Asiatic Wild Ass (*Equus onager*) from S.W. Asia, presented by Capt. H. L. Nutt; an Anubis Baboon (*Cynocephalus anubis*) and a Patas Monkey (*Cercopithecus ruber*) from W. Africa, presented by Mr. A. E. Oakes; a Bonnet Monkey (*Macacus radiatus*) from India, presented by Mr. F. E. Bradley; a Hybrid Duck (between ♂ *Aix sponsa* and ♀ *A. galericulata*), presented by Mr. J. C. Parr; a Yarrell's Curassow (*Crax yarrelli*) from S.E. Brazil, and a Coypu (*Myopotamus coypus*) from S. America, purchased.

SCIENCE IN KÖNIGSBERG

WE have before us the *Schriften der Königlichen Physikalisch-Okonomischen Gesellschaft zu Königsberg*, for 1871-72, in which is to be found a considerable amount of useful scientific observations, both of local and general interest. Dr. Berendt, who, along with some coadjutors, has been engaged in preparing a full geological map of Prussia, and in other geognostic researches, describes a specimen of immature amber brought from the sea-bottom on the Samland coast. Under a wrinked and brittle crust, the resinous substance was soft, transparent, and highly elastic. From some similarity of physical properties (not complete, however), Dr. Berendt inclines to identify it with a fossil resin found by Bergemann in brown coal of Lattorf, and described under the name of kranzit. The sp. gr. of the new substance is 0·934; it is insoluble in alkalies, spirit of wine, oil of turpentine, soluble in sulphuric acid; it begins to melt at 300°; in air it burns with a luminous sooty flame, giving a peculiar smell; it is free of sulphur, but contains a little nitrogen, like amber and some kinds of asphalte.

The same author has given much attention to the formation of amber in Prussia, and in an earlier number of the *Schriften* (1869, first part) will be found a very full investigation, by him, of the subject. In one of the present numbers he gives an account of preparations lately made for subterranean mining of the substance in Samland. Hitherto this method has not been adopted, and on two accounts chiefly; the nature of the superincumbent strata (which are generally sand and clay), and the high value of amber, which sufficiently repaid the other method. The Government, however, has lent some aid, and in July 1872 boring was commenced at the southern base of Carlsberg, where, at a depth of about forty-four metres, blue earth was found containing amber in abundance. This is about 5·7 m.,

or eighteen feet below the sea. The results were of a highly promising nature, and exceeded expectation.

The coast of Samland affords a good opportunity of studying the Algæ of the Baltic; and this forms the subject of a communication from M. Caspary. It is known that the water of the Baltic contains a much smaller proportion of salts than that of the North Sea or Atlantic. According to a recent analysis by Von Behr, the quantity was only 0·6766 per cent. To this fact, chiefly, and also to the fact of a colder climate, M. Caspary attributes the much smaller number of species of Algæ in the Baltic than on the English coast. He enumerates only twenty-five from the Prussian coast, whereas, at Falmouth, in Cornwall, 176 different species have been found. The water of the Atlantic contains about four per cent. of salt, or nearly seven times more than the Baltic water.

We further note, in the department of Botany, a paper in which Dr. von Klingraff describes the species and varieties of Sphagnum found in Prussia. In referring to the colouring of the leaves as a means of characterisation, he points out that the red and yellow colours almost always exclude each other. Red is found in only three species; *S. acutifolium*, *tenellum* and *cymbifolium*; and each of these has a purple-red variety. On the other hand, yellow is wanting in the first two, and the variety *congestum* of the third is the only known example in which the red and yellow co-exist in forms of the same species.

Among the various organic remains found in amber, those of molluscs are peculiarly rare. It might have been expected that the liquid resinous matter would more readily surprise such animals than running or flying insects (which are abundant), while the shell, after death of its tenant, would offer a longer resistance to destruction than an unprotected body. It would be rash to conclude that the amber forest contained as few molluscs as our present exclusively pine forests; and botanists have shown that other trees than those of the pine species must have been present. In these mixed forests there were doubtless numerous molluscs, and we are led to suppose that the resin-producing trees were carefully avoided by them. Such is the view given by M. Künow, who describes two snail shells found in amber, and probably belonging, he thinks, to the genus *Helix*. Only three previous notices of similar discoveries has he met with; and among the 13,000 organic remains of amber in the Society's collection, there is no piece of the kind in question.

Dr. Buchholz furnishes an account of the Hansa Arctic Expedition, and many interesting particulars as to the forms of life observed in the North Polar regions.

The anatomical collection in the University at Königsberg contains three bear skulls found in the province. These are described at some length by M. Müller. They differ much in size and form, and it is striking that such different individuals of the same species should have lived so near one another (the places of discovery not having been more than 20 miles apart). A few similar bear skulls have been found in this country and in Ireland, and are described by Owen under the name of fen-bears.

It has been commonly believed that living trees struck by lightning are frequently consumed. In a paper on the effects of lightning on trees and telegraph posts, M. Caspary shows this is a mistake, and that the case is extremely rare. He cites 93 authenticated cases of trees having been struck; the species were as follows (and here also some common notions are disproved):—1 *Populus alba*, 2 *Pirus communis*, 2 *Ulmus*, 3 *Pinus picea* L., 3 *Betula verrucosa*, 3 *Fraxinus excelsior*, 12 *Pinus sylvestris*, 12 *Picea vulgaris* Link., 14 *Populus monilifera*, 15 *Quercus pedunculata*, 20 *Populus italica*. Several valuable experiments and results are detailed in this paper, of which, however, accounts may be found in English serials.

Another important paper in physics treats of the arrangements at a station for measuring ground temperatures in Königsberg, and the correction of the thermometers there employed. It is by Dr. Ernst Dohrn.

Archæology claims a considerable share of the Society's attention; and there is one paper by Dr. Berendt, which specially deserves our notice. It enters very fully into the question of certain curious "face urns" which have been found in the region about Dantzic, &c. The forms of these articles are calculated to throw a good deal of light on the physiognomical features and the manners of the people that used them.

Königsberg now numbers over 100,000 inhabitants, and the sewage question becomes urgent. Dr. Müller calls the attention of the Society to what is being done in other cities and countries, way of improvement in this direction.

WELLINGTON N.Z. PHILOSOPHICAL SOCIETY

THE President, Dr. Hector, delivered his annual address before a meeting of members on Aug. 6, 1873. Dr. Hector in his opening remarks paid a tribute to the memory of Dr. Fred. John Knox, who had during a life-time contributed greatly to the science of comparative anatomy. Dr. Knox was an undoubted authority on all matters relating to the Cetacea, having made it his chief study. As one of the oldest members of the New Zealand Society he contributed largely and valuably to its transactions and the museum, which latter is specially indebted to him for the numerous contributions of anatomical preparations. The society, during its six years' existence, has gone on steadily increasing its members, who now number 142. Referring to vol. v. of the Transactions, Dr. Hector stated it contained forty-eight original papers, some of which possess a value from their originality of research which cannot fail to make the Transactions in future times important for reference.

Mr. T. Locke Travers' paper on the Life and Times of Te Raupara is a valuable page in the history of New Zealand, as the career of a man like Te Raupara is not merely of interest from its association with the early history of the colonisation of these islands, but affords a subject for study in connection with the more general historical question of the rapidity with which changes can be effected in uncivilised races, and the aptitude which they show in acquiring the arts, both peaceful and warlike, from colonists or conquerors as the case may be. Mr. Travers' contribution, valuable though it is, is but a small portion of the material relating to the Maori race which would find a fitting place in the Transactions of the Institute. The Maoris present a peculiarity of a mental type, the reason for which is not yet fully explained; as a race they show evidence of greater mental vigour than might have been expected in a people possessing no written knowledge. The facility with which they acquire our written language, and the delight which they take in exercising it, in reducing to writing their ancient *waiatas* (songs) and traditions is of itself a remarkable evidence of their vigour of mind. It does not appear, however, a reliable course in the collection of these songs to employ the Maori narrators to reduce them to writing, as it must be a process of translation of a most complex kind, and must lead to loss of accuracy both in matters of fact and in form of expression. A most interesting feature in the Maori language is the minute detail with which natural objects have been discriminated and named. He contrasted this with the North American Indians, who have only names for objects of immediate and practical utility in their affairs of every-day life. The Maoris, on the contrary, appear to have possessed a pure love of exercising their discriminating faculty; every tree or shrub, useful or useless, nearly every fish of large size or insignificant, and even many insects and lower forms of life that would remain unnoticed by most Europeans unless specially trained to the observation of such objects, have all their special names to the Maoris. The frequent reference made in their songs and traditions to these natural objects, invests them with a richness of imagery that adapts them for the poetical expression of sentiments and emotions that could only have been feebly if at all developed to the minds of the originators and narrators of those legends.

One of the most important events connected with this subject is the publication of the poem "Ranolf and Amohia," to the talented author of which all who love natural history must feel grateful for the abundant allusions which he has made to the characteristic features of the fauna and flora of the country, and the care which he has exercised in making his descriptions accurate. When a poet qualifies himself to appreciate the precise relations of the objects that enter into the scenes he depicts he will find that it is not necessary to sacrifice either facility or grace of expression in order to obtain the impressiveness which arises from strict accuracy. From this point of view Mr. Domett's poetical descriptions of the natural history of the new country cannot fail to aid in linking the sympathy of literature and fancy with the study of Science, and do good service to those objects which the society has most in view. The president also eulogised the efforts of a member of the Institute, Mr. G. H. Wilson, whose graceful and vigorous pen has been devoted to the rendering of those legends which relate to events that occurred in past time in the immediate neighbourhood of Wellington. The President referred to the papers of Messrs. Mantell and Taylor as bearing out his (Dr. Hector's) view of the recent date of the extinction

of the moa. The discovery of a large bird of the *Anser* family, but which could not fly adds another remarkable feature to New Zealand's extinct ornithology. Chief among the additions which have been made to the zoological literature of the colony during the past year is Dr. Buller's great work on the Birds of New Zealand, which is to be rendered more complete by the publication of additional plates. The President expressed a hope that a second edition might be called for in order to give Dr. Buller an opportunity of bringing up the information to a still later date. The enumeration of our whales and dolphins communicated to the Society by Dr. Hector has already called forth critical remarks from the veteran zoologist, Dr. J. E. Gray, of the British Museum. The President expressed his opinion that the fur seals frequenting the South Island all belong to one species, *Arctocephalus cinereus*, although skulls of a second species (*A. lobatus*) are found in caves and Maori ovens. Captain Hutton's valuable addition to the list of fishes was also referred to, as also the successful introduction of salmon during the past year. Dr. Hector expressed an opinion in favour of introducing ova not only of salmon but of trout, white fish, and other species, that inhabit the inland waters of British Columbia. The catalogues of the Marine Mollusca, and the Star Fish of our coasts, prepared by Captain Hutton, will be found invaluable by collectors, but the most interesting contribution to the Zoology of New Zealand is Captain H.'s essay on the Geographical Relations of the Fauna, which to a great extent bears out the hypothesis advanced by Dr. Hector in a previous address, that the peculiar insular characters of the forms of life in New Zealand have been present from a very remote period.

The President referred to the expected visit of the *Challenger* on a scientific exploration of the Southern Seas, and expressed a hope that it would add largely to our knowledge on this interesting subject. Referring to the great Southern Continent, which is full of interest with its active volcanoes amidst perpetual snows, he stated it was likely that the ensuing year will add greatly to our knowledge of that land, which is only 1,200 miles distant from New Zealand, on whose climate it probably exerts a marked influence. This little known land possesses large supplies of guano, and according to Sir James Ross, has a large and undisturbed whaling ground near it, in which whales of several different species abound. The President criticised Captain Hutton's paper on the Glacial period of New Zealand, and confirmed his dissent from the theory of a submergence of the New Zealand area on a grand scale during the post-pliocene or post-glacial period, and stated that unless palæontological evidence of recent date can be obtained from strata occupying valleys that were eroded during the last extension of the glaciers he must still adhere to his formerly expressed opinion, that the geological period previous to that which may be termed the recent period in New Zealand was characterised by a prolonged though perhaps not excessive elevation; and that especially in the South Island there is in consequence a marked absence of marine drifts and tills. The President commended the study of the subject of our soils, surface drifts, and beach rocks to the members of the Society. He also differed from Capt. Hutton, who underrates, he thought, the erosive power of existing glaciers, and referred to the recent changes reported to have taken place in the outline of the summit of Mount Cook, owing to a great avalanche having slipped from the ridge, leaving a conspicuous gap in the formerly even tent-like form of the apex.

After referring to the Geological reports for the progress made during the past year in the survey of the country, the President stated that descriptive catalogues of fossils from the tertiary formations, as also an illustrated work on the fossil plants from the different coal-bearing formations are nearly ready for publication. The development of the wonderful reptilian fauna in the upper secondary rocks will afford subject for several communications at the meetings of the Society during the present session. Already at least seven distinct forms belonging to the genera Plesiosaurus, &c., have been worked out from the blocks of matrix collected at the Amuri Bluff (Marlborough) and at the Waipara, and the description of these gigantic Saurians will be sure to excite great interest in the study of geological structure by exciting discussion at home, and indirectly to attract attention to the mineral and other resources of the colony. Mr. Skey's contributions were also favourably reviewed by the President, who concluded by thanking the members for the courtesy and support which he had received. He then vacated the Chair in favour of Dr. Knight, the President for the present year.

SCIENTIFIC SERIALS

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, November 1873.—In order to give warning of approaching storms, an important determination is that of "barometric gradient" between two places, found by ascertaining the difference of atmospheric pressure, and dividing by the distance. But as the places may be at unequal heights above the sea level, the influence of this inequality on the barometric state must first be eliminated. This may be done by either of two methods; reduction to the sea level (the more common way), or determining the divergence of the observed barometric state from the average for several years. At the recent meeting of the International Congress of Meteorology at Vienna, the question came up, which method was preferable; and it was decided, that for stations not more than 300 metres above the sea, the method of reduction had advantages over the other. Dr. Hann here compares the two methods, and presents the grounds of the Congress's decision. Austria adopts, this year, the method recommended, in place of the other.—The paper is followed by one giving a sketch of the organisation for meteorological observations in France, under the direction of M. Le Verrier.—We further note some observations by M. Caloria, of Mailand (communicated to the Istituto Lombardo), comparing the number of sun-spots with the temperature and rainfall during the period 1763–1872. The tables indicate pretty clearly an increase of heat with decrease of spots; though anomalies occur. In rainfall the connection is less marked. Among the other notes will be found information as to the climate of the Philippines, statistics of earthquakes in Austria, meteorites, &c.

Bibliothèque Universelle et Revue Suisse for November 1873, commences with a paper by M. Rahn on the Origin of the Renaissance in Italy. He considers the essential character of the art of that period to have been, that the works produced were no longer the product of a collective activity, but the creation of such and such a master. He also shows from the Palais Pitti at Florence, and other edifices (as compared with the Gothic style), how the sense of harmony in proportion was developed.—M. I. Piccard communicates the second part of a paper entitled "Poisons and Counter Poisons," giving here a clear popular account of the three different methods of remedy in cases of poisoning—mechanical elimination of the unabsorbed poison, neutralising of the poison by substances forming with it a harmless compound, and symptomatic treatment, dealing with the effects produced.—Mdlle. Anneville, criticising the public instruction in the United States, thinks history and literature, and æsthetical studies, are too much ignored.—M. Glardon has a review of some English works on Patagonia. The remaining papers do not specially call for notice here.

Bulletin de L'Académie Royale de Belgique, Nos. 9 and 10. This issue contains some interesting observations by Dr. Nuel, of Utrecht, on the electrical phenomena of the heart. Electrodes being applied, one to the apex, the other to the lateral face of an intact, fresh heart, beating regularly, there is, *in diastole*, a small current from the former to the latter, increasing with distance between the points. If the heart is exposed to air, however, the current is soon reversed. Any wounded part is negative to every other point on the surface. The circuit being closed between an intact surface and a transverse section, there is a considerable current from the former to the latter (greater than in ordinary muscles); this diminishes rapidly, but increases again somewhat, when a contraction has been excited. As to the phenomena *during contraction*, the weak current at the surface of the intact and fresh heart does not change; but if a strong current is obtained from lesion, this is weakened or reversed during systole. The negative variation precedes contraction; it reaches a maximum at commencement of systole, and lasts to the end of the contraction. The same author has experimented on the influence of the vagus nerve on the heart; and finds that stimulation affects the auricular contraction differently from the ventricular, implying the presence of different nervous elements. The nerve also contains some fibres which excite, instead of retarding, the heart's movements. In an investigation of the orbits of comets, M. Houzeau shows that the greater axes have a decided tendency to place themselves parallel to the double heliocentric meridian 102° 20′ and 282° 20′, and this longitude differs little from that of the point in space, towards which the solar system is found to be moving. —M. Plateau describes a parasite of the Belgian Cheiroptera. There is a short account, by M. Quetelet, of the proceedings of the recent international Congress of Meteorology held at Vienna; and

M. Van Rysselberghe's "universal meteorographic system" (which we lately noticed), is here described in full, with illustrations, and deserves the attention of meteorologists.

SOCIETIES AND ACADEMIES

Edinburgh

Royal Society, Dec. 22, 1873.—Sir W. Thomson, president, in the chair. At the request of the Council, Dr. Andrews gave an address on ozone. After giving a full *résumé* of the history of the discovery of the more important properties and relations of ozone, Dr. Andrews showed a number of beautiful experiments. Especially remarkable among these was a class-illustration of the contraction of oxygen by the silent electrical discharge. By the use of a new form of apparatus a diminution of volume was obtained, exceeding any hitherto recorded. Among the more remarkable of the new experiments shown was one quite recently made by the lecturer, proving that coarsely pounded glass, shaken in a vessel containing electrolytic oxygen, rapidly destroys the ozone reactions. This experiment forms a new link between a purely mechanical action and a chemical change, closer than any hitherto observed. The chairman, thanking the lecturer in the name of the Society, pointed out how very large a portion of all that we know about ozone is due entirely to the exquisite researches of Dr. Andrews.

Royal Physical Society, Dec. 17, 1873.—Dr. James M'Bain, R.N., president, in the chair.—The communications read were the following:—On a deposit of magnetic iron ore on the shores of Bute, by James Middleton, M.B. (with exhibition of specimens.) It seems that some time ago Mr. Cameron, of Rothesay, had noticed some remarkable kind of black sand on the beach at Bogany Point, at the entrance to Rothesay Bay. Being interested in it, he carried home a specimen, dried it, and made an examination of it, the result being that he found the sand to consist of almost pure magnetic iron-ore. Bogany Point is not the only part of Bute where it has been found, as it occurs at Kilmichael in the Kyles of Bute. An interesting circumstance, probably connected with this deposit, is that captains of small coasters in the neighbourhood say that they have noticed a divergence of the compass near the point where the principal deposit lies.—Experiments regarding the rate of deposition of sediment from fresh and salt water, by David Robertson, F.G.S. A simple way to illustrate the experiment of the precipitation in fresh and sea water is to take two small glass jars of equal size. Fill the two about four-fifths full, the one with sea and the other with fresh water; then fill both up with clay dissolved in fresh water—say about the consistence of cream—and stir both well up. Set the jars side by side to settle, and in a very short time the precipitation in the jar containing the sea-water will be seen to be going on rapidly, while in the jar with the fresh water little or no change will be observable. From these results, we can easily understand that whatever changes may have taken place relatively to land and sea from other causes, it does not appear that deposits from fresh water currents can be carried far seaward.—Note on the deposition of mud from various solutions, by Joseph Sommerville.

Manchester

Literary and Philosophical Society, Dec. 16, 1873.—E. W. Binney, F.R.S., vice-president, in the chair.—"Method of Construction of a New Barometer," by Dr. J. P. Joule, F.R.S., president. The condition of the instrument placed on March 18 in the Society's Hall proves that it is possible to use sulphuric acid on the top of the mercurial column without chemical action taking place. I have therefore proceeded to prepare other tubes with a view to test, by practical work, the merits of the new contrivance. A tube of about $\frac{3}{16}$ inch bore is selected. It is first cleaned by drawing a knotted string through it. It is then bent to the siphon shape; and near the longer end it is drawn to a capillary tube. It is then washed with nitric acid; afterwards with sulphuric acid. The sulphuric acid is then drained off. Mercury is then poured into the short limb. The end of the longer limb is then attached to my mercurial exhauster. On working this the mercury rises in the tube, and, being replenished by pouring it into the short limb, soon arrives at the height due to the atmospheric pressure. It carries with it the acid left adhering to its sides, so that after a few hours half, or, what is better, one third of an inch of acid stands above the mercury. Small bubbles of air are seen to arise; but by leaving the tube in connection with the exhauster for a day or two these finally cease. Mercury is then poured into the short limb until that in the longer rises nearly to the capillary part of the tube. This is then sealed and detached from the exhauster. Mercury is then removed from the shorter limb until it stands in the long one at a convenient height. Sulphuric acid is then introduced into the short limb until it forms a column equal to that in the longer limb. A small tube is finally attached to the short limb, and dipping a little way into a small bottle containing a small quantity of sulphuric acid, prevents the access of moist air into the short limb. The tube thus completed possesses the following advantages:—1st. There is the utmost facility in the movement of the column, so that the most minute changes of pressure are at once registered without any dragging. 2nd. The depression produced by capillary action is reduced to one half, so that the siphon arrangement can be satisfactorily used as affording an accurate neutralisation of capillary action.—Mr. Baxendell read a letter from Prof. C. Piazzi Smyth, F.R.S., Astronomer Royal of Scotland, referring to Prof. Reynolds's experiments on exploding glass tubes, and confirmatory of the conclusions of the immense force exerted by water when suddenly converted into steam, as when lightning rends a tree.

Vienna

Imperial Academy of Sciences, Oct. 9, 1873.—Prof. Krasan made two contributions in plant physiology; one of them as to what degree of heat wheat-seeds can bear without losing the power of germination. It is much higher than had been thought. They could bear a boiling heat for some hours, desiccation being effected by very gradual rise of temperature, and the use of chloride of calcium (65° for one hour was the limit previously supposed)—A second paper treated of the germination of tubers and bulbs of some early-spring plants.—Prof Lindemann communicated a paper on the behaviour of acrylic acid towards hydrogen liberated from acid solution, and towards agents of oxidation. He finds that acrylic acid at 100° C., with zinc and sulphuric acid, readily passes into ordinary propionic acid; and that, in oxidation, it furnishes no acetic acid. He thinks acrolein and acrylic acid cannot be constituted similarly to true aldehydes and fatty acids.

October 16.—Prof. Heller, who had been requested to study the Tunicata of the Adriatic, gave a paper on the vascular system of these animals, and especially Ascidians. The walls of the heart (which is a long cylindrical bag, with a thin pericardium), show fine striated muscular fibres, not parallel, but forming a network. The two vascular trunks immediately proceeding from the heart have a similar wall-structure, and contract along with it. The vessels supplying the outer coat in Ascidians always appear as double vessels, joined together only at the end of the last ramification; in one vessel the blood flows outwards, in the other inwards. The blood in Ascidians is often coloured; sometimes greenish yellow, sometimes brownish; while in some species (as *A. intestinalis*), it is quite colourless.—Dr. Von Reuss communicated the first part of a monograph of the fossil bryozoa of miocene Tertiary strata in Austro-Hungary.—Prof. Ritter read a paper on the path of Winnecke's Comet (III. 1819).—Prof. Böhm described experiments which proved the injurious action of ordinary gas on plants. For example, of ten plants (Fuchsia and Salvia), in pots, in which gas was constantly being conducted to the roots, seven died in four months. It was also shown that the gas does not in the first instance kill plants, but that it poisons the ground. Dr. Böhm recommends Von Jürgen's method of preserving plants from gas in the ground, which is, to place the pipes in wider pipes communicating with the outside air, and in which a draught is produced.

October 23.—M. Stefan gave the result of experiments on evaporation, made chiefly with ether. The rapidity of evaporation of a liquid in a tube is inversely proportional to the distance of the liquid surface from the open end of the tube; it is independent of the diameter, and increases with the temperature. If a pipe, closed at one end, open at the other, is dipped with the latter in ether, bubbles are developed, and the times in which successive equal numbers of bubbles appear, are (initially) in the proportion of the odd numbers. If the tube contains hydrogen instead of air, the same number of bubbles appears in a four times shorter period. Thus evaporation in hydrogen is four times quicker than in air. If a pipe, with open stop-cock, is dipped in ether, and the cock then closed, the

surface of liquid within the tube sinks under that without, and the depths to which it sinks in given times are as the fourth roots of the times.—Dr. Peyritsch communicated a memoir on Laboulbenia, describing a new species of the parasitic fungus, also the mode of development.

I. R. Geological Institute, Oct. 30, 1873.—Prof. Dr. A. Alth sent the first part of a monograph on the palæozoic rocks of Fadolla and "its organic remains," which will be published in the transactions of the Institute. This first part of Dr. Alth's memoir contains the geological description of the oldest formations of Padolia which, covered by large masses of cretaceous and tertiary deposits, and nearly horizontally stratified, appear only in the deep creeks along the beds of the rivers. The lowest rudimentary beds, resting immediately upon granite are sandstones which alternate with violet Argyle-slates, and are almost deprived of fossils. They contain the known concretionary globes of phosphorite. The next layer consists out of bituminous limestone with many fossils which belong to the Wenlock series; it is covered by grey marly slates which contain Brachiopods and Crinoids, and rarer Trilobites and Orthoceratites. The highest Silurian beds are green or grey shists alternating with crystalline limestones, which correspond to the Ludlow-series and contain, besides other fossils, very interesting remains of fishes. The Silurian strata are covered by red sandstone of Devonian age, and these immediately by the cretaceous strata. Of the fossil remains are described in the first part of the memoir, the fishes, chiefly Cephalaspidæ but partly also Placadermata (M. Cay) and the Crustaceæ, as Trilobites and Ostracadæ. They are figured on five plates.—Dr. O. Leny describes a fossiliferous bed belonging to the upper Neocomian limestone (Spatangenkalk) near Klein, in Vorarlberg. It consists chiefly of well-preserved oyster-shells and contains, besides, many different forms of Brachiopods, which certainly lived here in company with the oysters. This observation furnishes a new proof that the ancient Brachiopods were not confined to the deep sea like the modern representatives of this class, but inhabited the shores, also, together with the oysters; analogous observations had been made formerly by Th. Fuchs in the tertiary deposits of the Vienna basin, and by Dr. Majsisovics in the Muschelkalk of the Rhaetic.—Dr. C. Doelter examined last summer the environs of the Gurgl-valley in the Oetzthal Alps. He sends a notice about the different crystalline rocks which form this region.

GÖTTINGEN

Royal Society of Sciences, Sept. 3, 1873.—Chemical papers were communicated, on a base from nitrobenzanilid (Hübner and Retschy), on the xylidine from coal tar (Hübner and Struck), on the combination of nitrile with aldehydes (Hübner and Jacobsen).

November 12.—Dr. Hermann Ethé made a lengthy communication on the oldest period in new Persian poetry, criticising works of the poet Rûdagê, some of whose songs he translates.

BOSTON, U.S.

Natural History Society, Oct. 15, 1873.—Mr. S. H. Scudder described some kittens which he had seen at Plymouth, N.H., supposed to be a cross between the rabbit and the cat. The animals had a short rabbit-like tail, long haunches, and the gait of a rabbit, but in other respects were cat-like. Mr. Scudder could not believe the possibility of a cross between animals so far apart in the natural system, and asked for information from those present.—Dr. T. M. Brewer read a paper on the specific characters of the hermit thrushes, and also read extracts on their habits from the forthcoming work on "Birds of North America," by Prof. Baird, Mr. Ridgeway, and himself.—Dr. T. Sterry Hunt gave some account of the crystalline rocks of the Blue Ridge and their decomposed condition, as seen by him at various points in the region to the south-west of Lynchburg, Va. They are principally gneisses with hornblendic and micaceous schists, like those of the Montalban or White Mountain series, and are completely decomposed to a depth of 50 ft. or more from the surface, being changed into an unctuous reddish brick-clay, in the midst of which the interbedded layers of quartz are seen retaining their original positions, and showing the highly-inclined attitude of the strata. The nature of these chemical changes of the gneissic and hornblendic rocks consisted essentially in the removal, in the form of soluble carbonates, of the alkalies, lime, and magnesia of the silicated minerals and the hydration of the residues. The great antiquity of this chemical decomposition of the rocks was next alluded to. It was, in his opinion, effected at a time when a highly carbonated atmosphere and a climate very different from our own prevailed.

PARIS

Academy of Sciences, Dec. 22, 1873.—M. de Quatrefages, president, in the chair.—The following papers were read:—Note on the report of the last meeting by M. Pasteur. The author called attention to the tone of M. Trecul's paper, which he considered was too personal; he briefly re-asserted his statements with regard to the origin of Mycoderma, &c.—M. Trecul replied and adduced in support of his own views as opposed to those of M. Pasteur, the experiments of Wyman, H. Hoffman, and Bastian. After a brief reply from M. Pasteur the subject was dropped.—On loss of magnetism, by M. J. Jamin. The paper dealt with the loss of increasing magnetism, as exhibited on cooling, suffered by a steel bar subjected to increasing temperatures.—Researches on the stability and reciprocal transformations of the oxidised compounds of nitrogen, by M. Berthelot.—On the results of the experiments made by the commission on vine sickness of the department of Herault, by M. H. Marès.—On a skeleton of *Paleotherium Magnum*, found in the Vitry-sur-Seine gypsum quarries.—On the anharmonic relation of four points of a plane.—Note on magnetism (6th part), by J. M. Gaugain.—On the phenomena of gaseous thermo-diffusion in leaves and on the circulatory movements which result from the chlorophyllian respiration, by M. A. Merget.—On the action of incandescent bodies in the transmission of electricity, by M. E. Douliot.—On an eruption of mud from the volcano of Nisyros, by M. Gorceix.—On the limit of the ice in the Arctic Ocean, by M. Ch. Grad.—On the form of the *Phylloxera*, a comparative study of the young, from leaves and branches, of hybernating and of sexed insects, by M. Max-Cornu.—An essay on the geographical distribution of the primitive populations of the departments of the Seine-et-Marne and Moselle.—On bilinear polynomes, by M. C. Jordan.—On the physical constitution of the sun, an answer to M. Faye's criticisms, by M. E. Vicaire.—Note on a process for the measurement of the relative intensity of the constituent elements of different luminous sources, by M. H. Trannin—On the chemical composition of certain vegetable parenchyma, by M. Maudet.—New researches on the preparation of Kermes mineral, and on the action of alkaline carbonates and alkaline earthy bases on sulphide of antimony, by M. A. Terreil.

CONTENTS

PAGE

ERRATUM.—Vol. ix. p. 124. 1st col. l. 6, for "South Villa," read "Campden Hill, Kensington."

THURSDAY, JANUARY 8, 1874

VIVISECTION

THE question of the propriety of vivisection has ever and anon cropped up for the last two centuries, and learned and unlea ned persons have not been found wanting to condemn the practice. Amongst the latter the term vivisection has been taken to mean the dissecting of animals alive, with no other motive than curiosity or a malignant desire to be cruel to animals.

This arises from the utter and entire ignorance, on the part of the great mass of the public, of the scope and nature of physiology or the laws of life. If the elements of this noble and most useful science were taught in our schools as they should be, the unmeaning outcry against the practice of "dissecting live animals," as it is called, would not be heard. People would then know that the wonderful knowledge now possessed by man of the functions of his body has mainly been acquired by experiments on living animals, and that by the practice of vivisection is not meant the dissection of living animals, but the performance of experiments by which the nature of the functions of living beings may be ascertained.

Whatever excuse may be made for the public on account of their ignorance, there ought not to be any for men belonging to the medical profession, who should know the history of the science of physiology and the dependence of all true practice of medicine and surgery on the laws of life, mainly gained by humane and careful experiments upon living animals. These men would be answerable for much human suffering and premature death if they compelled men of science to give up the practice of studying the laws of human life and arrest the hand of Science in investigating the functions of living animals by inspection and experiments.

We feel almost ashamed in the present age to have to speak of the grand results which have been reaped by mankind from the observations of our great physiological discoverers in experiments on living animals. To begin with Harvey, whose name is a household word amongst us, and one of the grandest on the long page of England's discoverers; it is no perversion of words to say that he could not have discovered or demonstrated the circulation of the blood without the aid of vivisection.

In his great work, "An Anatomical Disquisition on the Motion of the Heart and Blood in Animals," he heads the second chapter "Of the motions of the heart as seen in the dissection of living animals." In this work he gives detailed accounts of his experiments, and also of those performed before the noblest and most learned in the land, who did not object to Harvey's experiments, but felt they were witnessing the demonstration of a truth that would for ever be a benefit to mankind. Had public opinion, had the Government of the day, instead of encouraging Harvey proceeded to prosecute him for cruelty to animals, then mankind would have lost a discovery that has saved myriads of human lives from torture and premature death by disease.

The discovery of the circulation of the blood produced an immense revolution in the practice of medicine and surgery. Counting the pulse became an intelligent aid to the diagnosis of nearly all diseases. Operations for the relief of disease were undertaken with fearlessness and the greatest success. The nature of aneurism and its means of cure were now understood. This last disease was studied and the surgical operation for its cure almost perfected by experiments on living animals by John Hunter. This great anatomist also made most important contributions to our knowledge of the nature of venous absorption, by his operations on animals. Nearly all the advances that have taken place in the treatment of aneurism since the time of Hunter have been made by experiments on living animals, amongst others we may name those of Spence, of Edinburgh.

Only to mention names rising to the surface from the greatness of their discoveries, we refer to Sir Charles Bell, to whom we are indebted for a knowledge of the nature of sensationary and voluntary nerves and their double origin in the spinal cord. These discoveries were made by experiments on living animals, and belong to a series which cannot be performed by the aid of anæsthetics, as the very essence of them consists in demonstrating that whilst one set of nerves is devoted to the feeling of pain, the other is the means of producing locomotion.

Another almost equally important discovery, the nature of the excito-motory action of the nervous system, was demonstrated by experiments on living animals by Marshall Hall. To say that these discoveries of Bell and Hall have had no influence on pathology and therapeutics, is to deny the experience of every medical practitioner in the kingdom—is to proclaim that the science of medicine is now practised on the system pursued by physicians and surgeons previous to the time of the discovery of the circulation of the blood. Numerous are the discoverers who have made great advances in our knowledge of the functions of the nervous system, by observations on living animals, who still live to be honoured for the advances they have made in that science which leads to the amelioration of human suffering. We need but mention here the names of Brown-Sequard and Ferrier. No human mind could have guessed at the conclusions at which they have arrived, but they have done so by the sure and certain method of observing facts in the living organism.

We might go on and fill our pages with the memories of great men who have not hesitated, for the benefit of mankind and the advancement of Science, to sacrifice the life of the lower animals. Majendie was accused in Paris of cruelty to animals, but his experiments led to a more accurate knowledge of the influence of medicines on the animal frame, and the introduction of a number of new remedies, which are still in common use. Blake, by the introduction of saline substances into the blood of living animals, showed what was the action of these matters on the blood, and he produced a sensible effect on the practice of medicine.

To the instructed this will seem a meagre list; but we hope enough has been said to show that to deny the utility of experiments on living animals is to deny that medicine has advanced at all during the last two centuries and a half, and to admit that the guesses of uninstructed practitioners are as good as the practice of the most cultivated practitioners of medicine and surgery.

Against this proof of the benefits of vivisection it has

been urged that man has no right to inflict pain on animals. The same argument has been urged against the destruction of the life of animals at all, and the adoption of a vegetarian diet has been the result. It is surely not needful to answer the last argument here, but in a degree the answer is the same against giving pain to animals; if we take animal life for the purpose of food, it is only taking the life we have given us for the purpose of our existence; and in giving a minimum of pain to animals we give it for the higher purposes of securing human life and freedom from pain. It is curious to see those who defend the cruel sports of fox-hunting, hare-hunting, and partridge and pheasant shooting exclaim against the cruelty of vivisection. Yet it could be clearly shown, we believe, that those physiologists who are in the habit of practising vivisection would not be found at Hurlingham taking part in pigeon-shooting, or meeting with the hounds in any part of the country. In fact, so far from producing a hardening effect on the mind, these experiments seem to engender in the mind of the observer a love and a care for the brute creation, that does not exist in the mind of an ordinary person. A celebrated entomologist, in answer to the objection made to the pursuit of his science, the destruction of the life of insects, made answer that his habit of observing insects had induced him at various times to save more lives of insects—as flies from the cream-jug and tea-cup—than he had ever destroyed to make his entomological collection.

The question still arises whether the experiments that resulted in the discoveries to which we have referred should be repeated for the instruction of a class, or be regarded as final? Many physiologists think that the renewal of the experiments in the form of a demonstration before a class is not necessary. This position, however, cannot be maintained, if regard is had to the good of mankind. He would be a poor chemist who did not re-perform the experiments of those who had gone before him; and the natural philosopher could not make progress in his science if forbidden to repeat the observations of his predecessors. It is not only necessary to make good practitioners of medicine, and surgery that these experiments should be repeated but it is necessary for the advancement of the science of physiology.

Of course all these experiments should be performed with the greatest attention to diminishing pain to the utmost extent. Happily, by the use of anæsthetics, we can now do this so that an animal does not suffer more than it would in passing out of existence in any other way. And we are glad to find whilst writing this, that Prof. Schiff, of Florence, who has been so unrighteously assailed for these experiments, in a letter to the *Times* completely refutes all the charges brought against him, never failing to administer anæsthetics in the performance of these operations.

THE RELATION OF MIND AND BODY

Mind and Body. The Theories of their Relation. By Alexander Bain, LL.D., Professor of Logic in the University of Aberdeen. (Henry S. King and Co., 1873.)

IN this volume, which forms one of the international scientific series, the thoughtful reader is once more called on to consider those leading positions in psychology for which Prof. Bain has so long and so ably contended. He has here succeeded in presenting his views in language as concise, clear, and popular as the nature of his subject will permit. Whoever attaches importance to the application of scientific method to mental phenomena must welcome this popular statement of doctrines, which, if not the whole truth, are immeasurably nearer the truth than are the superstitions to which not only the uneducated, but also the great mass of the learned, are subject.

It is already known that Prof. Bain has given his adhesion, more or less fully, to the doctrine of inheritance in the region both of intellect and emotion—a doctrine without which the "experience" philosophy was utterly inadequate to explain the known facts. We may therefore be allowed to regret that he has not in this volume given more prominence to a conception without which his own system is but a half truth plus something of positive error. We are disappointed, for we certainly expected more than grudging references to "the new theory."

We have before now indicated our opinion that there is something wrong about Prof. Bain's celebrated theory of the Will; and we cannot now refrain from observing that in the present volume he seems to us to make the weakness of his position more manifest by placing alongside of his old theory some of the clearer and more thorough conceptions of recent development. "The distinguishing peculiarity of our voluntary movements," says Prof. Bain, "is that they take their rise in Feeling, and are guided by Intellect." Now our contention is, that there is no fact in nature corresponding to this description. Taking it for granted that "feeling" and "intellect" here mean facts of consciousness, and not physical facts—the objective activity of nerve cells and nerve fibres —we assert (1) that taken in the lump it is an expression of the popular notion, which Prof. Bain rejects, that the body is governed by the mind somewhat in the same way that the horse is governed by his rider; (2) that looked at closely it is a string of words making up a proposition that cannot be represented in thought. In support of the first point in our criticism it must suffice to show that Prof. Bain's teaching with regard to the will is relied on by the most thoughtful advocates of the doctrine of the soul—a belief against which Prof. Bain has been fighting all his life. A perfect example of the way in which Prof. Bain's theory is interpreted in favour of the hypothesis of a soul will be found in Mr. Lowne's "Philosophy of Evolution." We had recently occasion to make a few remarks on this essay, and we cannot now do better than quote part of what we then wrote:—"It is in studying the phenomena of volition (as understood by Prof. Bain) that Mr. Lowne finds the unmistakable evidence of a spiritual clerk employed in working the nervous apparatus. . . . Comparing the nervous system to a complex telegraphic system, he says:—'If the electric fluid became periodically liberated and affected all the instruments at once, or in a given succession, mechanism alone would account for the phenomena (reflex action); but if the electric current were always utilised according to ever-varying conditions which do not bear any direct relation to the manner in which the effect is produced—that is, which are them-

selves unable to alter the arrangement of the apparatus by which the effects are brought about—a guiding intelligence is needed (voluntary action). Such appears to be the condition of the nervous system in the higher forms of life; and we recognise such a guiding power, although we know of its existence only by its effects on the organic mechanism; and we speak of it as the mind or soul.'" It is for those who, holding Prof. Bain's theory of volition, reject the popular hypothesis that the body is endowed with a soul, to show the flaw in Prof. Lowne's argument. In saying this, however, we by no means wish to imply that there is not much in the writings of Prof. Bain quite inconsistent with this interpretation of his doctrine. Indeed we find set out with remarkable clearness in the volume before us some of the considerations which we urged, not against Mr. Lowne's argument, but against the theory of volition on which it is founded. "There is no warrant for the assumption (we said) that any movement of the kind called voluntary is not as completely and necessarily the result of purely physical antecedents, as are the movements of the planets or the spelling out of a telegraphic message . . . Whatever may be the link of connection between consciousness and nervous action, it seems both unnecessary and irrational to assert that either the amount or the direction of any nervous discharge depends in the slightest degree on the state of consciousness that preceded or accompanies it.

Sitting in his easy chair, Mr. Brown debates with himself how much he will give to the Mill Memorial Fund. Greed, small vanity, respect for Mr. Mill, the fear of being thought shabby, and perhaps a score of other mental states come and go, and at last he writes a cheque for 5*l.* Mr. Brown was aware of the mental side of his deliberations, while the corresponding physical changes in his nervous system were hidden from his observation. Hence the easy mistake of supposing that in writing out the cheque the fingers moved in obedience to spiritual direction." This view seemed, and still seems to us, to forbid every conceivable interpretation of the proposition that movements "take their rise in feeling and are guided by intellect." It would appear, however, that what we feel to be an incongruity, does not strike Prof. Bain as such. For he also, if we understand him aright, believes the physical chain to be at all points complete and sufficient within itself. At least we find it difficult to understand the following extract from the chapter "How are Mind and Body united?" in any other sense. "From the ingress of a sensation, to the outgoing response in action, the mental succession is not for an instant dissevered from a physical succession. A new prospect bursts upon the view; there is a mental result of sensation, motion, thought, terminating in outward displays of speech or gesture. Parallel to this series is the physical series of facts, the successive agitation of the physical organs, called the eye, the retina, the optic nerve, optic centres, cerebral hemispheres, outgoing nerves, muscles, &c. While we go the round of the mental circle of sensation, emotion, and thought there is an unbroken physical circle of effects. It would be incompatible with everything we know of the cerebral actions to suppose that the physical chain ends abruptly in a physical void occupied by an immaterial substance; which immaterial substance, after working alone, imparts its results to the other edge of the physical break, and determines the active response—two shores of the material with an intervening ocean of the immaterial." Now remembering that movements of all kinds are physical facts, have their place in the "unbroken material succession," we once more put the question—In what sense can a particular class of movements be said to take their rise in the mental series which runs parallel to, without forming part of, the physical series?

The truth or meaning of our assertion that the proposition, "movements take their rise in feeling," cannot be rendered into thought, may now be perceived by anyone who will attempt to picture to themselves a state of consciousness turning on, or in any way determining the direction of, a nervous discharge. But as some of our philosophers, strong in logic, can surmount psychological impossibilities with the same ease that our divines can rise above them on the wings of faith, the disciples of Mr. Mill and Prof. Bain may demur that the question is not one of conceivableness or inconceivableness, but of proof. Well, then, let them show, if they can, that they have any better ground for the opinion that voluntary movements take their rise in feeling and are guided by intellect, than a superficial observer ignorant of the construction of the steam-engine might have for a belief that the movements of a locomotive take their rise in noise and are guided by smoke. Should it be attempted to turn the point of the foregoing argument by aid of the curious description of a mental fact, that it is a "two-sided fact"—both body and mind—our difficulty only requires to be restated. In what sense can a movement called voluntary—the objective side of a "mental fact" — take its rise in feeling the subjective side of the same "two-sided fact"? Using Prof. Bain's own words, "it is, after all, body acting upon body."

In this work Prof. Bain does not advance his idealism; probably he may have concluded, and justly, that it would prove too metaphysical for the readers of the International Scientific Series. Throughout his language is that of a realist. Mind and Matter seem to be accepted as ultimate facts; and "the institution of two distinct entities" is spoken of as "not in itself a crushing dispensation." Not only so, in such expressions as "undivided twins," "one substance, with two sets of properties, two sides, the physical and the mental—a double-faced unity," we have, to say the least, very much of the ring of Mr. Spencer's hypothesis that nervous action and consciousness are the objective and the subjective faces of his Unknowable—the one Ultimate Reality. We do not say that Prof. Bain is attempting the dangerous experiment of trying to put new wine into old bottles, but we fear until he has explained more fully the modifications which, by changes or additions, he means to make in his system, his present deliverance will be apt to suggest this. DOUGLAS A. SPALDING

THE ELEMENTS OF LOGARITHMS

The Elements of Logarithms. By J. M. Peirce. (Boston, U.S.A.: Ginn Brothers, 1873.)

IN the preface Prof. Peirce writes:—"Logarithms ought not to be comprised, as they often are, in the midst of a treatise on algebra. For, in the first

place, they are not algebraic functions; and, besides this, the student is unlikely to form an adequate comprehension of their purpose, or to appreciate the importance of acquiring skill in the use of his tables if he takes them up in the course of a study to which they have no application. If logarithms must needs be combined with any other branch of mathematics, their true alliance, on grounds both theoretical and practical, is not with algebra but with trigonometry." In point of fact, logarithms are usually included in works on trigonometry; and we can see no reason why their principle should not also be explained, as at present, in treatises on algebra, to which the theory does really belong. Ordinary students of mathematics never learn to use logarithms properly, not so much owing to deficiency of explanation in the existing works as to the fact that they never meet in the course of their reading with anything requiring such a knowledge. Prof. Peirce's work contains 82 small octavo pages, and is intended for readers possessed of only a very trifling knowledge of algebra. It is simply what a chapter on logarithms in an ordinary algebra would become if printed separately, with the addition of copious examples and an appendix on their use in trigonometry. To show how limited is the range of the book, it is only necessary to state that all the rules have reference merely to three and four figure tables, and that the natural base e is not even alluded to, though it is stated that a chapter on the Napierian system will be added in another edition. There is little either to commend or blame in the book. It is partly intended for the entrance examination at Harvard, but it seems to us it would be most useful to computers who wished to obtain some notion of the reason for the rules they were in the habit of employing. In one respect the book is in advance of the time, viz., some paragraphs are devoted to the history of the subject. We believe the day will come when no scientific treatise will be considered complete that does not contain short historical notices relative to the discovery of the principal results.

Prof. Peirce defines the arithmetical complement as the complement from 10; we should much prefer to see it defined as the complement from zero, so that the arithmetical complement of a logarithm of a number should be the logarithm of the reciprocal of the number, viz. its cologarithm. We also hope the day will come when the addition of 10 to the mantissæ in our logarithmic trigonometrical canons will be abandoned, and the true negative characteristics printed and used. A complete seven-figure table with negative mantissæ was published at Paris by M. J. Dupuis in 1868, which was a step in this direction.

PEDIGREE AND RELATIONSHIP OF MAN

The Story of the Earth and Man. By J. W. Dawson, LL.D., F.R.S. (Hodder and Stoughton.)

Man and Apes. By St. George Mivart. (Hardwicke.)

THESE two works possess some points in common. Neither of their authors accept Darwinism in its entirety, the former absolutely rejecting it. They both treat of the relations of man to the lower animals, and both find the chasm of the human mental and moral phenomena the great drawback against bringing man into the same category with the apes. The manner in which the subject is treated, and the facts employed, are however not the same, while the results arrived at are very different, as will be seen from the following remarks.

Dr. Dawson is very much irritated by the manner in which many of the biologists of the present day, without feeling any necessity for giving the reasons for their belief, are in the habit of writing and talking as if the evolution hypothesis were fully proved, and established as a fundamental principle of nature. "That in our day a system destitute of any shadow of proof, and supported merely by vague analogies and figures of speech, and by the arbitrary and artificial coherence of its own parts, should be accepted as a philosophy, and should find able adherents to string upon its thread of hypotheses our vast and weighty stores of knowledge, is surpassingly strange,' remarks our author in a spirit which we are surprised to meet in one who thinks that "in the present state of natural science in Britain this evil (of regarding geologic facts from an evolutionary point of view) is to be remedied only by providing a wider and deeper culture for our young men." In the same dogmatic and unscientific spirit all the theoretical questions which are discussed, are written for the perusal of the readers of a popular journal, and such being the case, it is hardly surprising that false notions are so common as to the direct bearing and tendency of the greatest theory of modern times.

"We need not stop to mention the usual inaccuracies as to facts" is the way in which a criticism of a paragraph in one of Mr. Herbert Spencer's works is commenced, and as might be almost predicted from so self-satisfied an author, it is in the criticism only in which the inaccuracy is to be found. On the following leaf we are astonished to learn with reference to the Ascidian, that its "resemblance to a vertebrate animal is merely analogical, altogether temporary and belonging to the young state of the creature, without affecting its adult state or its real affinities with the mollusks." The author can hardly have studied Kowalevsky's memoir on the subject, in detail.

In his anatomical structure, man, according to Mr. Dawson's distorted view, presents differences from all the apes which are at least of ordinal importance, distinctions "mainly dependent on grade or rank, and not to be broken down by obscure resemblances of internal anatomy having no relation to this point, but to physiological features of very secondary importance." When, in association with this, we are told that it is merely begging the question to say that "the fact that the human skeleton is constructed on the same principles as that of an ape or a dog, must have some connection with a common ancestry of these animals," we think it hardly necessary to make further comment on the work in question, except to hope that it will not fall into the hands of commencing biological students, who would find it difficult to shake off the false associations that, in it, surround the facts which are discussed.

Mr. Mivart treats his subject in a very different manner. His object is "to investigate by the unimpassioned process of enumeration and weighing facts of structure, what is the teaching of Nature as to the affinities of various apes to man." In doing this, after a rapid review of the clasification of Mammalia generally, and the geographical distribution of the apes and lemurs, or half

apes, as they are termed, the peculiarities of the osteology of the Primates, and their soft-part anatomy, are entered into in detail. From the facts thus obtained, especially from the peculiarities of the liver and brain, it is shown that the, at present accepted, notion that the Gorilla is man's nearest ally, is not borne out by anatomical investigation, and that the Chimpanzee, the Orang, or the Gibbon can either of them claim a closer relationship. The recapitulation of the many different points in which man in some one or other point resembles the various higher and lower apes, leads the author to think that the laws of affinity form a "network" or "tangled web" rather than a "ladder," from which it is only possible to infer that in the course of development there has been blood relationship established between the different species of apes, after their differentiation into distinct species, which is hardly compatible with our notions of the definition of a species. No decided opinion is given as to which ape does stand nearest to man, the various points of similarity in each being considered as fairly balanced. However, there are two structural features at least that are not mentioned, which, when added to those noted, go strongly to support the placing of the Orang-Utang, as the nearest ally to the human race. The first of these is an osteological one; in man and the orang the postero-internal angles of the orbital plates of the frontal bone do not meet and blend behind the cribriform plate of the ethmoid bone, as they do in the gorilla and chimpanzee. The second is in the soft part, the penis of the orang being very similar in general proportions to that of man, whilst in the chimpanzee at least, it is decidedly different, being smaller proportionately, and with a button-shaped glans.

Mr. Mivart adds the weight of Gratiolet's bold attempt to classify the monkeys by their cerebral convolutions, to show more demonstrably that the gorilla is anything but as high as he has been placed in the scale. Though Gratiolet may have been correct in so displacing the gorilla, nevertheless it is difficult to believe from their general appearance, structure, and geographical range, that, as he thought, the baboons and cercopitheci are far separate from one another, that the Asiatic true macaques and the African chimpanzee, are most closely allied; and that the affinities between the Entellus monkey and the orang are very intimate. These somewhat shake our faith in the results that have as yet been arrived at from the study of the cerebral convolutions.

No animal seems more difficult to depict correctly than the monkey, man alone excepted, which may in itself be considered to indicate a point of affinity; the illustrations accompanying Mr. Mivart's work, are, however, of the poorest description, many not being the least worthy of their author; old, and imperfect, inaccurate in not in any way giving the expressions or correct attitudes of the originals, we should have preferred to see them omitted.

OUR BOOK SHELF

Geology. By Prof. Geikie. Science Primers. (Macmillan and Co. 1873.)

THIS is a charming little book of 128 pages. It is well arranged, well written, and well illustrated, and is thoroughly well adapted for its purpose. Of course the geology in it is unexceptionable, and therefore it follows that the only thing with which a reviewer can quarrel at all is the selection of subjects for omission. Among small omissions he might mention that of Darwin's theory of coral islands as a "proof that a part of the crust of the earth has sunk down." This is so beautiful an instance of an explanation of the curious phenomena of coral islands, that it never fails to interest boys. To lead them up to this theory, and then test it as Darwin tested it, is an excellent exercise in that peculiar kind of reasoning about past causation which is of the essence of geology. A greater omission is perhaps that of the history of geological science. A sketch of this in half a dozen pages would greatly interest boys; it would show them how science grows; and they would infer that geology is not yet completely mastered, but that there is something left for them to do. It strikes one also as an omission, of a very grave kind, to say nothing at all about stratigraphical geology, a few pages of it with a general description of the stratigraphical structure of England would increase the value of the book, and what is more, inspire the reader with a desire to learn more. And lastly, one cannot but desiderate some sketch of the sequence of life on the earth as the result of palæontology, for the same reasons. If all these things were put in, the book would still be small, and would really introduce the reader to the whole of geology, and excite his curiosity. J. M. W.

Jahrbuch der kais. kön. geologischen Reichsanstalt. Band xxii. Nos. 3 and 4.

IN the first of these numbers, perhaps the most interesting paper to an English geologist is one by von Theodor Fuchs, "On Peculiar disturbances in the Tertiary Formations of the Vienna Basin, and on a self-evident Movement of Unconsolidated Earth-masses," which is accompanied by a number of illustrations and sketch sections, taken chiefly from the cuttings of the railway at Marchegg. The writer thinks that the contortions and displacements witnessed in superficial deposits, and which have been variously accounted for—some geologists supposing them to be due to subterranean action, others to glacial action, and so forth—have been induced by causes, which have hitherto been either overlooked or treated as insufficient. His studies have led him to conclude that these superficial confusions and displacements are brought about by a movement amongst the earth-masses themselves, which, as a rule, beginning with some local slip of the beds, becomes eventually converted into a movement of the whole. The motion of the earth-masses, now rolling, now gliding, can only be compared to the flow of a mud-stream or that of a glacier. After the author's paper was written, he became aware that he had been preceded in his general conclusions by Mr. R. Mallet, whose paper in the Journal of the Dublin Geological Society ("Some Remarks on the Movements of Post-tertiary and other discontinuous Masses," vol. v. p. 121) will no doubt be known to many of our readers. It is not likely, however, that glacialists will ever be got to believe that their boulder-clays, &c., and scratched rock-surfaces have been produced by the continuous or intermittent slipping of loose material which is in daily progress around all the existing coasts. The other papers in this number are, "The Mountain-land of South Glina in Croatia," by Dr. Emil Tietze, and "On the so-called gas-shales of Nyran and their flora," by von Ottokar Feistmantel. Number 4 opens with the second part of Professor Hochstetter's interesting paper "On the Geology of the eastern parts of European Turkey." This part is accompanied by a geological map of Central Turkey, which shows the distribution of the rock-masses, while several diagram sections scattered through the paper enable us to understand more clearly their succession and relative position. Amongst primary rocks

the author enumerates gneiss, amphibolgneiss, mica-schist, talc-schist, phyllite, granite, syenite, amphibolite, serpentine, and crystalline limestone. Under the mesozoic division, he gives red sandstone, quartzite, and conglomerate, which he considers to be of Triassic age, and compact limestone and dolomite, which may be either of Triassic or Jurassic age, or both. Above these come deposits of chalk and marl of middle cretaceous age. The tertiary and quaternary deposits consist of miocene lacustrine beds with lignites, post-miocene diluvium or fluviatile gravels, and alluvium. Amongst eruptive rocks he enumerates quartz-porphyry, augite-porphyry, pyroxenic tuff and conglomerate, trachyte, trachyte-conglomerate, pumaceous tuff, &c. The only other geological paper in this number is an explanation of Sheet iv. (East Carpathia) of the Geological Survey's map of the Austro-Hungarian empire. Both numbers of the *Jahrbuch* are accompanied by the usual mineralogical communications, which contain a number of papers, amongst them one by von Johann Rumpf upon "Kaluszite," a new mineral, the chemical formula of which is given as $CaK_2(SO_4)_2 +$ aq. or in another way as $CaO, SO_3 + KO, SO_3 +$ aq. An illustrative plate accompanies the description.—Prof. Tschermak furnishes some account of the meteorites in the imperial mineralogical collection up to October 1872, giving a table that shows in a condensed form the names of the places where the meteorites were found, the hour of the day, the day of the month, and the year in which the stone fell, &c.—Special mention must also be made of a paper by Fuchs on the Island of Ischia, which is geological and historical, as well as petrological—a paper which will well repay perusal by those who are engaged in the study of igneous geology.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

The Largest Amphipod.—Willemoesia (Deidamia).

In a paper which was read at the Royal Society this year, I described the anatomy of a female amphipod caught in the Atlantic, and remarkable for its large size and the absence of the second pair of antennæ. This female had a length of 84 mm., not of 14 mm., as has been stated in NATURE and in other periodicals which have reprinted my abstract from the Proc. Roy. Soc. We have since also caught males of this interesting amphipod, which were still larger, more than 3 in. long. A description of these has been added to the above-mentioned paper, so that now the anatomy of both sexes will be known. This amphipod, which, as we have discovered, lives on the surface, is, thus, by far the largest one known. Some figures representing the male and parts of the mouth, which at first could not be dissected, and therefore not well be seen, will appear in a larger paper on some of the remarkable deep-sea and other crustacea caught during the *Challenger's* cruise in the Atlantic.

This amphipod, however, which was supposed to be new, and to which I gave the name of *Thaumops pellucida*, has been already described by Guérin-Méneville under the name of *Cystosoma neptuni*. The distinguished French naturalist has described this species from a single specimen caught in the Indian Ocean. This I found out only when I got Mr. Spence Bates's catalogue of amphipods sent out to me, in which the original figure has been reproduced. The first description of this species seems, however, to be so incomplete, that some additional knowledge about its structure will be welcome, I hope, to zoologists.

The geographical distribution of certain amphipods seems to be a very wide one, for we have not only caught several specimens of Cystosoma in the Atlantic, but also a species of the genus Oxycephalus, which hitherto seems to have been found in no other but the Indian Ocean.

With regard to *Willemoesia* (*Deidamia*), Mr. Grote has been kind enough to point out in vol. viii. p. 485 of NATURE, that the name Deidamia has been used already for a genus of Sphingidæ, by Dr. Clemens, and honoured me by calling the two blind crustacea, which are so closely allied to the fossil Engonidæ, by our family name; I am very much obliged to the curator of the Buffalo Museum for this information, and will always be glad, during the time of our cruise, to receive communications of this kind. For though we have a good library on board, mistakes like these cannot always be avoided, when it is necessary to give a name to those animals which I describe, not because they are new, but because they furnish interesting additions to our knowledge of the morphology of lower animals.

R. v. WILLEMOES-SUHM

H.M.S. *Challenger*, Simons Bay, Cape of Good Hope, Nov. 24, 1873

Physiological Effects of Ozone

Long before Schönbein discovered ozone, electricians who had been in the habit of employing Franklinic or statical electricity as a therapeutic agent, had discovered that the electrical aura, as they termed it, or the current of air proceeding from an electrified point, possessed decided physiological properties, and the effect appeared to be the same whether, on the single fluid hypothesis, the electrical current or breeze passed from the point to the animal surface, or *vice versâ*. The physiological effects principally noticed were the power of this breeze to allay chronic inflammatory actions in delicate organs, such as inflamed eyes, or to relieve pain arising from a decayed tooth; but they were most remarkable in the curative effect produced on obstinate ulcers, when the electrified current or aura was daily thrown upon their surfaces for some minutes. The *rationale* of this process was not understood, and electricians were contented to accept the facts without being able to explain them.

About 45 years ago I employed Franklinic electricity as a collateral branch of my electrical pursuits pretty extensively as a therapeutic agent, and had abundant opportunities of noticing these physiological actions. In addition to these a fact gradually developed itself during the course of my electrical investigations, namely the effect which an electrified atmosphere had upon the mucous lining of the throat and bronchial tubes. It was no uncommon thing, after a day's continuous use of an electrical machine in a close room, to feel a considerable amount of irritation over the respiratory tract very similar to that experienced when recovering from an attack of influenza, and I found that I could often produce the same irritation by removing the prime conductor from the cylinder of an electrical machine and holding my face in such a position as to breathe the copious ramifications of electricity that were thrown off from it.

These effects are all now referable to the development of ozone, and the interesting experiments of Mr. Dewar and Dr. M'Kendrick, recorded in NATURE (vol. ix. p. 104) open up a field of inquiry, the extent and importance of which can scarcely be estimated. Of late years ozone has, by a kind of *post hoc propter hoc* reasoning, been designated the scavenger of the atmosphere, since raging epidemics have been suddenly checked in their course after the occurrence of a good rattling thunderstorm, and hence the old notion, not without good foundation, that lightning clears the air. So much importance has been attached to the supposed value of this antiseptic agent, that not a few, and myself amongst the number, have recommended various forms of apparatus for the development of ozone within the precincts of fever hospitals, but the experiments of Mr. Dewar and Dr. M'Kendrick seem to show that there is a limit beyond which it would not be prudent to ozonise an atmosphere destined for respiratory processes.

The further investigation of its physiological effects will therefore be looked forward to with no small interest. The examination of the subject, however, must not end with its effects upon animal physiology.

From experiments which I have made on the extraordinary electrical conditions which are suddenly induced in an atmosphere forming the extended di-electric of a thunderstorm, I can trace an intimate relation between the copious development of ozone and a corresponding effect upon delicate vegetable organisms, which may lead to the discovery of the proximate causes of blight so frequently the accompaniment of thunderstorms. Some years ago I extended a small atmospheric exploring wire between my own house and the cupola of a chapel 400 ft. off. One end of this wire was brought into my study, and connected with an electrical battery containing about 12 square feet of internal surface; a discharging apparatus, which also served the purpose

of a lightning-conductor to the ground, was connected with this wire. The changes which this wire indicated as occurring in the stratum of atmosphere with which it was in contact, were of a most extraordinary character.

Simultaneously with the occurrence of a flash of lightning, even at a mile distance (the battery being disconnected), a torrent of sparks rushed between the exploding balls, presenting the appearance of a thick bundle of brilliant sparks, with a noise similar to that of suddenly breaking a hard fibrous stick. When the battery was in connection with the atmospheric wire, the quantity of electricity brought in by it was sufficient to charge and discharge the battery, over an interval of a quarter of an inch several times so rapidly, that it was impossible to count the discharges, the cracking noise being correspondingly loud. This effect is now accurately imitated by the bundle of sparks passing between the terminals of a powerful induction coil, having an electrical battery connected with it. When it is considered that the earth's surface in immediate connection with this electrified stratum is acted upon electrically by it, one can easily see the influences which such actions are likely to produce upon the delicate vegetable organisms which have not only to act as conductors in these electrical changes, but are exposed to the actions of a sudden development of an enormous amount of ozone. It will therefore be an interesting matter to know how vegetable life will be influenced by an ozonised atmosphere, especially as the conditions necessary for artificial experiments will not be difficult to obtain.

Plymouth, Dec. 29, 1873 J. N. HEARDER

Photographing the Transit of Venus

THE following is the result of some experiments recently made on photographic irradiation :—

If, as is generally supposed, photographic irradiation is caused by the reflection of light from the back surface of the plate, then photographs taken on non-actinic coloured glass ought to be free from irradiation, because the light would be quenched in the glass, and therefore no reflection could take place. Photographs of a model transit were taken on yellow, orange, and red glasses ; but in all cases the irradiation was nearly as bad on the coloured glasses as on the clear glass.

Photographic irradiation may possibly be caused, either by the bright light producing an intense state of chemical activity, which has the power of spreading itself, or what seems more probable, the parts of the collodion on which the bright light is falling become luminous, and reflect light to the surrounding parts of the sensitive film, and thus extend the chemical change in each side of the true optical boundary line. If this is the explanation, then we can correct photographic irradiation by allowing only sufficient light to fall on the plate to produce the necessary chemical change, so that there shall be no surplus to be reflected ; or we may make the sensitive film of such a nature that it cannot reflect the actinic ray. There are two ways of carrying out the first of these plans. We may either "stop" down the lens by means of a diaphragm, or we may pass the light through a non-actinic coloured screen. The first should be the best plan, but was not found practicable with the Dallmeyer "triplet" lens used in the experiments. Screens of glass and coloured solutions were then tried, and photographs of the model transit taken perfectly free from irradiation, and not to be distinguished from photographs of the model taken against a dull sky, which required 15 seconds' exposure. Experiments were then made to make the sensitive film incapable of reflecting actinic rays. This was done by adding red aniline to the collodion, till the colour was found by experiment to be deep enough. Photographs taken in this way were also quite free from irradiation. After the photographs were developed and fixed in the usual way, they were treated with chlorine gas, which destroyed the red colour and left the photographs on a clear film.

Ocular irradiation is also, in all probability, in part caused by the reflection of light in the eye. But in addition to this cause there is another of considerable importance—namely the "persistence of the image" combined with the unconscious motion of the eye—as the impression received by the brain is not only that of the light on the part of the retina where the image at the time is, but also that of where it was a short time before, the mental impression must therefore be larger than the image on the retina. Ocular irradiation can also in all probability be corrected, by reducing the amount of light falling on the eye, to the minimum necessary to give a distinct impression. The reflection in the eye will then be less. The image not being so bright will not "persist" so long—and the light not being so brilliant, the stimulus to the unconscious motion of the eye will not be so great. Diaphragms will of course be preferred for this purpose. When screens are used it is probable that neutral tinted ones will be found to suit best.

JOHN AITKEN

The New Marine Animal

IN NATURE, vol. viii. p. 488, under the heading "New Marine Animal from Washington Territory," Mr. P. L. Sclater announces the description by Mr. Stearns of the *Verrillia blakei*, the long-sought-for owner of the wand-like rod named by Gray, *Osteocella septentrionale*.

I write to say that the nationality of the Polyp is altogether British ; Burrard's Inlet—the only place it has yet been found—is in British Columbia, close to the north mouth of the Fraser, and the first description of it would have been British too, but for unavoidable postal delays in the transmission of my paper, the receipt of which by the Zoological Society Mr. Sclater mentions. EDWARD L. MOSS

Royal Naval Hospital, Esquimalt, B.C., Nov. 26, 1873

The Potato Disease

IN NATURE, vol. ix. p. 161, it is stated by Mr. W. G. Smith that the bodies referred by Dr. Montague to Artotrogus are possibly no other than *Volutella ciliata*. Nothing can be more common on decaying potatoes than *V. ciliata*, but I can state most positively that Montague's fungus, whatever its nature may really be, had nothing to do with *V. ciliata*. It is very important that attention should not be drawn off from Dr. Montague's, or rather Dr. Rayer's curious observation by a supposition which is entirely without foundation. A reference to the figures in the *Journal of the Horticultural Society* (vol. i. tab. 4, figs. 27, 28, 29), and the characters of Artotrogus, apart from the specimens submitted to myself, and the occurrence within the cellular tissue, ought to be quite sufficient.

Jan. 3 M. J. BERKELEY

Specific Gravity of Sea-water

IN Prof. Wyville Thomson's work "The Depths of the Sea" there appears to me a curious discrepancy between two statements of the specific gravity of the sea, to which it may be useful to direct general attention. At p. 505, Mr. W. L. Carpenter states that the average specific gravity of surface-water, at a sufficient distance from land to be unaffected by local disturbances, was 1·02779. At p. 513, Dr. Frankland gives the specific gravity of four samples of surface-water, the mean of which is only 1·0267, even less than the minimum value as given by Mr. Carpenter. Both results are said to be for temperature 60° F. I should have expected Dr. Frankland's determination to have been the higher, from possible loss by evaporation. The difference may probably be due to want of identity of indication between the instruments used. From whatever cause it may arise, the difference is so considerable, as to leave no doubt whatever that it ought to be accounted for in some way ; and the error wherever it lies fully exposed. R. STRACHAN

Meteorological Office

Optical Phenomenon

A SHORT time ago I was lying, during the heat of the day, in a darkened room in a house at one of the hottest stations in India. There was a great glare of sunlight outside. All at once I became aware of figures moving about on the opposite wall. On examination they proved to be the inverted images of the servants of the establishment who were walking about in the performance of their several duties in the gravelled courtyard outside the house. The white colour of their clothes, the dark colour of their skin, and the red colour of their sashes or turbans, were distinctly reproduced, and every servant was recognisable without difficulty. The images were produced by rays passing through three or four holes in the Venetian shutters ; and while they all remained open there was a large penumbra round the images, but on closing all but one hole, this was very much reduced. The holes were of the size of a shilling or half-crown, and made in an outer door as well as the shutter, having been constructed to admit of a punkah rope passing through. The explanation appears to be this :—The sun was

above and slightly behind the house. The solar rays falling on the objects in the court-yard were transmitted through the shutter holes. There being no other light in the room, and the rays being strongly scattered by the rough whitewashed wall, the rays were sufficiently powerful to produce an image on the retina of an observer in whatever part of the room he might be; the room became, as it were, the box of a large camera.

On intercepting the rays with a smooth oval looking-glass, they were not, of course, scattered, and no image was visible on the glass, but the image could be reflected from the looking-glass to any part of the wall which contained the shutters through which the rays passed. The appearance produced when a servant was made to stand in the required position, was singular. A full-length (inverted) coloured figure appeared in an oval frame of bright white light, much larger, of course, than the looking-glass. The white light was produced by the glare from the gravelled yard, shadows on which were reproduced.

A dog-cart and horse were imaged on the wall most clearly, the chesnut colour of the horse being very distinct. The whole phenomenon was always producible at any time when the sun was in the proper position above the house.

Are not mirages of one class, *i.e.* the appearance of inverted images in clouds, produced in a similar way? The rays from a figure might pass through an opening in one cloud to the face of another otherwise unilluminated, and be thence scattered. I believe I have seen this explanation given somewhere, but I cannot remember where.

E. C. BUCK

N. W. P., India

ON TEMPERATURE CYCLES *

SINCE the discovery of an eleven years' period in the phenomena of solar spots, several corresponding periods (it is now well known) have been demonstrated in terrestrial phenomena, more especially in those of magnetism, auroras, cyclones, and rainfall. With regard to weather changes, it has been thought by Dove, that the tracking of a cycle in these could not, theoretically, be made an object of research; and that while some indications of a periodicity might appear, a great part of the complicated changes named must be, from the nature of the case, quite unperiodical. The series of observations by Dove on the subject led him to the conclusion (1) that divergences from the normal, especially those of temperature, are not local, but spread over large surfaces; but (2) that negative divergences, in one region of the earth, are compensated by positive in another; and conversely. That the compensation is perfect, and that the quantity of heat annually given by the sun is constant, has been affirmed also by Maury and others.

The data on which this conclusion is based are limited. They appeared quite insufficient to a German physicist, Dr. W. Köppen, who has recently been led to undertake a wider investigation of the subject. He has communicated to the Austrian Society for Meteorology a preliminary notice of his inquiries and results (*Zeitschrift*, Aug. and Sept. 1873), which will be found of considerable value.

We may first note here his materials and method. He furnishes a long list of places from which observations (more or less extensive) have been had; and in his first table he gives the divergences of temperature of individual years (1820—71) from the average temperature, and for the following regions: India, Tropical America, Temperate South America, South Africa, Australia, China, and Japan, Mediterranean region, Southern United States, Western U.S., Western Central Europe, Austria, South Russia, South-West Siberia, East Siberia, Central part of U.S., Atlantic States, British Islands, North Germany and Netherlands, North-West Russia, North-East Russia and Ural, North-West America, North East America, Iceland, Northern part of Europe. [The particular towns, &c., are given, and the author's purpose partly is, that the list may be supplemented by other series of observations (which he has not been able to see), being sent to the Central Physical Observatory at St. Petersburg, where he has chiefly been prosecuting this research.] The periods of observation ranged from three to thirty years; the average was taken from several years' observations. In many observation-series, the yearly average had to be calculated for the first time. Series of six years' length were the shortest admitted, and such short series only by way of completing the longer. The original sources of Prof. Dove's material were consulted.

A second table shows the divergences of temperature in various regions for the years 1768—1819. By way of condensing, a third table is given, in which the material from 1820—71 is arranged in five series, one of which represents the tropics, and the four others four successive ex-tropical zones. The zones are not bounded by determinate parallels of latitude, but it was sought to combine approximately equal material of observation and earth surface.

On comparison of the curves of Table III. with the sun-spot curves (according to Wolf), a striking correspondence at once appears, as far as the year 1854. In the tropics, the maximum of heat occurs $\frac{1}{2}$—$1\frac{1}{2}$ years *before* the spot-minimum; in the ex-tropical zones, on the other hand, it occurs *after* the minimum; in some cases (in the forties, *e.g.*) as much as three years after. The regularity and extent of the variations diminish from the tropics to the poles.

It is further noticeable that as the interval from maximum to minimum of the spots is always greater than that from minimum to maximum, a corresponding inequality occurs in the temperature changes.

On these results Dr. Köppen remarks that, while there is evidently some connection between the two kinds of phenomena, the sun-spots do not act directly by darkening a part of the solar disc; for, as the temperature of the earth's surface is a function of the solar radiation, the change in the former must follow that in the latter; but the opposite occurs, as we have seen, in the tropics. It is probable that the temperature of the sun's surface is (from some unknown cause), at its highest one or two years before the minimum of the sun-spots. That the spots (if we suppose them to be solid bodies) take so long to melt that their minimum only occurs after the maximum temperature of the earth's surface, is not remarkable, considering their size.

If we consider the period 1800—71, we find a section of about 40 years, with marked periodic variation, 1815—54, and two periods, before and after, showing great disturbances, (say) 1792—1815, and 1854—66. Whether in 1865 we have again entered (as the curve would seem to indicate) on a time of distinct periodic variation, will doubtless appear in the next ten years.

The observations before 1800, again, show such anomalies in the temperature, that we should almost doubt the existence of connection with the sun-spots were it not for the convincing evidence of the years 1815—54. We find all possible cases, from complete indifference of the temperature in contemporaneous change of the sun-spots (1750—71), and a short correspondence of both (1772—77), to a well-marked and regular variation of temperature (1777—90), which stands to the sun-spot curve, in exactly the opposite relation to that found in 1816—54. True, the observations here are only from a small fraction of the earth (West Europe and the New England States); but the continuance of the same curve shows the normal variation in 1816—54 quite distinctly. The estimation of the spots previous to 1826 is somewhat arbitrary, but an error such as that the maximum is put in the place of the minimum cannot be supposed. And lastly, if it be urged that the turning points

* Abstract of paper by Dr. W. Koppen in the Austrian *Zeitschrift fur Meteorologie.*

of the temperature curve (1779 maximum and 1785 minimum) are precisely where, according to the mean length of the sun-spot period of 11·1 years, they must be; that there may, perhaps, be an 11 years period in the temperature independent of the sun-spot period, and that, in the present case, a displacement which the spot period has experienced is not shared by the temperature period; we have to remember that the correspondence of the temperature changes in 1815—54, does not merely extend to the average length of the periods, but that all peculiarities and disturbances in the sun-spot curve are, in these 30 or 40 years, reflected in the temperature curve. Further observation is needed to explain this phenomenon. Possibly (the author suggests), we have here the interference of a number of quite independent periodical actions; and (without laying stress on the fact, in default of causal evidence), he notices that the greatest negative anomalies occur, for a considerable time, in a series which progresses by multiples of 9, and in such a manner that an interval of 27 alternates with one of 18 years. Thus—

$$1740 = 1767 = 1785 = 1812 = 1830 = 1857$$
$$+27 \quad +18 \quad +27 \quad +18 \quad +27$$

The first four agree; there is merely the quite isolated cold year 1794 intermediate. Going further, we find divergence; for the table shows a strong negative anomaly about 1836; but we have, again, the well-authenticated negative anomaly of 1856—57 conforming to the rule. Renou has assigned, for the return of the cold winter of south-western Europe, a period of 41 years; the author asks whether the time $27 + 18 = 45$ years does not better agree with the phenomenon. On this view, the first winter, reckoning back from 1740 is 1695, and this is recorded as having been one of excessive cold. Between these two occurs one winter of extraordinary cold, 1709, but it is quite isolated, the neighbouring years having been warm. If we go still further back, the periodicity cannot be ascertained with any certainty. If the rule is correct, and its validity between 1740 and 1857 not a mere accident, *i.e.* the expression of quite other laws, we have to look for a very cold year in 1875 (being $1857 + 18$).

Dr. Köppen proposes, in a future communication, to treat of hydro-meteors, and to examine the influence of periodic weather changes (at several years' interval) on some phenomena of organic nature.

LAVOISIER'S WORK IN THE FOUNDATION OF THE METRIC SYSTEM

SINCE the publication of the article on the Metric System, in NATURE, vol. viii. p. 386, my attention has been drawn to some recent information showing the important part taken by the celebrated Lavoisier in the scientific operations for establishing the basis of the metric system of weights and measures in France. Lavoisier's name has hitherto been little noticed amongst those of the men of science who were prominently engaged in this work; but it is now clearly proved that up to the period of his being guillotined on May 8, 1794, when he fell a victim to the revolutionary fury during the reign of terror, no one took a more active or serviceable part in the scientific labours for founding the Metric System than Lavoisier.

This information is contained in a "Notice historique sur le Système Metrique," by General Morin, lately published in the "Annales du Conservatoire des Arts et Métiers." It is derived from original documents left by Lavoisier, and now in the possession of the Académie des Sciences. These documents have since been submitted to my inspection by M. Dumas, and full details of them will soon be given to the world in the fifth volume of the works of Lavoisier, which M. Dumas is now completing.

Although Lavoisier's name does not appear in the list of the original Committee of Weights and Measures in France, yet it is shown that he was very actively engaged in making the arrangements for their meetings and in preparing the minutes of their proceedings, as appears from papers and letters in his own handwriting. It was through his personal agency that funds were provided at Paris for continuing the measurement of the arc of the meridian in Spain by Méchain. And more particularly, all the actual comparisons for determining the length and dilatation of the standard measures used by Méchain and Delambre for measuring the basis, and known as the *Règles de Borda*, were made, not by Borda, but by Lavoisier. The subsequent computations only were made by Borda. Lalande has expressly stated that the work of preparing them was executed by Lavoisier and Borda, but that the construction of the measures of platinum and brass, forming metallic thermometers, and of the comparing apparatus used, was carried out under Lavoisier's directions. The published report upon the construction and verification of these measures in 1792 is contained in the "Base du Système Metrique," vol. iii. p. 313. It was drawn up by Borda, but Lavoisier's name is not mentioned in it.

Another very important part of the work, the determination of the weight of a cubic decimetre of water, was carried out, in the first instance, chiefly by Lavoisier. This branch of the operation had been specially entrusted by the Committee to Lavoisier and Haüy. The necessary apparatus was constructed under Lavoisier's directions, and all the requisite measurements and weighings of the cylinder were made by Lavoisier and Haüy. Hitherto few details of the actual processes of this scientific determination have been given to the public, and the whole credit of determining the weight of a cubic decimetre of water, upon which the kilogram, the unit of metric weight, was based, has been attributed to Lefèvre-Gineau, to whom, in conjunction with Fabbroni, the work was entrusted after Lavoisier's death. In point of fact, Lefèvre-Gineau appears to have repeated, in the winter of 1798-9, all the observations made by Lavoisier and Haüy five years before, using the same instruments and obtaining nearly similar results.

The facts are stated as follows by Bugge, the Danish member of the Commission, in the thirtieth of his letters describing his visit to Paris, and published in 1800:—

"The final results of the labours of this special commission, consisting of Lefevre-Gineau and Fabbroni, to whom Van Swinden and Trallès were afterwards joined), was that the true kilogram, the weight of a cubic decimetre of water at its maximum density, or at 4° C., was 18,827 French grains of the old French pound, *poids de marc*.

"By the laws of August 1, 1763, and April 7, 1795, the kilogram is determined to be 18841 grains of the old French pound, *poids de marc*, in accordance with the experiments of Lavoisier and Haüy. This determination was adopted by the Chief Office of Weights and Measures in France, and the Standards have been hitherto made for the Departments accordingly. So that there now exist two kinds of kilograms, the legal or provisional, and the scientific or true kilogram. The difference between them is fourteen old French grains."

The difference is partly attributable to Lavoisier's determination having been made at the temperature of melting ice, instead of that of the maximum density of water adopted for Lefevre-Gineau's determination. The unit of Metric weight, the Kilogramme des Archives, appears to have been based on the later observations of Lefevre-Gineau, and to have been legalised by the law of Dec. 9, 1799, after Bugge's letter was written.

H. W. CHISHOLM

THE COMMON FROG*

VIII.

THE skeleton of the ankle as developed in the frog's class presents us with some characters, which, more than even those of the wrist, suggest the passage of the line of affinity directly from Batrachians to mammals, leaving both reptiles and birds on one side.

FIG. 51.

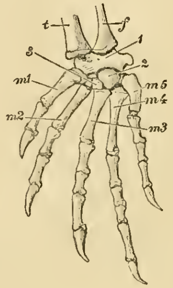


FIG. 52.

FIG. 51.—Right foot of Emeu. *a*, astragalus; d_2—d^4, second, third, and fourth digits; *m*. metatarsals anchylosed together except at their distal ends; *t*, tibia; t_2, distal tarsal element.

FIG. 52.—Left foot of a Monitor Lizard (*Varanus*). *f*, fibula; m^1—m^5, the five metatarsals, m^1 being that of the hallux; *t*, tibia; 1, astragalo-calcaneum; 2, cuboides; 3, ecto-cuneiforme.

In the first place we meet in the frog with certain extra ossicles in the inner side of the foot, which present the appearance of a broad rudiment of an extra digit on the inner side of the great toe. Now we find a structure very

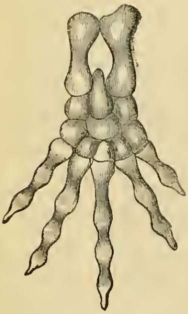


FIG. 53.

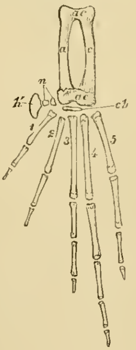


FIG. 54.

FIG. 53.—Skeleton of posterior extremity of an eft.

FIG. 53.—Bones of foot of Frog.—*a*, astragalus; *c*, os calcis; *ac*, united portions of these bones; *li*, extra ossicle of inner side of foot; *cb*, ossicle representing cuboid and other tarsal bones—1, 2, 3, 4, 5—the five metatarsals.

similar in form in animals remote enough from Batrachians, yet rarely do we find such in any intermediate kinds. Thus in certain tree-porcupines the ankle is furnished in like manner—another instance of the independent origin of strikingly similar structures.

* Continued from p. 150.

There are other matters, however, more important than this. It has been remarked that the wrist shows an

FIG. 55.—The Maholi Galago.

amount of resemblance to the same part in beasts which

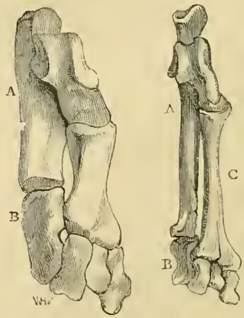


FIG. 56.—Elongated tarsus of Lemuroids. Left-hand figure, tarsus of *Cheirogaleus*; right-hand figure, tarsus of Tarsius. *A*. calcaneum; *B*, cuboides; *C*, naviculare.

is wanting in most reptiles and in all birds. The same

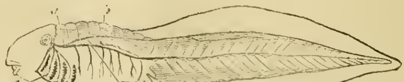
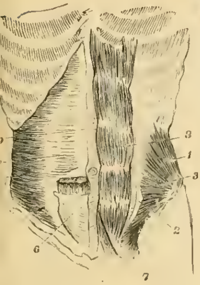


FIG. 57.—Tadpole of Bull Frog, partly dissected, to show the muscles of the tail and the branches of the 8th nerve or the *vagus*. *a*, great lateral branch giving off—*b*, a dorsal branch, and *c*, the lateral branch (or *nervus lateralis*); *d*, branches descending and passing along the branchial arches. The descending branches seen behind the branchial nerves on the side of the belly are not branches of the vagus at all, but spinal nerves, which come out from beneath the muscles and pass down under the *nervus lateralis*, and without having any communication with it.

observation may be repeated with far greater force as regards the ankle.

In all beasts, as in man, the motion of the leg on the foot takes place by means of a joint between the shin-bone of the leg and the small bones of the ankle; and though in some beasts (as in the orang) there is considerable power of motion between the first and the second row of ankle bones; this is small compared with the mobility of the foot and ankle taken together, upon the leg.



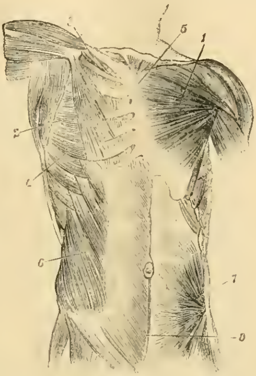


FIG. 58. FIG. 59.

FIG. 58.—Anterior muscles of the Trunk: the pectoralis major of the right side and the left external oblique being removed. 1, pectoralis major; 2, pectoralis minor; 3, subclavius; 4, serratus magnus; 5, internal intercostals; 6, external oblique; 7, internal oblique; 8, linea alba.

FIG. 59.—Deeper Abdominal Muscles—the external oblique being removed from the left side of the body, and the internal oblique and part of the rectus also, from its right side. 1, the internal oblique; its outer tendon (2) is cut and reflected from the outside of the rectus to show its deeper tendon (3), which passes within the rectus except towards the pubis; 4, transversalis; 5, its fascia; 6, sheath of the rectus—near the pubis, the conjoined aponeuroses of the abdominal muscles pass in front of that muscle; 7, pyramidalis; 8, rectus of left side, showing the tendinous intervals, or *lineæ transversæ*.

In all birds, on the contrary, not only is there no motion between the ankle-bones (as a whole) and the shin-bone, but the two rows of ankle-bones actually anchylose respectively with adjacent parts—the row nearer the leg coming to form one with the shin-bone; the second row coming to form one with the bones of the foot. Thus in birds the motion of the foot on the leg takes place not

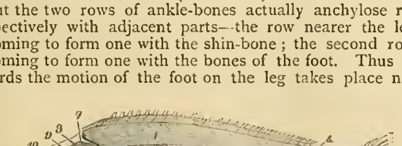


FIG. 60.—Superficial Muscles of the Perch. The fin-rays of all the fins are cut off. 1, great lateral muscle, showing the numerous vertical tendinous intersections slightly but variously inflected; 2, small superficial muscles inserted into the fin-rays of the dorsal and ventral fins; slender longitudinal muscle running (in the interval of the summits of the two great lateral muscles) between the dorsal and caudal fins; 5, similar muscle on the ventral margin, which also appears between the anal and ventral fins; 6, small radiating muscles of the caudal fin; 7, part of the great lateral muscle inserted into the skull; 8 and 9, elevators of the operculum; 10, elevator of the palato-quadrate arch; 11 and 12, muscular mass by which its contraction closes the jaws; 13, superficial muscles of the pectoral fin; 14 and 15, muscles of the ventral fin.

between the ankle and the shin-bone but between the two rows of ankle-bones.

The same thing to a less degree takes place in reptiles; the ankle-bones do not indeed *anchylose* with the shin-bone and foot respectively, but they nevertheless unite with those parts so firmly that motion takes place between the bones of the ankle and not between the whole ankle and the leg.

Now in the frog's class, *e.g.* in the order *Urodela*, we meet with a condition which is mammalian rather than reptilian or avian. Motion takes place freely between the leg and the whole tarsus. Moreover, the number and proportions of the ankle-bones themselves far more closely agree with the condition of the same parts exhi-

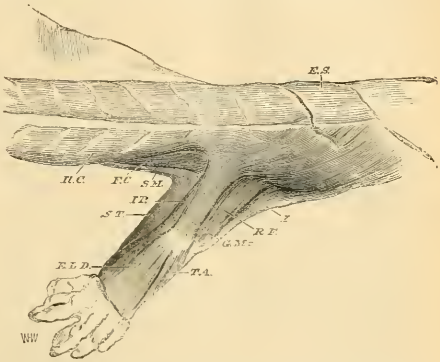


FIG. 61.—Superficial Muscles of Extensor Side of Leg and of parts of Trunk and Tail of Menopoma. *ES*, erector spinæ—directly continued into dorsal half of tail; *ELD*, extensor longus digitorum pedis; *FC*, femoro-caudal; *GMx*, probably rectus femoris; *I*, muscle resembling iliacus; *ILC*, ilio-caudal; *IP*, ilio-peroneal; *RF*, part of great extensor of thigh; *SM* and *ST*, muscles like the semi-membranosus and semi-tendinosus.

bited to us by certain beasts than it does with that which is possessed by any bird or of most reptiles.

The frogs and toads, however, differ from the *Urodela* and present us with a peculiar condition of the ankle-bones, in that the two which represent the bones of the first row are so greatly elongated as to give to the limb an additional segment—as it were two "long bones" more.

We should search in vain through every other order of the Batrachian class, through every known group of birds and reptiles, both living or fossil, to find any analogous structure. None of the lowest mammals, no marsupial, no rodent, no insectivorous or carnivorous beast, no hoofed mammal, presents us with anything of the kind. Nevertheless, at almost the other end of the series, in the very

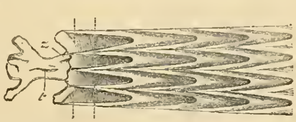


FIG. 62.—Diagram of Caudal Muscles of Right Side of Tail of *Iguana*, showing how the ventral mass resembles the dorsal part, and how the tendinous intersections of the muscular fibres are drawn out into cones. *N*, neural spine; *H*, hypapophysial spine; *z*, zygapophysis; *t*, transverse process; 1, dorsal series of cones; 2, upper lateral series of cones 3, lower series of cones; ventral series of cones.

highest order, that to which man himself belongs, we actually find a very similar development.

Amongst the very peculiar beasts which inhabit the island of Madagascar, there are certain small creatures, "Half-Apes," belonging to the genus *Cheirogaleus*, in which two of the ankle-bones are elongated in a manner similar to that of the frog. The same character is more marked in an African genus of half-apes (*Galago*), and still more so in a third half-ape (*Tarsius*), from the island of Banca. Now it is absolutely impossible to believe that a special genetic affinity connects together by a peculiarly

common descent, Half-Apes and Frogs! We are then driven to the conclusion that we have here again a striking similarity of structure in two instances which are quite independent in their origin.

That the power of rapid and prolonged "jumping" does not carry with it as a necessary consequence the elongation of ankle-bones, is demonstrated by the fact that in other animals which, to say the very least, jump no less than do these half-apes—as for example in the kangaroos, jumping shrews, and jerboas—it is not bones of the ankle but bones of the foot proper, which take on an augmentation in length.

The Muscles of the Frog

We may now pass to the consideration of some points exhibited by another set of structures—namely, the muscles.

The muscles of an animal constitute its flesh, which as the most ordinary inspection shows us, is composed of different portions of soft fibrous substance separated from one another by interposed layers of membrane. Each such portion, so separated, is a muscle, and is attached at its two ends to two parts (bones or what not), which may be adjacent or more or less distant. The fibres which compose it have the remarkable property of contracting under certain conditions, and, when contracted, the whole muscle is shorter and thicker than before, and the two parts to which it is attached become consequently approximated.

Muscles may be large expanded sheets of flesh (as in the abdomen) or long and more or less narrow, as in the limbs.

Muscles are said to be "inserted," or to "take origin from" the parts to which they are attached, and they may be so inserted either by their own muscular fibres or by the intervention ot a tough membrane or a dense fibrous cord called a "tendon."

All the motions of an animal are produced by means of the contractions of its muscles pulling the bones, which act as so many levers (of different kinds according to circumstances), and so effecting locomotion.

These muscular contractions are in life produced by the agency of certain of the nerves proceeding from the nervous centres, *i.e.* from the brain and spinal marrow, and which carry an influence outwards to the muscles. Other of the nerves so proceeding convey an influence inwards to the nervous centres from an irritated portion of the body's surface.

The muscles, however, especially in the frog may, for a time, be made to contract after death by direct irritation of the nerves themselves.

After the skeleton, it is the muscular formation of the body which mainly determines its general form and aspect, though occasionally—and often in the Frog's order—the voluntary inflation of the lungs will alone produce a vast modification in an animal's appearance.

The curious and grotesque resemblance which exists between the figure of the adult frog and that of man has been a common subject of remark. It may then be less surprising to some to learn that there is a great degree of resemblance between the muscles of the Rational and of the Batrachian animals; though the much greater gulf which separates the Batrachian than the Reptilian class from mammals may lead others to anticipate a greater divergence than in fact exists.

The frog, however, in its immature stage of existence, is widely different from the adult in its muscular (or myological) furniture, and this from one obvious reason.

"Muscles" are, as we have shown, *par excellence*, "organs of motion," and the motions of the tadpole are essentially different from those of the frog.

The frog, as all know, progresses on land by jumps, and swims through the water by a series of movements which are in fact aquatic jumps. This action is familar to many of us, not only from observation but also by imitation (the frog being a swimming-master given us by nature), but it is none the less a mode of swimming which is very exceptional indeed.

The tadpole progresses through the water in a very different manner, namely, by lateral undulations of its tail, which is the usual mode of swimming among vertebrate animals—that made use of by sharks and porpoises, as well as by the overwhelming majority of fishes.

Studying the life-history of this one animal, then, we become acquainted with a process of direct transition from the condition of a fish to that of a quadruped, as regards a most important group of organs.

In ourselves, the back is provided with muscles which extend along its length in a complex series of longitudinal divisions, from the middle line outwards.

The abdomen of man is inclosed and protected by successive muscular layers laid one upon another, the fibres of the successive muscles being differently directed. Thus we have (1) the external oblique (the fibres of which pass obliquely downwards and backwards, (2) the internal oblique (the fibres of which pass obliquely downwards and forwards), (3) the *Transversalis* (with transverse fibres), and (4) the *Rectus abdominus* (situated in the middle line of the body, and with fibres directed antero-posteriorly).

In the frog we also meet with the vast sheets of muscle with oppositely directed fibres (the external and internal oblique) and with a median, antero-posteriorily directed rectus muscle.

A very different condition exists in fishes, where there is indeed a median antero posteriorly directed rectus, but where the abdomen and tail are encased with a mass of muscular fibres not arranged in superimposed sheets, but as a series of narrow segments separated from each other by layers of membrane. The edges of these membranous layers, when the skin is removed, appear as a successive series of undulating lines proceeding from the back to the belly.

Now the tadpole exhibits a muscular condition (Fig. 56) quite similar to that of the fish, and in the great persistent larva the axolotl, we find no truly oblique abdominal muscles, but only as it were a hypertrophied rectus.

In other species of the frog's class which retain a tail throughout life, the marked superimposed lamellæ are distinctly developed, but more or less distinct traces are also retained of the successive membranous partitions separating the muscular segments of both the dorsal and ventral regions.

Another stage of development may be detected in the tail-muscles of certain reptiles.

Here the membranous partitions have become drawn at short intervals from above downwards out into a formal shaped condition, so that the muscular fibres enclosed, assume the forms of cones. Moreover, the apices of the membranes enclosing the cones, become denser in substance, and so modified into ligaments.

We come thus to have a key to the process of development, by which the muscles of the back may be conceived to have arisen.

The muscles of the back may be conceived as having arisen through increasing obliquity, conical prolongation, and partial detachment (from muscle) of the separating membranous lamellæ; the produced ends becoming condensed with firm tendons directed more or less obliquely forwards.

The muscles of the abdomen may be conceived as having arisen through atrophy, in that region, of the separating membranes and subsequent splitting up of the muscular mass into super imposed sheets of differently-directed fibres.

This filiation between piscine and mammalian myology could hardly have been detected but for the remarkable series of gradations which the frog's class exhibits—

gradations both between species, and between different ages and conditions of one and the same species.

ST. GEORGE MIVART

(*To be continued.*)

BEES VISITING FLOWERS

ON the cliffs at Llwyngwril, near Barmouth, *Lathyrus sylvestris* grows in large patches, and is freely visited by humble-bees. Where a plant grows in considerable masses, a great number of bees are naturally attracted, and the competition among them becomes severe. In this case the flowers are not sucked in the usual manner, but the bees bite holes through the corolla, and obtain in this way illegitimate access to the honey. Hermann Müller has shown that when flowers grow in any quantity, they are so diligently worked at by the bees that only comparatively a few contain any nectar; it is therefore important for the bees to find out as quickly as possible whether a flower is worth anything or not. These holes, bitten through the corolla, enable the bees to visit the flowers more quickly, and are thus a great saving of time. He also says that, although the bee which first gnaws the hole loses time in doing so, yet the advantage of being able to get the honey from the young and as yet unvisited flowers, fully makes up for the loss of time.

In *L. sylvestris*, as in many Leguminosæ, the honey is secreted within a nectary formed by the filaments of nine of the stamens soldered together. The trough-like cavity thus formed is covered in above and converted into a tube, by the tenth stamen. But at the base, where the trough enlarges into a bulb, the stamen is not wide enough to cover it, so that it leaves a pair of holes piercing the tube one on each side. It is through these "nectar-holes," as they are called, that the bee, after passing its proboscis down the tube of the corolla, or, as in the case already mentioned, through the holes bitten at its base, gains entrance to the staminal tube, in its search for nectar.

In *L. sylvestris* the hole is gnawed through the tube of the vexillum, close to the edge of the calyx, and exactly over the left nectar-hole. (Throughout this paper I mean the right and left of an observer looking at the front of the flower.) I think the reason of this constant choice of the left side of the corolla is that the left nectar-hole is usually somewhat larger than the right. I found this to be the case in sixteen out of twenty-four specimens of the wild *L. sylvestris*, and in eleven out of sixteen in the garden variety (the Everlasting Pea). It is difficult to say how the bees have acquired this habit. Whether they have discovered the inequality in the size of the nectar-holes in sucking the flowers in the proper way, and have then utilised this knowledge in determining where to gnaw the hole; or whether they have found out the best situation by biting through the vexillum at various points, and have afterwards remembered its situation in visiting other flowers. But in either case they show a remarkable power of making use of what they have learnt by experience.

The united filaments not only form the nectary, but also a sort of casing in which the ovary is enclosed; and out of which the growing pod has to break its way as it increases in size. In *Vicia cracca* it does so by lifting up the tenth stamen, but in most *Lathyri* the filament is too stiff to allow of such a movement, and the growing pod was to squeeze its way between it and the edge of the trough formed by the nine united filaments. In doing this it enlarges and at last splits open one of the nectar-holes. In *L. sylvestris* the left nectar-hole, usually the larger of the two as I have before said, is almost always the one which is thus opened. In *L. pratensis*, on the other hand, where the nectar-holes are equal, the pod emerges indifferently to the right or left of the tenth stamen.

I am inclined to believe that the want of symmetry in the growth of the pod and the inequality in the size of the nectar-holes are in some way correlated, and that both are connected with a third asymmetrical character in the flower of this species. In most Lathyri the brush of hairs on the pistil is directed straight backwards towards the stalk of the flower. This is the case with *L. pratensis*, and also with the flower-buds of *L. sylvestris*, while very young; but, as they get older, the pistil rotates on its own axis, so that, in the adult flower, the brush is turned towards the left. I have often watched the bees sucking the flowers of the Everlasting Pea in the ordinary way, and have observed that the pistil, in consequence of being slightly bent as well as twisted on its own axis, emerges from the keel on the right side of the bee. The function of the brush is, as Mr. Farrer has shown (NATURE, vol. vi. p. 479, 1872), to sweep the pollen out of the keel, so that it may be transferred to the bees visiting the flower, and may be in this way subservient to the cross-fertilisation of the species. I believe that the twisting of the pistil helps to ensure this end, since in consequence of the brush being turned towards the left it rubs against the bee and smears it with pollen. Thus the mechanism for ensuring the cross-fertilisation of the plant is made more complete. At present the supposition that the asymmetrical character of the pistil is connected with the above described peculiarities and in the growth of the pod, is merely a conjecture.

These facts have a certain bearing on a peculiarity in the structure of the staminal tube in *Phaseolus multiflorus*, the Scarlet-runner. This flower, in common with many Leguminosæ, has a pair of nectar-holes at the base of its staminal tube; but the tenth stamen differs, as far as I know, from that of any other Leguminous plant, in possessing a little flap which projects from its upper surface just in front of the nectar-holes, and which almost completely blocks up the tube of the corolla. Mr. Farrer supposes (*loc. cit.* p. 480) that by pressing with its proboscis against this flap the bee levers up the tenth stamen, and in this way passes its trunk into the staminal tube. If this occurs at all, it must be like gnawing holes in the corolla, an illegitimate way of treating the flower, since it is impossible to believe that it should have well developed, but totally useless, nectar-holes. I believe the true function of this curious little flap to be as follows:—In many Papilionaceæ, Lathyrus for instance, the insect visiting the flower rests on a platform which is formed of the carina and the expanded alæ, but in the Scarlet-runner this platform is made up by the alæ alone, the carina being tightly coiled into a spinal close up to the entrance to the tube to the corolla. The alæ are attached, one on each side to the proximal part of the carina, so that when an insect rests on them, its weight bears on the carina, and causes the pistil which is contained in it as in a sheath to be forced out. The direction of movement of the pistil is downward and to the left, so that a bee resting on the expanded alæ and pushing in its head to the left of the coiled-up carina would come in contact with the pistil as it darted out of its sheath; but if the insect went to the right of the coil it would escape the pistil altogether. The end of the pistil is covered with hairs, and performs the same function as the brush in Lathyrus in smearing the bee with pollen. It is, therefore, of great importance for the cross-fertilisation of the plant that the bees should go to the left of the coil. As a matter of fact they all but invariably do go to the left; the very few bees that I have seen going to the right appear dissatisfied and unable to find their way into the corolla. Now to reach the nectar-holes the insect's proboscis has to pass down a tunnel formed above by the tube of the vexillum, below by the upper surface of the tenth stamen; the entrance into this tunnel is a narrow

archway leaning towards the left, *i.e.* having its highest point to the left of the middle point of its base. As before stated, the flap almost blocks up the tunnel, so that to get to the nectar-holes the proboscis must pass over the top of the flap, and must therefore travel along the highest part of the tunnel, but since at the entrance arch the highest point is to the left, the bee finds it necessary to go to the left of the coiled-up carina to reach the nectar-holes in the easiest way. If this view of the function of the flap, when considered in relation with the disposition of the pistil, carina, &c., be correct, it adds another instance to the long list of mechanisms for ensuring the cross-fertilisation of flowers by means of the visits of insects. FRANCIS DARWIN

THE FRENCH MUSEUM OF PHYSICAL AND MECHANICAL SCIENCE

THE following official report of General Morin, the director of the Conservatoire des Arts-et-Métiers, Paris, to the Minister of Agriculture and Commerce, which we take from the *Journal of the Society of Arts*, furnishes some interesting details as to the present condition of this magnificent educational establishment, the like of which, dealing as it does with experimental and mechanical science, is entirely wanting in our country, although in the British Museum, the student of Natural History finds all he needs.

"The total number of persons who attended the lectures of the fourteen professors amounted in 1872 to 135,443, at 559 lectures, or in the proportion of 241 to each lecture. The smallest number of lessons given by any one professor was 40, from the opening in the commencement of November, until the last days of April. The total number of persons attending is smaller than in preceding years, which is explained by the decrease of the floating population of Paris. This year, as in all others, the decrease commenced when the days got longer, and work kept the people in the workshop.

"I would here limit this report if I did not think it necessary to add a few words upon the means of instruction which the Conservatoire offers to the public and the working-classes of all ranks.

"This establishment, as is known, owes its origin to the illustrious Vaucanson, inspector of factories, who, after having made at the Hotel du Montagne, Rue de Charonne, a collection of machines, instruments and tools, for the instruction of workmen, presented it to the Government, on the sole condition that its original purpose should be maintained. Louis XVI. accepted the gift by an act of council, and the illustrious Vandermonde, member of the Academy of Sciences, was named administrator and conservator of this first industrial museum. Later, by the decrees of the 15th and 18th of August, 1793, the Convention created a temporary commission of arts, to put a stop to the dispersion of objects of art, science, and industry. This commission succeeded in collecting a large number in a depot formed at the Hotel d'Aiquillon, Rue de l'Université. The value of these collections soon after determined the Convention, upon the report of Gregory, to make a decree, the 19 Vendémaire, year 3, that there should be formed in Paris, under the name of Conservatoire des Arts-et-Métiers, a public collection of machines, models, tools, drawings, descriptions, and books of all kinds of arts and science, the use of which should be explained by three lecturers attached to the establishment.

"It may be well to mention that the title of 'demonstrateur' or lecturer, often corresponded to that of professor, and that the professors of the Jardin des Plantes remained long after they had commenced giving regular courses. However that may be, the organisation of the Conservatoire, which was checked by several circumstances, was again mooted by Alquier at the Council of the Ancients, on the 27th Nivose, year 7, which urged the great advantage of such an institution to workmen, by saying that it is of more use showing them articles than merely s eaking of them. It was not, however, until the 12th Germinal, year 7, that the buildings of the priory of St. Nicholas of the Fields were put into the possession of the members of the Conservatoire, who were then composed of Le Roy, Conti, Molard, and Benvelot, designer. The names of these savants, and that of Montgolfier, who soon after replaced Le Roy, did not allow of any comparison being made between the functions of these lecturers and those who are differently named now-a-days.

"At length, in the year 8, all the models and machines belonging to the State were definitively removed to this building, and formed collections destined solely for the instruction at sight. The functions implied by the title of lecturer were never exercised, and this will easily be believed when it is said that the numerous visitors who are attracted by the rich collections sometimes amount to 200,000, which makes all verbal explanation on the spot impossible. But that which is not possible to do for the public has been for a long time afforded by the Conservatoire to persons who are really desirous of information. A complete and methodical catalogue has been made out and published, and to it are added, from time to time, all new acquisitions; this has already passed through four editions. The galleries have been systematically classified, a guide has been placed in each, who, if he cannot give any practical explanation, can at least show where such and such a model is to be found, each of which is ticketed and numbered, both in the catalogue and in the inventory. Should an engineer or a workman wish to examine separately a machine or machinery, a study card for the necessary time is given to him. Or should any more complete information or explanation be required, either the curator of the collections, the under-director, or the director, is always ready to furnish them, their office being freely open to all.

"The staff in charge of the collections consists of the conservator, an assistant conservator, and of fourteen chosen guardians, who, for the most part, are picked from old non-commissioned officers or soldiers. The wish to give explanations by these, even with the aid of written details for the 9,000 models or articles which are there, would lead to great errors and confusion by a zealous but a badly instructed staff. In asking that popular conferences, such as are held at the Polytechnic Institution of London, should be introduced here, account has not been taken of the great difficulties which stand in the way, and greatly exaggerated ideas exist as to their value.

"It is not by common and vulgar explanations that the principles of Science can be spread amongst our workmen, and the facts and experience which are so necessary; their minds and intelligence are developed enough, so no fear need be had to speak to them on difficult scientific questions, if it is done with wisdom.

"All the professors who have followed this mode of teaching have often been convinced, on meeting some of their old hearers in workshops, that what may be termed the knowledge of truth and scientific principle has more deeply entered into their minds than into that of scholars of more celebrated schools. Hence it was not without reason that, in 1819, a decree of the king, brou ht about by the respected Dean, M. le Baron Charles Dupin, added to the instructions at sight given by the collections, that of oral instruction in the amphitheatres, by professors chosen from among the ranks of science. The number of chairs, at first only three, is now fourteen, and the half of the professors are members of the Institute, who diffuse and popularise science, the progress of which they promote by their labours. This instruction, unique of its kind in Europe, only takes place during winter; it is free

to all without any condition for admission or any examination, and the number of persons who have frequented it during the last few years amounts to from 150,000 to 180,000.

"To the honour of workmen it must be said, that a more attentive audience can nowhere be found; never does the slightest disorder arise, and I am happy to say that during the unhappy events which have taken place in France, the Conservatoire was always respected, and underwent no disturbance or invasion.

"But if we think the part of casual lecturers in the galleries useless, and if we are convinced that the real duty of the Conservatoire des-Arts-et-Métiers consists in the classification, maintenance. and increase of its collections, and in the teaching of the applied sciences, which it gives on such a large scale, we also believe that the Government should attach great importance to that teaching, which, during twenty years, we have developed under the name of technical education, and which has produced such good results in several of our great industrial centres.

"Your department pursues the realisation of this wish, and we hope it will be able, with the aid of the resources placed at its disposal by the National Assembly, to develop more and more this practical instruction, which, beginning at the primary school, gradually enables men, according to their intelligence and love of study, to rise from the lowest to the highest grades of society."

NOTES

WE have with much regret to record the death of Mr. Edward Blyth, on December 27 last, in his sixty-fourth year. Of Mr. Blyth it may be said that he was a Zoologist in the truest sense of the word, and his practical knowledge of the birds and mammals of India and the surrounding countries was probably greater than that of any living naturalist. Up till 1840 he devoted himself to the study of the ornithology of the British Isles, and in that year appeared an English translation of Cuvier's "Regne Animale," in which the mammals, birds, and reptiles were edited by him; many of his own notes suggesting modifications in the then existing systems of classification, have been subsequently fully substantiated and adopted. For twenty-two years after this date Mr. Blyth held the post of Curator to the Calcutta Museum of the Asiatic Society of Bengal, during which time, and in conjunction with Dr. Jerdon, he did more than anyone to advance the study of Natural History in India, and to improve the value of the collection he controlled. After a short visit to Burmah, during which he did much good to zoological work, he returned to England in 1863, since which time he has contributed many valuable papers to ornithological and other journals, and under the very appropriate signature "Zoophilus," a large number of excellent articles to the *Field*. With an unparalleled memory Mr. Blyth combined exceptional powers of observation and a genuine enthusiasm for natural history, which is but rarely seen; these made his impromptu observations and opinions of more than ordinary value, and no one was more willing than himself freely to give all information at his command, towards the assistance of any fellow-worker, or the elucidation of any difficulty in his favourite subject.

DR. FRANCIS C. WEBB, editor of the *Medical Times* and *Gazette*, died suddenly on the morning of December 24 last, at the age of 47 years.

AT a preliminary meeting of the Varley Testimonial Committee, held on November 20, it was resolved to recommend that a Memoir of the late Cornelius Varley, illustrated with a Photographic Portrait, should be prepared and issued under the superintendence of the Committee, and that a copy be presented to his family, in token of the high estimation in which he was held; and further, that some Memorial be erected to his memory at the place of his interment.

TELEGRAMS from Naples of the 3rd and 4th inst., state that Prof. Palmieri announces a severe eruption of Vesuvius to be imminent. A rumbling noise is audible from the mountain, and although fire has not been seen in the interior of the craters, the density of the smoke indicates the proximity of fiery matter.

MR. MANLEY HOPKINS, Consul-General at Hawaii, having written to the *Times* that he had discovered in the Samoan Islands a living specimen of the Dodo, believed to have been extinct a century ago, Prof. Owen wrote to the same paper that the bird referred to is the dodlet. "The extinct dodo of the Island of Mauritius was about six times bulkier. Coloured figures of both birds—that of the dodo, copied from paintings by the Dutch artists, who saw the living bird in the time of their Stadtholder Maurice, that of the dodlet from the bird living in the Zoological Gardens about ten years ago, with the skeletons of both didus and didunculus are given in my work on the Dodo (quarto)."

A VERY suggestive anatomical point has been made out by Sir Victor Brooke, respecting the tarsus in certain of the *Cervidæ*. He finds that in the species of the genus *Cervulus* (the Muntjacs), the tarsus, instead of consisting of a naviculo-cuboid bone, together with two separate cuneiform bones, has the outer of the two cuneiform masses anchylosed to the naviculo-cuboid mass, to form a single bone, leaving the minute internal cuneiform free. In a very young specimen of *Cervulus muntjac* the cuboid was free, and the naviculare anchylosed to the outer cuneiform bones, showing that the tendency to blend in this direction is greater than that of the naviculare and the cuboid to combine. This same peculiarity is also found in the Pudu Deer of South America.

THE question as to the limit of capability of the microscope is investigated by Prof. Abbe, of Jena, in a recent number of Max. Schultze's *Archiv*; and he is led by a series of physical deductions to the remarkable result, that this limit is already as good as reached by our best microscopes, and that all hope of a deeper penetration into the material constitution of things, than such microscopes now afford, must be dismissed. Experiment and theory agree in showing how the changes wrought by diffraction of light passing through fine structures, whose elements are so small and near each other as to call forth this phenomenon, are such as to prevent the object being imaged *more geometrico*. Thus it may happen, on the one hand, that different structures give the same microscopical image, and, on the other, that like structures give different images. Consequently, while objects of the kind (systems of fine lines and the like) may appear ever so distinct and well marked in the microscope, we are not entitled to regard such appearances as of morphological significance, but merely as physical phenomena, from which nothing further can certainly be inferred than the presence of such structural conditions as are capable of producing the diffraction effects obtained. The remark has notable applications to many of the microscopical researches on markings of diatoms, and on striated muscular fibre. And it affects not merely the morphological relations of the objects, but the deductions, made from microscopical observation, as to properties (such as differences of transparence, colours, polarisation, &c.). The author lays down the following principle as basis for determination of a limit:—By no microscope can parts be distinguished (or the marks (*Merkmale*) of a really present structure perceived), if they are so near to each other that the first bundle of light rays produced by diffraction can no longer enter the objective simultaneously with the undiffracted cone of light. Prof. Abbe has also recently described a new illuminating apparatus for the microscope,

formed of a condensing system of two unachromatic lenses, which are fixed in the stage of the microscope, and transmit the rays from the mirror below; the purpose being that the object (immediately above the upper lens) may be illuminated by light from a great many different directions.

WE have received from the Science and Art Department "Extracts from the Reports of the Professional Examiners in Science on the Examinations of May 1873." The reports are most thorough and painstaking analyses of the results of the examinations, and give one the conviction that there is little chance for candidates who are not masters of the subjects they profess. On the whole the examiners report unfavourably on the great bulk of the candidates, and it would be for the good of future candidates, especially such as expect to be able to pass by cramming, that these reports should be brought under their notice.

AN observation of particular interest has been made by Mr. C. S. Tomes (*Quarterly Journal of Microscopical Science*). In studying the development of the teeth of the Armadillo (*Tatusia peba*), he finds, contrary to what would have been expected, that in their earliest stages, the first indications of their differentiation are manifested by the formation of an "enamel organ" as in those of higher mammals; whereas in the teeth themselves there is no enamel present, as is well known. Another peculiarity is that behind each primitive tooth a second smaller sac is seen, which corresponds in all its relations with the germ of the permanent tooth in other mammalia. Consequently, *Tatusia peba* at least, amongst the *Dasypodidæ*, is not monophyodont, as has been previously stated by Rapp, Gervais, and Flower, from which it may be inferred that the Edentata as an order, must have descended from a truly diphyodont type, and have become subsequently specialised.

THE U.S. Exploring Expedition under Lieut.-Col. Wheeler has now brought its work nearly to a close, having surveyed about 100,000 miles of territory in Southern Colorado, Southern Utah, Eastern Arizona, and Western New Mexico. The entire geological formation of all this vast country has been carefully studied, and from this study and the survey, accurate maps will be drawn this winter. Over 1,000 species of plants have been collected in Southern Colorado, and over 500 in Arizona and New Mexico. Some plants, supposed to have medical properties, or such as might prove of technical use, have been taken along for investigation. For example, the muskal, which is used by the Indians as a principal article of food, is tasteless when raw, but upon cooking, by being embedded in hot coals, turns sweet and is like the best honey. Attention was also paid to the geographical distribution of plants, and many interesting points elucidated. With regard to the fauna, more than 800 bird skins have been collected and stuffed by one of the naturalists, many of them very rare and beautiful. Some very rare reptiles have also been obtained, among which the gilamonster forms a peculiar feature. This animal, which is repulsive in appearance to many, and generally believed to be exceedingly poisonous, is quite harmless and very interesting. Some new species of rattlesnakes have been found. Very few butterflies have been seen, but bugs and beetles were collected in great quantities. The waters of the different streams were searched for the finny tribe. Skulls of bears and mountain lions and other specimens of the animal creation are included in the list of collections. With regard to the Indians, many interesting facts have been collected; among others the vocabularies of seven languages — the Apache, Navajoe, Tehua, Gohun (Tonta Apaches), Waltoa (Jemes), Isletta, and Moquis.

WE notice with considerable satisfaction from the statistics published in the *Publishers' Circular* that the number of scientific works issued during the past year in England bears a very large proportion to other classes and to the whole number of works published. The number of new books and new editions published during 1873, including 242 importations from America, is 4,991. Of these, 588 are classed under the head "Arts, Sciences, and Historical Works," by which, we presume, is meant Science theoretical and applied and the history of Science, as there are other heads under which history and the fine arts more appropriately come. This number, 588, is inferior only to that of works of fiction, and theological and religious works, the former numbering 831, and the latter, second in the list for the first time, 770. Were we to class "Voyages, Travels, and Geographical Research," 283 volumes, among scientific works, the number would be 871, exceeding even that of works of fiction, not to mention theology. The number of *new* books in Arts, Science, and Geography is 593.

DR. E. REGEL, Director of the Botanical Gardens, St. Petersburg, has published a work on the species of vines met with in North America, Northern China, and Japan, in which he discusses the long-controverted question of the origin of the vine. According to him, the cultivated vine, which forms our vineyards and produces our wines, is not a distinct and separate botanic species; it is a hybrid of two species, belonging equally to the genus Vine, viz. *V. labrusca* L., and *V. vulpina* L. The former of these two species is met with in a wild state in Northern America, in Japan, in Mantchuria, and in the Himalayas. Its leaves have their inferior face covered abundantly with a cotton-like down. The second species, which grows naturally in the same countries, has upon the inferior face of its leaves only small hairs, short and very stiff upon the nerves. The first of these two species has furnished the two most remarkable varieties of American vines, the *Catawba*, much cultivated for the production of wine, and the *Isabella*, the grape of which, sought after for the table, has a perfumed flavour and peculiar odour, agreeable to some, but disagreeable to others.

ON Thursday evening last, by invitation of the Committee of the Post Office Library, a large company assembled in the galleries of the new Post Office buildings, St. Martin's-le-Grand, in commemoration of the reopening of the library. In the south-west gallery there was arranged a museum of early telegraphic instruments and appliances, the latest improvements in the science of telegraphy being illustrated by the mode of transmitting news to, and receiving messages simultaneously from, nineteen of the larger towns of the kingdom. The new process of despatching messages simultaneously in opposite directions through a single wire by the instrumentality of Mr. Stearn's invention was worked throughout the evening, communication having been effected for the purpose with Southampton. In the central gallery there were wires working in direct communication with Australia, India, Teheran, America, St. Petersburg, Paris, and Berlin, the process being rivalled in interest by the action of the pneumatic tubes which connect the Central Telegraph Station with the principal offices for the collection and delivery of messages in the metropolis. There was also in this gallery a working model of the travelling post-office, with the apparatus for the receipt and delivery of the mails while the train is in motion. In the course of the evening the Postmaster-General briefly addressed the company, sketching in outline the history of the English postal service. The Post Office Library was founded in 1859 for the benefit of the clerks and other officers of the Post Office. It was started by subscription among the employées, but has received large donations of books from authors, publishers, and the public. The library contains at present 2,500 volumes, of which we are glad to hear a fair proportion consists of popular scientific works, which it is hoped will be shortly increased.

MESSRS. LOVELL, REEVE, AND Co., have in the press a volume on St. Helena, comprising a physical, historical, and topographical description of the island, with its geology, fauna, flora, and meteorology. The author is Mr. J. C. Melliss, C.E., F.G.S., F.L.S., late Commissioner of Crown Lands, Surveyor and Engineer of the Colony.

THE *Scotsman* reports that a piece of gold-bearing quartz has been found in the island of Bute.

BEE-KEEPING has become a vocation or avocation of so much importance in America that there actually exists a "North American Bee-keepers' Society," which, like more important associations, meets yearly in one of the towns of the States. This year the society met at Louisville and continued its sittings for several days. Among the papers read was one by General D. L. Adair against the practice, common among apiarians, of clipping the wings of the queen, the paper showing a very considerable acquaintance with the structure of the bee.

THE *Times* takes the following from an American paper, and asks "Why not in London?":—"In Pittsburg, Pennsylvania, an electric clock has been established to move the hands of seventy different clocks, scattered all over the city. The motive clock is powerful, and has a pendulum composed of hollow coils of copper wire. These swing to and fro over the poles of horseshoe magnets, and every time they pass from one pole to the opposite a current of electricity is called up inductively in the coils, flows up the wire, and then to the seventy dials, giving a current of an opposite nature at each swing. Behind each dial is an astatic permanent magnet, suspended on a pivot, and surrounded by a coil of wire, and it rotates under the electric influence from the wires. A small weight may be used to each dial if the hands are heavy, and the pivoted magnet may merely regulate the time. Of course every clock will be exactly alike, and will run with very little attention. To prevent the pendulum of the motive clock from moving too fast by the increase in the length of vibration of the pendulum, a magnetic bridling apparatus is attached."

A LETTER appears in the *Times* of the 30th instant, from a correspondent with the "Livingstone East Coast Expedition," dated Mdaburu, Ugogo, Central Africa, July 15, and is principally occupied with a description of the many annoyances to which the expedition was subjected.

THE finest kitchen garden in France is that of Versailles, which belongs to the State, and brings in a yearly revenue, taking good and bad years together, of about 20,000f. The Assembly has determined to apply this valuable property to the formation of a model market garden and school of horticulture. The details of the institution are not yet arranged, but it is presumed that it will be self-supporting, and that it will render valuable assistance in the development of horticultural science in France.

THE additions to the Zoological Society's Gardens during the past week include two Violaceous Plantain-cutters (*Musophaga violacea*) from W. Africa, purchased; two Senegal Touracous (*Corythaix persa*) from W. Africa, presented by Mr. Hawkins; two Chinese Storks (*Ciconia Boycei*) from China, presented by Mr. R. B. Boyce of Shanghai; a Grivet Monkey (*Cercopithecus lalandii*) from W. Africa, presented by Mrs. Couteam; a Coati (*Nasua nasica*) from S. America; three Derbian Screamers (*Chauna derbiana*) from Columbia; a Chinese Water Deer (*Hydropotes inermis*); a Common Otter (*Lutra vulgaris*), British, deposited; two Black-tailed Hawfinches (*Coccothraustes melanurus*) from China, purchased.

ON THE SPECTRA OF COMETS*

THE spectrum-analytic method of examining the light from comets has only been applied hitherto to comets of weak light; yet the observations are fitted to extend considerably our knowledge of these objects. The spectra of all the comets that have been examined have consisted of a few bright lines or bands of light, and a very faint continuous spectrum. The chief part of the comet's light appears, accordingly, to be proper to it, and is probably from glowing gas, while the remaining portion is reflected sunlight.

Among the brightest comets which have appeared since the introduction of spectrum analysis are those of Brorsen (I. 1868) and Winnecke (II. 1868). The spectrum of the former consisted of three bright bands, whose position Huggins sought to determine with great accuracy; but he found no coincidence with the spectral lines of any terrestrial substance. The spectrum of Winnecke's comet, also examined by Huggins, was somewhat different, but similarly consisted of three bright bands (in addition to the continuous spectrum always present), which were sharply defined on the side nearest to the red end of the spectrum, but diffuse on the other. A comparison of the comet's spectrum with that of olefiant gas showed striking similarity between them; and Huggins was able to establish, with some certainty, a coincidence of the three bright bands. The expressed opinion that the material of this comet might be hydrocarbon found general acceptance; and the inference has been extended to other comets, so that it has been taken as demonstrated, that the comets are formed of hydrocarbons. (Dr. Zenker in *Astr. Nachr.* Nos. 1890 to 1893.)

I will now give a summary of all the observations known to me of cometary spectra, from which it will be seen how far the conclusion in question is warranted.

1. The first comet examined by spectrum-analysis is the Comet I. 1864. Donati found its spectrum to consist of three bright bands, which (if one may judge from the figure in *Astr. Nachr.* No. 1488) do *not* coincide with those of the hydrocarbon spectrum.

2. Huggins and Secchi observed Tempel's Comet I. 1866, and got from it a weak continuous spectrum, in which Secchi saw *three* bright lines, Huggins only *one* The line seen by both was the brightest, and situated in the middle between *b* and *F* of the solar spectrum; accordingly *no* coincidence with the hydrocarbon spectrum.

3. In the spectrum of Comet II. 1867, the continuous spectrum was relatively so strong that Huggins found it difficult to detect bright lines. "Once or twice," he says, "I suspected the presence of two or three bright lines, but of this observation I was not certain. The prismatic observation of this faint object, though imperfect, appears to show that this small comet is probably similar in physical structure to Comet I., 1866." In this case, again, probably no hydrocarbon.

4. Brorsen's Comet I. 1868, was observed by Huggins and Secchi. Both observed three zones of light; the middle one being brightest, and lying in the green; while its brightest part was somewhat less refrangible than the brightest line of the air spectrum (wave-length = 500·3 mill. millim.). From this observation, and the determination of the position of the other two faint bands, it appears that the comet spectrum was *neither* similar to that of *nitrogen*, nor to the *hydrocarbon spectrum.*

5. Winnecke's Comet II. 1868, was also observed by Huggins and Secchi. The measurements and direct comparisons of Huggins gave an agreement of the cometary spectrum with that of carbon in olefiant gas. From Secchi's measurements it appears, that the sharply defined side of the middle band (towards the red end), nearly coincided with the line-group *b* of the solar spectrum; at which part also the beginning of the middle band in the spectrum of hydrocarbons is situated.

6. Comet I. 1870 was observed by Wolf and Rayet; the spectrum consisted of three bright bands, whose position, however, was not accurately determined.

7. Comet I. 1871 was observed by Huggins and myself. Huggins found *three* bands, I only *two*. The measurements of the bands observed in common agree well; the spectrum appears to be identical with that of Brorsen's comet.

8. Comet III. 1871 (Encke) was observed by Huggins three days, by Young four, and by myself six; it showed, as usual, a spectrum of three bands. Huggins thought this agreed with

* Abstract of paper in Poggendorff's Annalen, by H. Vogel.

the hydrocarbon spectrum; while Young and I observed *no* such coincidence.

9. Comet IV. 1871 (Tuttle), examined only by me, gave a spectrum of three bands. Accurate measurement of their position showed *no* coincidence with the hydrocarbon spectrum.

Of these nine comets, there is only one (I. 1870) for which we have no observations as to the position of the bright bands. Of the remaining eight, the spectra of five (1, 2, 4, 7 and 9) have shown *no* agreement with the hydrocarbon spectrum. As regards the Comet II. 1867 the supposition is offered that its spectrum was similar to the spectrum named; as to Encke's Comet III. 1871, it remains uncertain in which class it is to be reckoned (Huggins' observations being at variance with those of Young and myself). There remains only the Comet II. 1868, for which Huggins' and Secchi's observations assert a probability of coincidence of the lines in its spectrum with those in the spectra of volatile hydrocarbons.

It thus appears a somewhat questionable view, that the comets consist of such matter; and we should, I think, content ourselves with the deduction, that a portion of the light emitted by the comet is its own light, and very probably from glowing gas. Perhaps a brighter comet may enable us to find out their nature more exactly, yet it seems to me extremely difficult to determine the nature of the glowing gas of the comet through a comparison of spectra from the electric spark in Geissler tubes; since there must be, in the comet, circumstances of pressure and temperature, which it is impossible for us to imitate, and through which, it is known, the spectrum undergoes great modifications.

Dr. Zenker has further asserted (*Astr. Nach. loc. cit.*) that "in the spectrum of Brorsen's comet, Huggins has recognised the bright line of nitrogen." This statement is incorrect; the observation having been, that the bright band situated in the green of the spectrum, had *nearly* the same position as the brightest line of the nebulæ, which, it is known, coincides with the double line of nitrogen. The band in the comet spectrum is a little displaced towards the red end; and this displacement could not be due to the motion of the comet, for, as Huggins pointed out, the latter was moving towards the earth, and the line would have been displaced towards the *violet*. At an earlier date, Huggins, observing the Comet I. 1866, gave out the opinion that the material forming it might be nitrogen; the spectrum appeared to consist of only *one* band of light, which nearly coincided with the brightest nitrogen line. But Secchi disproved this view, having observed three bands, and the weaker bands showing no coincidence with those of the nitrogen spectrum. The accurate measurements afterwards made by Huggins with the bright Brorsen comet, are of interest specially because they put it beyond doubt, that there is no connection between the spectrum of nitrogen and that of the comet.

Again, Dr. Zenker arrives at the conclusion that there must be water-vapour in the comets; since they have, according to Schmidt, a yellowish-red colour, and the sun's rays, when they pass through a considerable thickness of aqueous vapour, are coloured thus. But apart from the consideration that sunlight has a yellowish-red colour on passing through other vapours, as well as aqueous, I would remark, that we must take the proper light of the comet, which appears from spectral analytic observations, to be generally more intense than the reflected light, as determining its colour. According to the observations made, we should expect that the comet is, on the whole, of greenish or greenish-blue colour, since all the spectra consist, as we have seen, of two or three bands of light, of which one is in the yellow, the second and brightest in the green, and the weakest in the beginning of the blue. Of the (generally very faint) continuous spectrum, only the brightest part—yellow, green, and commencement of blue—is visible. The entire image, therefore, even where the weak continuous spectrum appears, will seem of greenish colour. Colour-data have been furnished by other observers besides Schmidt; and the head of the Comet 1811, *e.g.* had, according to Herschel, a greenish or bluish-green colour; the nucleus was slightly red. The colour of Halley's comet, at its return in 1825, was a bluish-green (Struve). Winnecke says of the comet of 1862, "The colour of the neck appears to me yellowish; the coma has bluish light."

With regard, lastly, to Dr. Zenker's proposition that "every gas belonging to the solar system, as soon as it is visible on the dark ground of the heavens, must appear with the same lines of the spectrum, as, according to its nature, it absorbs out of the sunlight," I may be permitted to remark that I am not quite convinced of this; there is not yet furnished a satisfactory experimental basis for the assertion. But to seek to explain the line spectrum of a nebula thus, and by saying that the nebula is shone upon by a fixed star in its "near neighbourhood," is doubtful, inasmuch as it is a very rare case that bright stars are situated in such nearness to nebulæ (especially the planetary, which best show the gas spectrum), that one can suppose a physical connection between them and the nebulæ.

I have been prompted to the foregoing remarks by the observation that in recent speculations on the constitution of the universe, the value of perceptions of sense, on which these speculations rest, has been greatly over-estimated. The principles on which the edifice of an hypothesis is raised must, above all, be secure, and observations not sufficiently confirmed, or even denoted as uncertain by those who have made them, should preliminarily be disregarded, if it is desired that the hypothesis have a stimulating and furthering influence on the progress of scientific research.

SCIENTIFIC SERIALS

Justus Liebig's Annalen der Chemie. Band 169, Heft 3.—This number of the Annalen contains the following papers:—On the decomposition of nitric acid by heat, by L. Cairus. This paper, upwards of seventy pages in length, deals exhaustively with the subject. Very numerous tables of the results of various conditions of temperature, &c., are given, and the paper is illustrated with two plates.—On the chlorides of molybdenum, by Dr. L. P. Liechti and B. Kempe.—Chlorides of the formulæ $MoCl_2$, $MoCl_3$, $MoCl_4$, and $MoCl_5$ are described. The authors point out the parallelism shown by these bodies to the Tungsten chlorides, where, however, Tungsten wants the corresponding trichloride, while molybdenum wants the hexachloride. In both these series the colours of the salts become darker as the chlorine increases in quantity.—On the atomic weight of molybdenum, by L. Meyer. The author from sixteen results deduces the atomic weight 95·86 for molybdenum, chlorine being taken as 35·37 and silver 107·66. This agrees very well with the result obtained by Dumas 96, and by Debray 95·94. The author also points out the following relations in three groups of elements:—

V	51·2	Cr	52·4	Cu	63·3
Plus	43		43·2		44·4
Nb	94	Mo	95·6	Ag	107·7
Plus	88		88·4		88·5
Ta	182	W	184·0	Au	196·2

On chromic dioxide, by E. Hintz. The author describes the preparation, &c., of this body.—The number concludes with a paper on sulpho-ortho-toluidinic acid, by F. Gerver, and one on the specific heat of zirconium silicon, and boron, by W. G. Mixter and E. S. Dand.

THE new number of the *Quarterly Journal of Microscopical Science* contains many papers of interest. Prof. Allman commences by giving an account of Kleinenberg's researches on the anatomy and development of Hydra, in which, while he has confirmed many of the statements of former observers, he has shown the incorrectness of others, and has discovered several important points in its anatomy, specially in connection with the structure of the ectodermic layer, and the subject of development.—Prof. Martin Duncan records some observations on the method of development in *Fucus vesiculosus*, in which, after suggesting that they obtain their nutrition in part at least, from the organic matter always present in sea-water, he describes the growth of the terminal cells of two sets of finger-shaped processes; showing that by in-growths from the lateral walls, membranous septa are formed at the apices of the processes, an active mass of protoplasm occupying the extreme end.—Following this is a translation, with a plate illustrating it, of George O. Sars' paper on the anatomy of that aberrant form *Rhabdopleura mirabilis* (M. Sars), so peculiar in combining a creeping stem in which is an axial cord; lateral cells in which the somites are free, except that a contractile cord binds each to the axial cord; a pair of tentacular arms; a differentiated alimentary canal, and a foot-like process between the alimentary orifices. Mr. E. R. Lankester, in a separate paper, very clearly shows, with the aid of some excellent diagrams, that this animal is a true molluscan form, intermediate between the Polyzoa and Mollusca, and not in reality related to the Hydrozoa as imagined by M. M. Sars.—Mr. Tomes' observations on the development of the teeth of the Armadillo are referred to in our Notes.—A translation follows of the researches of Ph. van Tieghem and G. Le Monnier, on the *Mucorini*, condensed from their memoirs in the

Annales des Sciences Naturelles. It will well repay the study of microscopists.—Rev. E. O'Meare continues his researches on the Diatomaceæ, describing the *Achnantheæ*, *Gomphonemeæ*, *Amphipleureæ* and their allies.—Dr. Bowditch, of Harvard University, gives a new method of injecting the Lymph Spaces in fasciæ, by stretching fascia over the neck of a bottle; and injecting in several places a turpentine solution of alcannine with the point of the syringe partially perforating the fascia; allowing the whole to dry, during which process the fluid penetrates the finest lymph spaces.

SOCIETIES AND ACADEMIES

London

Royal Society, Dec. 18, 1873.—"On the Nervous System of *Actinia*," Part I., by Prof. P. Martin Duncan, F.R.S.

After noticing the investigations of previous anatomists in the histology of the chromatophores, the work of Schneider and Rötteken on these supposed organs of special sense is examined and criticised.

Agreeing with Rötteken in his description, some further information is given respecting the nature of the bacillary layer and the minute anatomy of the elongated cells called "cones" by that author. The position and nature of the pigment-cells is pointed out, and the peculiarities of the tissues they environ also. It is shown that the large refractile cells, which, according to Rötteken, are situated between the bacilli and the cones, are not invariably in that position, but that bacilli, cones, and cells are often found separate. They are parts of the ectothelium, and when conjoined enable light to affect the nervous system more readily than when they are separate. Further information is given respecting the fusiform nerve-cells and small fibres noticed by Rötteken in the tissue beneath the cones, and the discovery of united ganglion-like cells, and a diffused plexiform arrangement of nerve is asserted. The probability of a continuous plexus round the *Actinia* and beneath each chromatophore is suggested, and the nature of the physiology of the structures in relation to light is explained.

The nature of the minute construction of the muscular fibres and their attached fibrous tissue in the base of *Actinia* is noticed; and the nervous system in that region is asserted to consist of a plexus beneath the endothelium, in which are fusiform cells and fibres like sympathetic nerve-fibrils. Moreover, between the muscular layers there is a continuation of this plexus, whose ultimate fibrils pass obliquely over the muscular fibres, and either dip between or are lost on them.

The other parts of the *Actinia* are under the examination of the author, but their details are not sufficiently advanced for publication. The nervous system, so far as it is examined, consists of isolated fusiform cells with small ends (Rötteken), and of fusiform and spherical cells which communicate with each other and with a diffused plexus. The plexus at the base is areolar, and its ultimate fibres are swollen here and there, the whole being of a pale grey colour.

Anthropological Institute, Dec. 30, 1873.—Prof. Busk, F.R.S., president, in the chair.—The following paper was read:—"Ethnological Data from the Annals of the Elder Han," Part I. Translated by A. Wylie, of Shanghai, with an introduction by H. H. Howorth. The Imperial Chinese Annals of the various Dynasties which are as yet almost untouched are distinguished by the extreme accuracy of their details, and in them is to be found a minute account of the intercourse of China with its neighbours, reaching back in contemporary annals to at least the second century B.C. The series of Chinese annals begins properly with those of the Han dynasty which reigned from about 202 B.C. to about 220 A.D. That was the golden prime of Chinese history, when the empire reached its furthest limits, when Buddhism was introduced and when a great literature flourished. During the dynasty of Cheou, the old imperial unity had been invaded by the creation of various feudatories who became almost independent. It was the aim of the immediate predecessors of the Han dynasty to destroy those feudatories and to restore the unity of the empire; and to effect that purpose all the ancient books and histories were ordered to be burnt. The annals, in the present communication, contain an account of the numerous conquests from the date of the Elder Han and embrace the history and migrations of a large portion of the peoples of Central and Eastern Asia. Mr. H. H. Howorth communicated the twelfth and concluding paper on the Westerly Drifting of Nomades: the Huns.

Edinburgh

Royal Society, Jan. 5.—Prof. Sir William Thomson, president, in the chair.—The following communications were read:—A New Method of Determining the Material and Thermal Diffusivities of Fluids, by Sir William Thomson.—Continuants: A New Special Class of Determinants, by Thomas Muir, M.A.—Remarks upon the Foot-Prints of the Dinornis on the Sand Rock of Poverty Bay, New Zealand, and upon its recent Extinction, by T. H. Cockburn Hood.

Dublin

Royal Irish Academy, Nov. 29, 1873.—Prof. Jellett, president, in the chair.—Samuel Ferguson, LL.D., read a paper on "The completion of the biliteral key to the values of the Letters in the South British Ogham Alphabet."—The president read a paper on "The question of Chemical Equilibrium," the determination of the law, according to which an acid divides itself between two bases which are present in the same solution, has been long known to be one of the obscure questions of chemistry, it is generally admitted by chemists that there is a division, and that the relative masses of the two bases exercise an important influence upon the law which governs it, but the law itself remains unknown, and the object of Prof. Jellett's paper was to give at least a partial, possibly a final, solution to the problem, treating the question as one of chemical equilibrium, and defining these terms as follows:—Two or more substances may be said to be in chemical equilibrium if they can be brought into chemical presence of each other, without the formation of any new compound or change in the amount of any of the substances which are thus brought together. If an acid be added to a mixture of two bases, four substances will be present, *i.e.* two salts and two portions of bases remaining uncombined, these four are in chemical equilibrium—the question is why—and the author showed that there can be but one equation of equilibrium, inasmuch as the quantities of the four substances which are present in the solution, are functions of three independent variables, namely:—the original quantities of each base (2) and the original quantity of acid (1) denoting by b_1 b_2 the quantities of free base, and by s_1 s_2 the quantities of each salt respectively, the equation of equilibrium is necessarily of the form $U = F(b_1, s_1, b_2, s_2) = 0$, and the object of the author's investigations was to determine the form of the function F. The bases selected for experiment were quinia and brucia. In quinia the rotatory power of any of its salts exceeds the rotatory power of the base. In quinia the reverse is the case, and as the result of careful and long continued experiments, it was proved that equilibrium is not troubled by dilution, for a disturbance could not arise without altering the rotation—there was no alteration, and the equilibrium, therefore, depended only on the ratios of the four substances, hence:—

$$U = F\left(\frac{1_1}{s_1}, \frac{b_2}{s_2}, \frac{b_1}{b_2}\right)$$

By a second series of experiments it was proved—putting r_1 = rotatory power of brucia, ρ_1 = rotatory power of hydrochlorate of quinia, r_2 = rotatory power of brucia, ρ_2 = rotatory power of hydrochlorate of brucia, r = actual rotation for acidulated mixture, a = total amount of acid corresponding to the unit of bulk of solution, x = amount which combines with the quinla, it is easily seen that

$$r = \left(\frac{\beta_1 x}{\alpha}\rho_1 + (b) - \frac{\beta_1 x}{\alpha}\right) r_1 + \frac{\beta_2 (a - x)}{\alpha}\rho_2 +$$
$$\left(b_2 - \frac{\beta_2(a - x)}{\alpha}\right) r_2$$

where β_1, β_2, α are the atomic weights of the two bases and the acid respectively, and b_1 b_2 are the quantities of each base contained in the bulk of the solution. Solving this equation for x, we have

$$x = A\,a + B\,(r - b_1 r_1 - b_2 r_2), \text{ where}$$
$$A = \frac{\beta_2 (r_2 - \rho_2)}{\beta_1 (\rho_1 - r_1) + \beta_2 (r_2 - \rho_2)}$$
$$B = \frac{\alpha}{\beta_1 (\rho_1 - r_1) + \beta_2 (r_2 - \rho_2)}$$

If r_o be the actual rotation caused by the unacidulated mixture, it is evident that $r_o = b_1 r_1 + b_2 r_2$. The foregoing may therefore be written

$$x = A\,a + B\,(r - r_o)$$

By a third series of experiments it was seen that if a solution of

quinia is acidulated so that the quantity of uncombined base bears to the acid the same ratio as in the foregoing mixture between the uncombined quinia and the quantity x, and a solution of brucia is prepared so as to preserve the ratio of the uncombined brucia to $a - x$. Then the ratios in these of b_1 to s_1 and of b_2 to s_2 are the same as in the case of equilibrium, the rotation caused by these fluids being r_1 and r_2. Let them be mixed in the proportions $m : n$, and the rotation caused by the mixture is $\frac{m r_1 + n r_2}{m + n}$, and whatever be the ratio of $m : n$, there being no rupture of equilibrium, it is evident that if the ratios $b_1 : s_1$ and $b_2 : s_2$ have the values proper for equilibrium, the latter will be preserved, however the ratio $b_1 : b_2$ may vary. Hence, in mathematical language, $U = F\left(\frac{b_1}{s_2}, \frac{b_2}{s_2}\right)$ By a fourth series of experiments a mixture of solution of quinia and brucia was made, in which these bases have to each other the same ratio as the uncombined bases in the second series of experiments. A second mixture is made of the same solutions in which the bases have the same ratio as the combined bases in the second series of experiments. Sufficient acid is added to the latter mixture to convert the bases into salts. Here the ratios $b_1 : b_2$ and $s_1 : s_2$ have the values for equilibrium. If these now be added to each other in the proportion of $m : n$, the rotation caused by the mixture is—

$$\frac{m r_1 + n r_2}{m + n}$$

$r_1 r_2$ being the rotation caused by each of the added fluids separately, it is inferred as before that $U = \int\left(\frac{b_1}{b_2}, \frac{s_1}{s_2}\right)$, but if U satisfy both these conditions it is easily shown mathematically that $U = \int\left(\frac{b_1}{s_1} \div \frac{b_2}{s_2}\right)$, hence it is evident that the required equation of equilibrium is $\frac{b_1}{s_1} \div \frac{b_2}{s_2}$ = constant. The author showed the bearing of the law upon the theory that chemical combination is not statical but dynamical, observing that this theory is quite in accordance with the results obtained by him. (This valuable memoir will appear in full in the Transactions of the Royal Irish Academy.)

PHILADELPHIA

Academy of Natural Sciences, Aug. 19, 1873.—Dr. Ruschenberger, president, in the chair. "The Composition of Trautwinite." The author gave a few additional details concerning this new mineral, which was described in the Proceedings of the Academy for January 1.

Sept. 9.—Mr. Gentry communicated a notice of a great swarm of ephemerids which passed through the town of Lewisburg, on the Susquehanna River, on the afternoon of August 22. The swarm was estimated to be about a mile in length by nearly a half mile in width, and was so dense as even to obscure passers-by on the opposite side of the street.

Sept. 15.—The following papers were presented for publication:—"On a new American species of Glyptocephalus," by Theo. Gill; "Description of fifty-two species of Unionidæ," by Isaac Lea. The last-named paper was, on report of the committee, ordered to be published in the Journal of the Academy.

BOSTON, U.S.

Society of Natural History, Nov. 5, 1873.—Mr. F. W. Putnam read a paper on *Myxine*, a low genus of fishes, known to fishermen as *hags*, giving an account of its anatomy, which was illustrated by a series of specimens exhibited. The several species described by various authors must be reduced to one, having a wide geographical distribution, being found on both sides of the Northern Atlantic, and also on the southern coast of South America. Mr. Putnam showed that the variations in the number of lingual teeth, which are from eight to eleven in each row in specimens from the North Atlantic and from the Straits of Magellan, could not be considered as of specific importance. The different varieties of this species he considered as follows:—*Var. septentrionalis*, the short and thick form, from the North Atlantic, *var. limosa*, the long and slender variety, also from the North Atlantic; while the southern variety may be called *australis*, the name under which Jennyns described it as a true species.—Dr. Thomas Dwight read a paper on the "Structure and Action of Striated Muscular Fibre." His studies had been made on the muscles of the legs of the small water beetle *Gyrinus*. Their covering is quite transparent, and after the leg has been cut off and put into a drop of water under a covering glass, the contractions can often be observed for over an hour. He found that the fibre, at rest, consisted of narrow granular transverse stripes, with broad light-coloured bands between them. Close to the black stripe there was a glaring white reflection, but midway between two stripes the fibre was gray. When the fibre contracted the black bands came nearer together, and their granular structure became more obscure; the gray band disappeared, so that there was merely an alternation of black and white stripes. The ends of the white stripes bulged out during contraction. As the wave of contraction moved along, it was easy to see that there was no interchange of position between the black and the light substances, and no homogeneous transition stage, as is maintained by Merkel. When one part of the fibre is in contraction, the part from which the wave is running is put upon the stretch; the black bands are divided into two rows of granules, and there is less distinction between the white and gray substances.

PARIS

Academy of Sciences, Dec. 29, 1873.—M. de Quatrefages, president, in the chair.—The following papers were read:—On the formation of equations of the condition which results from the observations of the Transit of Venus on December 8, 1874.—A new answer to M. Pasteur, by M. Trecul. This was a general review of M. Pasteur's views as to the origin of yeast. M. Pasteur briefly replied.—A theoretical essay on the equilibrium and elasticity of pulverulent masses and on the thrust of non-cohesive earth, by M J. Boussinesq.—On the isomerism of albumenoids, by M. Béchamp. The author gave many details with regard to various albumenoids; he had discovered three in cow's milk M. Dumas confirmed the latter result, which he had himself attained by different means.—Action of water on sheet lead, by H. Marais.—Note on hybernating *Phylloxera* and on their agility and artificial restoration, by M. Max. Cornu.—Observations on a note of M. Menabrea relating to Lagrange's series, by M. Genocchi.—Researches on arsenious hydride, by M. Engel. The author has been repeating Wiederhold's researches on the supposed As_2H; he, however, did not obtain the substance in question.—Note on the action of iodine on uric acid, by M. F. Wurtz. The author found that when these bodies were allowed to act in the presence of water, alloxan and hydriodic acid were formed, and probably also urea with other bodies.—Synthesis of oxalyl urea (parabanic acid), by M. E. Grimaux.—On a new arrangement of the sulphate of copper battery, by M. Trouvé.—Observations on the existence of certain relations between the colouring and geographical distribution of birds, by M. A. Milne-Edwards.—On fossil remains of Batrachia, Lacertia, and Ophidia found in the phosphate of lime deposits at Aveyron, by M. Filhol.—On the development of the *phragmostracum* of the *Cephalopoda* and the zoological connection of the *Ammonites* with the *Spirulæ*, by M. Munier-Chalmas.—On waterspouts and cyclones, by M. E. Mouchez.—On the effects of Indian hemp, by M. A. Naquet.—During the meeting, elections were held for the posts of correspondent of the astronomical section, vacant by the deaths of Encke and Admiral Smyth, to which Messrs. Lockyer and Roche were elected.

CONTENTS

THURSDAY, JANUARY 15, 1874

THE POLLUTION OF RIVERS

THE Rivers-pollution Commissioners (Prof. Frankland and Mr. J. C. Morton), having, during the last five years, made and published more than 2,000 analyses of river and other waters throughout England, Scotland, and Wales, before and after pollution, and no less than 1,200 examinations of impure drainage waters, and having visited and reported concerning the effluent waters from 245 Chemical-dye and Print-works, Paper-, Cotton-, and Woollen-mills, and mines and works of various kinds spread over the country, have recently published their fifth report on river pollution from mining operations, reserving to themselves in their forthcoming and last report the consideration of the potable waters of Great Britain.

The importance of this systematic and thoroughly scientific examination of the composition of the running water on the surface of our country can hardly be over-estimated, and the value to the nation of the mere analyses of the waters is such as amply to repay the cost of the Commission. In addition, however, to the special value to each district, to corporate bodies, or even to individual manufacturers and riparian proprietors which these analyses of river and drainage waters possess, they are of the highest importance as forming the body of evidence upon which alone action can be taken with regard to legislation on the subject of the prevention or abatement of river pollution throughout the country. That some measure to ensure a greater degree of purity in our rivers, especially those passing through the manufacturing districts, must, before long, be carried out by the Legislature, is admitted not only by those who opposed Mr. Stansfield's proposals of last year, but even by the manufacturers who are now helping to foul the streams. The question which has to be settled is not whether anything is to be done to remedy the certainly disgraceful state of some of our streams, but rather to what extent can the purification be pushed without detriment to the industry of the district; and when this has been decided comes the next question, how this partial purification is to be effected. That it can only be a partial purification is clear from the conclusions of the Commissioners themselves, who do not propose any plan by which the water of our rivers, in populous districts at present little better than sewers, shall be so purified as to be fit for drinking purposes.

Without attempting to give even a part of the data upon which the Commissioners base their conclusions, and declining altogether, as inopportune, to criticise their scheme, it appears to be desirable that conclusions arrived at after so much labour and consideration should be made widely known.

The proposal, then, which the Commissioners make as in their opinion the best and most feasible means of legislating on the prevention of river pollution is the establishment of certain standards, the infringement of which shall render the water liable to be deemed polluting and inadmissible into any stream, provided always that no effluent water shall be deemed polluting if it be not more contaminated with any of the polluting ingredients than the stream or river into which it is discharged.

The standards are as follows :—

(*a*) Any liquid which has not been subjected to perfect rest in subsidence-ponds of sufficient size for a period of at least six hours ; *or* which having been so subjected to subsidence, contains, *in suspension*, more than one part by weight of dry organic matter in 100,000 parts by weight of the liquid, *or* which, not having been so subjected to subsidence, contains, *in suspension*, more than three parts of dry mineral matter, or one part by weight of dry organic matter in 100,000 parts by weight of the liquid.

(*b*) Any liquid containing, *in solution*, more than two parts by weight of organic carbon, or 0·3 part by weight of organic nitrogen in 100,000 parts by weight.

(*c*) Any liquid which shall exhibit by daylight a distinct colour when a stratum of it one inch deep is placed in a white porcelain or earthenware vessel.

(*d*) Any liquid which contains, in solution, in 100,000 parts by weight, more than two parts of any metal except calcium, magnesium, potassium, and sodium.

(*e*) Any liquid which, in 100,000 parts by weight, contains, whether in solution or suspension, in chemical combination or otherwise, more than 0·05 part by weight of metallic arsenic.

(*f*) Any liquid which, after acidification with sulphuric acid, contains, in 100,000 parts by weight, more than one part by weight of free chlorine.

(*g*) Any liquid which contains, in 100,000 parts by weight, more than one part by weight of sulphur, in the condition either of sulphuretted hydrogen or of a soluble sulphuret.

(*h*) Any liquid possessing an acidity greater than that which is produced by adding two parts weight of real muriatic acid to 1,000 parts by weight of distilled water.

(*i*) Any liquid possessing an alkalinity greater than that produced by adding one part by weight of dry caustic soda to 1,000 parts of distilled water.

(*k*) Any liquid exhibiting a film of petroleum or hydrocarbon oil upon its surface, or containing, in suspension, in 100,000 parts, more than 0·05 part of such oil.

The Commissioners further add that any law having for its object the prevention of river pollution, should

1. Absolutely forbid, under adequate penalties, the casting of solid matters into river channels.

2. Enact the foregoing standards of purity below which any liquid discharges into water-courses should, with the exceptions already mentioned (certain few short mining rivers), be forbidden.

3. Give power to all manufacturers in towns, except those of gas, paraffin oil, pyroligneous acid, animal charcoal, tin-plate, and galvanised iron, to discharge their drainage water into the town-sewers under suitable regulations.

4. Confer additional powers on corporations, local boards, manufacturers and mine-owners, to take land compulsorily under "Provisional orders" for the purpose of storing their waste refuse, or of cleansing sewage or other foul liquids either by irrigation, filtration, or otherwise.

They are of opinion that Government Inspectors

(similar to the Inspectors under the Alkali Act) should be appointed, to whom should be committed the duty of detecting and proving offences against the law, and of procuring the conviction of offenders. They consider that the formation of River Conservancy Boards for authorising and carrying out river improvements will in course of time become imperative, but they are convinced that the thing of immediate importance in connection with river improvement throughout the country, is simply the prohibition, under adequate penalties, of the gross pollution which at present renders so much of the running water of this country useless to manufacturers, agriculturists, and the like.

The time has not yet arrived for the full discussion of these proposals. We shall doubtless hear much on this subject in the approaching or in the next session in parliament. It is, however, certain, from the opposition made to the bill of last year, that manufacturers do not as a rule agree with the Commissioners as to the feasibility of enforcing the proposed standards of purity, as regards the effluent water from works of various kinds. Nor is public opinion respecting the other and far more important source of pollution, the sewage of towns, in a sufficiently advanced or satisfactory condition to render legislation easy. It is not, for instance, clear how one and the same system, say of irrigation, can be applied to all districts possessing different soils, rainfalls and situations. Indeed, the more we consider the whole question of the prevention of the pollution of rivers, the more difficult does any general method of treatment appear to be. Each locality has its own peculiarities, and a system of prevention which is suited to one district may be inapplicable or inexpedient in another. But even supposing that when the subject comes before Parliament that difficulties are found to be of such a character as to render it impossible to legislate upon the exact basis laid down by the Commissioners, still the value of their conclusions, and of the mass of experimental evidence which they have collected, is extreme: and they have most fully earned the gratitude of all those interested in the satisfactory solution of one of the most important, though most difficult, questions of our social economy.

THE CONSERVATION OF ENERGY

An Elementary Treatise on Energy and its Laws. By Balfour Stewart, M.A., LL.D., F.R.S., Professor of Natural Philosophy at the Owens College, Manchester. (Henry S. King & Co., 1873.)

IT is the proper function of Science to discover, among the ever-changing phenomena of the world, the permanent relations which are the conditions of reasonable thought. When we understand these relations well enough to express them in words we call them "Laws of Nature." When they rise to a higher stage of development and have become invariable habits of thought, we call them "Things."

Thus ice, under certain conditions, ceases to be ice. We observe that when the ice melts water appears in its place, and we find that there is always so much water in place of so much ice. We therefore obtain, in the first instance, a *law* of equivalence between a certain quantity of ice and a certain quantity of water, and finally, we arrive at the conclusion that water and ice are the same *thing* in different forms.

We are thus led to inquire what it is which remains permanent in the midst of all apparent changes, and the result of this inquiry has been the enunciation of a consistent definition of the quantity of matter in a body, and the establishment of the doctrine that the quantity of matter in a body is invariable, whatever transformations it may undergo.

This doctrine of the "Conservation of Matter" lies at the foundation of all reasoning, whether in physics or in chemistry. When the progress of Science rendered it possible to form exact ideas about the motion of bodies, men were again impelled to seek for something permanent, even in motion itself. They endeavoured to form some definition of the "Quantity of Motion" which should enable them to treat this quantity as a *thing* having a continuous existence. The long war between the followers of Newton and those of Leibniz as to whether, in estimating the quantity of motion, the mass must be multiplied into the velocity or into the square of the velocity, was not a mere debate about words and names, for it involved the question whether momentum or *vis viva* were the more fully possessed of that character of permanence which would justify its claim to the title of "The Quantity of Motion."

The doctrine of the Conservation of Energy is the most complete expression hitherto given to the belief that all the changes of phenomena are but different distributions of the same stock of energy, the total quantity of which remains invariable. The characteristic feature of scientific progress during the last thirty years has been the application of principles derived from this doctrine to the various branches of Science. The recent progress of the theory of heat is an instance of the direct and conscious application of the doctrine of the conservation of energy. In his electrical discoveries Faraday also was guided by the same doctrine, though less consciously, as he had no opportunity of becoming acquainted with it in the accurate form in which it may now be stated.

In the volume before us Dr. Balfour Stewart has explained, in a very clear and very elementary manner, what is meant by energy in its two forms, the energy of a moving system, and the energy due to the configuration of the system.

This exposition is so carefully drawn up that we think it ought to be intelligible even to students who approach the subject without any previous training in the technical dynamics of the ordinary text-books. This we consider a matter of great moment for the future progress of Science. It is no doubt easier, in dealing with the present generation of students, to gain their assent to doctrines about energy by deducing them from other principles which have been already taught them as the elementary principles of dynamics. But it is by no means always true in science that those principles which have been longest recognised are really the most elementary. The discovery of principles more fundamental and elementary than those which are already received, is not only of great importance in the philosophy of Science, but it tends to render Science less technical, and therefore more easily diffusible through the mass of society.

Dr. Balfour Stewart, however, has not only endeavoured to give to the ideas of Work and Energy their proper position among the most elementary ideas which we can form, but he has displayed an equal amount of freedom in treating the still more modern ideas of the Dissipation of Energy, and of the difference between exact and statistical knowledge.

Thus his very first words relate to

"*Our Ignorance of Individuals*

"Very often we know little or nothing of individuals, while we yet possess a definite knowledge of the laws which regulate communities.

"The Registrar-General, for example, will tell us that the death-rate in London varies with the temperature in such a manner that a very low temperature is invariably accompanied by a very high death-rate. But if we ask him to select some one individual, and explain to us in what manner his death was caused by the low temperature, he will, most probably, be unable to do so. . . ."

"Nor is our knowledge of individuals greater in the domains of physical science. We know nothing, or next to nothing, of the ultimate structure and properties of matter, whether organic or inorganic.

"No doubt there are certain cases where a large number of particles are linked together so as to act as one individual, and then we can predict its action, as, for instance, in the solar system, where the physical astronomer is able to predict with great exactness the positions of the various planets, or of the moon."

We regret that we have not space enough to quote the whole of this introductory passage, which, in the unpretending language of clear thought, expresses ideas which have as yet been appreciated only by a very small number of scientific men, but which will, in due time, greatly modify the popular notions as to the nature of human knowledge.

The uniformities, therefore, which we observe in our experiments on quantities of matter containing many millions of molecules in continual motion, are uniformities of the same kind as those first explained by Laplace, and in more recent times wondered at by Buckle, and arise from the slumping together of innumerable cases, each of which is by no means uniform with the others.

This statement acquires still greater significance when it is combined with another consideration which Dr. Stewart, if we mistake not, has already insisted on in his opening lecture at the Owens College. This is the distinction between stable and unstable arrangements of matter and motion. A system, whether at rest or in motion, is said to be stable if a slight variation of its initial circumstances will, at the end of a finite time, produce only a slight variation in the configuration or motion at that time. If, on the contrary, a variation, however slight, in the initial circumstances, may produce, in a finite time, a large disturbance, the equilibrium or motion of the system is said to be unstable.

Dr. Stewart illustrates this by several examples, among which we may select a clock as an instance of a stable arrangement in which everything is contrived so that any slight disturbance shall produce as little effect as possible on the position of the hands at any future time. A rifle, on the other hand, is an unstable contrivance, for a very slight pressure on the trigger is sufficient to occasion the motion of the hammer and the explosion of the gunpowder—effects, the energy of which is out of all proportion to the work done on the trigger.

Thus we have stable arrangements which, when at work, are not easily put wrong, and unstable arrangements which are characterised by great delicacy of construction.

The rifle, however, as Dr. Stewart points out, is a machine which, though delicately constructed, is not incalculably so. Its instability is not like that of an egg balanced on its longer axis. But in an animal we find a structure composed of materials which are chemically unstable, so arranged that on account of the changes to which they are liable, the smallest disturbance may produce the most varied states of motion. If, then, an animal is to be compared to a machine, the delicacy of that machine must be incalculable.

It is a metaphysical doctrine, that from the same antecedents follow the same consequents. No one can gainsay this abstract statement. But it is not of much use in a world like ours, in which the same antecedents never again concur, and in which nothing ever happens twice. Indeed, for aught we know, one of the antecedents might be the precise time and place of the event, in which case experience would go for nothing.

The physical axiom which has a somewhat similar aspect is, "That from like antecedents follow like consequents." But here we have passed from sameness to likeness, from absolute accuracy to a more or less rough approximation. The axiom is now applicable only to systems of the kind which we have called stable, in which slight variations in the antecedents produce slight variations in the consequents. In unstable systems, like antecedents do not produce like consequents; and as our knowledge is never more than an approximation to the truth, the calculation of what will take place in such a system is impossible to us.

Dr. Balfour Stewart's discussion of the Dissipation of Energy is perhaps as satisfactory as it could be made in the space allotted to it, and without the use of mathematical methods. Energy is indestructible, but it may cease to be *available*. Here we have a word not familiar in pure science—a word connoting usefulness. We must therefore define what is meant by available, and state the conditions under which we are supposed to be placed

Energy is available when it can be made to do visible work. The conditions under which we attempt to transform energy into work are that we must make use of the interactions of a given system of bodies, moving within a given region of space, out of or into which neither matter nor heat can pass.

If these bodies are in visible motion, we first reduce them to rest by causing them to do a certain amount of work. We thus obtain their energy of visible motion.

If they are now at different temperatures, we convey heat from the hotter to the colder bodies by means of a heat-engine, till the whole system is at the same temperature. We thus obtain a second portion of the available energy.

Finally, if the pressures of different parts of the system are not alike, we allow the portions in which the pressure is great to expand, and so compress the portions in which the pressure is less, the volume of the whole system remaining constant. We thus obtain the third and last portion of the available energy.

The parts of the system are now at rest relatively to each other, and are all at the same temperature and pressure. No more work can be done by the system if it is enclosed within a fixed boundary through which neither matter nor heat can pass. We have exhausted its available energy.

But there are two methods, both of them however unavailable to us, by which the energy of a system, even when rendered in this sense unavailable, may be recovered. One is by allowing the substances to expand into infinite space; the other is by conveying all the heat through a perfect heat-engine into a refrigerator at the temperature of absolute zero. Hence the importance of excluding these two methods, by limiting the statement to a system enclosed by a boundary through which neither matter nor heat can pass.

Now the doctrine of the dissipation of energy asserts that by the mutual action of the parts of such a system its available energy may be diminished, but can never be increased. If there is difference of temperature, conduction of heat takes place, and this is always accompanied by a diminution of the available energy. If there is visible motion, friction occurs, and this renders a certain amount of the energy unavailable.

Here, then, we have an irreversible process always going on, at a greater or less rate, in the universe. If, therefore, there was ever an instant at which the whole energy of the universe was available energy, that instant must have been the very first instant at which the universe began to exist. If there ever shall come a time at which the whole energy of the universe has become unavailable, the history of the universe will then have reached its close. During the whole intervening period the available energy has been diminishing and the unavailable increasing by a process as irresistible and as irreversible as Time itself. The duration of the universe according the present order of things is therefore essentially finite, both *à parte ante* and *à parte post.*

But, according to pure dynamics, every motion of a system may be performed in the reversed direction subject to the same system of forces. If then at a given instant, every particle of the universe were to have the direction of its motion reversed so as to start anew with an equal but opposite velocity, everything would run backwards from the end to the beginning. We might attempt a description of a world thus recoiling upon itself—the rivers running up into the hills, heat flowing from cold bodies to hot, and men passing over the stage of life from their graves to their cradles, ignorant of the past and remembering only the future, as Shelley sings, in his musical delirium :—

> "We have passed Age's icy caves,
> And Manhood's dark and tossing waves,
> And Youth's smooth ocean, smiling to betray;
> Along the glassy gulfs we flee
> Of shadow-haunted Infancy,
> Through Death and Birth, to a diviner day."

But then we must remember that every characteristic of the past is now transferred to the future, so that if this reversal of nature were actually to occur, we would be quite unconscious of it.

> "Thus
> Our weakness somehow shapes the shadow, Time."

Now why is this state of things, though dynamically possible, physically absurd? Simply because it requires the *exact* reversal of the motion of every atom in the universe. If but one atom were to receive a velocity differing infinitesimally from an exact reversal, that atom would leaven the whole universe with that tendency to dissipation of energy which actually exists, and things would go on as they now do.

We must now conclude, by thanking Dr. Balfour Stewart for bringing before the general public in so clear and intelligible a form some of the more intellectual results of physical science. We hope, however, that, in the next edition, the comparison between Euclid's *reductio ad absurdum* and the experimental verification of the results of a physical hypothesis, as given in Art. 118, will be re-written, as it is one of the very few passages which remind us of what is called the popular scientific style.

WEBERBAUER'S "FUNGI OF NORTH GERMANY"

Die Pilze Nord-Deutschland mit besonderer Berücksichtigung Silesiens. Beschrieben von Otto Weberbauer Heft I. mit sechs nach der Natur gezeichneten colorirten Tafeln. (Breslau: Kern; London: Williams and Norgate.)

THE mycologist has no reason to complain that he has not ample opportunities for identifying the various objects which fall into his hands, if he has but patience and book-learning enough to enable him to avail himself of all the various sources of information. There are not only abundant collections of dried specimens, like those of Rabenhorst, Fückel, and others, on the Continent, with others at home, but every day is bringing forward some new publication of greater or less excellence, with figures illustrative of obscure, or little known species, as well as those which are of more general occurrence. In that most difficult department, the Hymenomycetes, he has a host of excellent figures in Krombholz, more recent copies of which are, unfortunately, by no means equal to the original, while the analyses, for the most part, are unsatisfactory, and sometimes altogether deceptive. Eight numbers have already appeared of the Icones by Fries, which have all the advantage of coming from the author himself of nearly half of the species which are contained in the Epicrisis, a new edition of which is now in the press, including all the more recent additions, and which is proceeding with a rapidity which is somewhat wonderful, since the Prince of Mycologists is at least an octogenarian. It would be easy to mention other important works still in progress both in this country and abroad, but amongst them not the least so is the one whose title is given above, though from its nature the progress must, unfortunately, be somewhat slow. The first part now before us contains figures and analyses of twenty-six species in six plates, with descriptive letterpress, and two parts at least are promised every year.

Great care has evidently been taken in the identification, and it is, we think, a great merit that the author has been content to adopt the commonly received nomenclature, without carelessly sanctioning every new name which has been proposed by ambitious or shortsighted observers. We are glad, moreover, that the measurements are given

in French millimetres, and not in parts of German inches, which require reduction.

As the asci vary much in length, only the thickness is given, though, under certain circumstances, as in Sphæriæ, it is often quite as variable as the length. In one or two instances we should have been glad to see more critical remarks, as, for example, under *Peziza venosa*, where the larger figure so exactly accords with that of Fries in the "Atliga och giftiga Svampar" of *Discina perlata*, that we should have been glad to have heard whether there is any real distinction between the two. As we used to find it every spring in our younger days, it was more like the figure of Greville's *Peziza reticulata*, than that before us. Something again might have been said respecting the resemblance of our author's very curious *Peziza corium*, to the North American *Peziza craterium*, with which it has evidently a close affinity. There is, we think, no doubt that the *Verpa digitaliformis* of England is the same with that figured by Herr Weberbauer. We shall be truly glad to find that this beautiful work meets with such success as to ensure its continuance.

It is quite curious to observe how an interest in fungi has rapidly increased in this country. The late Fungus Show at South Kensington was so well attended that the Council offer for next year a very ample list of figures, and as especial prizes are to be given for collections of novelties, or for cultivated species, the meeting will be one of much importance. Even in Scotland, where a short time since fungi were looked on as "abominations," there is a very active movement in their favour, especially amongst the clergy, who have made some very interesting additions to our Mycology, and a fungus-show is projected next autumn at Aberdeen. In England, where some of the older students are passing away, it is a great pleasure to know that the subject is taken up by such strictly scientific observers as Mr. Plowwright, Mr. Renny, and Mr. Phillips, not to mention many other names of great promise.

M. J. BERKELEY

OUR BOOK SHELF

Beeton's Science, Art, and Literature. A Dictionary of Universal Information; comprising a complete Summary of the Moral, Mathematical, Physical, and Natural Sciences; a Plain Description of the Arts; an Interesting Synopsis of Literary Knowledge; with the Pronunciation and Etymology of every leading term. Containing nineteen hundred and eighty Columns, and upwards of six hundred Engravings. 2 vols. (London: Ward, Lock, and Tyler. No date.)

THIS book does not pretend to be, and very evidently is not, more than a compilation from other cyclopædias, and from works on the various subjects of which it treats. So far as we have examined it, most of the information contained in it is derived from the former source, and it is impossible that any thoroughly trustworthy reference-book can be compiled in this manner, especially if the compiler or compilers have no special knowledge of the subjects with which they deal. The work pretends to give only a summary of facts, but in many of the articles much space is wasted by comment and reflection. There is absolutely no article on the Spectroscope, which is referred to *Spectrum*, an article without any illustrative cut, occupying one-third of a column, that might have been written twenty years ago. Why is there no article *Evolution?* and why, under *Development*, is the greater part of the short article occupied with the "Vestiges of Creation," and no reference whatever made to the state of the doctrine in Germany and America? Under the very specific heading *Crannoges* the general subject of Lake-dwellings is discussed, the writer evidently not being aware of the important distinction between the Crannoges of Ireland and the Lake-dwellings of Switzerland. A very poorly-executed copy of Keller's restoration of a Swiss lake-dwelling is the illustration to the article *Crannoges*. We say again no work of this kind can be regarded as a standard reference-book unless the editor has at his command a band of master specialists. The illustrations, as a rule, are inferior, and many of them seem well worn; many, moreover, are totally useless, such as those put beside the article *Drawing* and similar articles, which seem to be inserted simply to make the book take with a certain class. We think there is still room for a comprehensive reference dictionary containing information on all subjects compactly put together, No one at the present day, when there are such multitudes of special treatises in every department of human knowledge, would ever think of resorting to an encyclopædia to *study* a subject; and thousands, we believe, would be thankful for an all-comprehensive reference-book which should present in the briefest possible space the leading and latest facts under each heading free of all comment and speculation. Such a work might be as comprehensive as the "English Cyclopædia," or the "Encyclopædia Britannica," perhaps more so, and yet not exceed in bulk of matter the work at the head of this notice. All the scientific articles in such a work, however, and many others besides, could only be written satisfactorily on such a plan by men of special knowledge in each department; such men alone can judge what is of primary and what is of secondary importance.

Scientific Handicraft; A Descriptive, Illustrated, and Priced Catalogue of Apparatus. Vol. I. Mechanics, Hydrostatics, Hydrodynamics, and Pneumatics. By J. J. Griffin. F.C.S. Pp. 186. (London, 1873).

THIS is a useful Catalogue of Apparatus, which contains an account of the method of using the principal pieces of apparatus which are described. There are also suggestions for keeping instruments in good order. It will be found useful by those who select apparatus for purposes of school teaching or public lecturing; and Mr. Griffin has done good service by endeavouring to introduce as many new forms of apparatus, or modifications of old forms, from Germany and France, as he could obtain knowledge of.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

The Shrinking of the Earth and Terrestrial Magnetism

SINCE writing my previous letter (vol. ix. p. 141) I have received a note from Mr. Darwin, who says that in his work on "Coral Reefs," he arrived at the conclusion that volcanoes are not found in areas of subsidence. As I have succeeded, I think, in eliminating them from areas of upheaval, it may be that they occupy the boundary line of the oscillating land, and are stationed on or near the fissures and joints along which the earth's crust has given way. At all events, I invite a careful examination of those areas which we know to be rising, such as the northern circumpolar region, Australia, &c., in the firm conviction that volcanoes will not be found on any of them.

On another point I am very glad to say Mr. Darwin agrees with me, and I am therefore supported by his great authority. He tells me that in his work on "Volcanic Islands" he arrived at the conclusion that the great continents are rising, and the ocean beds sinking. This, of course, is only an hypothesis, and will remain so until the world has been carefully surveyed, but the large number of facts I have collected, and which will,

I hope, be shortly published, go a long way towards proving it. Accepting this hypothesis, the next question we have to decide is whether the rising of the land is an absolute or a relative rising; whether, in fact, the earth's periphery as a whole is undergoing enlargement or contraction, is stretching or shrinking. To decide this by direct observation is not easy; for water being our only measure, the same effect will be produced either by the sinking of the one portion or the rising of the other, that is, of course, if the rising or sinking be general; while if it be a local rising at one place, it may (as is familiarly known, and as I shall point out presently) be due to the lateral pressure caused by an adjacent subsiding area. In the absence of direct experiment, we may be guided by analogies from other facts. These facts are of two kinds—astronomical and geological.

Since the days of Laplace, the nebular hypothesis has been generally received by astronomers, as the one which best meets observed facts. This hypothesis predicates the existence of gravitation everywhere, and shows how, by its influence, the various heavenly bodies have become condensed from nebular matter. It predicates that this force is still active everywhere, and that everywhere within our observation we have a condensation of matter in progress, matter condensing from a highly diffused condition to one of greater density. Thus each member of our own system, it is argued, is gradually and surely nearing the sun, and at the same time is shrinking, and the various planets are, in fact, in so many stages of evolution, and exhibit for us the various phases which the earth has passed through and will pass through before it is landed in the sun. This is all very elementary. I quote it only to show that the evidence of astronomy is that the earth is contracting, that its periphery is diminishing in area, and that therefore it is probable that the subsidence of the ocean-bed is absolute, while the upheaval of the land is relative only.

Geologists argue differently and yet come to the same conclusion. They argue that the original condition of the earth was an incandescent one, and that it has assumed its present form after a gradual cooling, that is a gradual contraction. In Mr. Geikie's words, recently reported in your pages, "Among the geologists of the present day there is a growing conviction that upheaval and subsidence are—concomitant phenomena, and that viewed broadly, they both arise from the effects of the secular cooling and consequent contraction of the mass of the earth." The evidence of geology, then, is at one with that of astronomy in making the shrinking of the earth absolute and not relative merely.

Now it is very clear that if the shrinking earth acquired a certain amount of rigidity, such shrinking would cease to take place uniformly, and the crust would give way along certain weak lines, and that corrugations, *i.e.* mountain-chains, and deep pits, or ocean hollows, would be formed; and not only so, but the sinking of a given area would give rise naturally to a certain thrust upwards of a contiguous area. To quote the graphic words of Mr. Geikie: "Some portions have sunk more than others. These having to accommodate themselves into smaller dimensions would undergo vast compression and exert an enormous pressure on the more stable tracts which bounded them. It could not but happen that after long intervals of strain, some portions of the squeezed crust would at length find relief from this pressure by rising to a greater or less height according to their extent and the amount of force from which they sought to escape." From this we may conclude (what I have not seen mentioned elsewhere), that from the contraction of the earth alone we may deduce the result that the land areas have been gradually growing larger and the ocean areas smaller; that originally when the crust was less rigid, its surface was almost uniformly level and covered with water, and that as it gradually became corrugated, the land first appeared as an archipelago of islands which were gradually joined together into continents in the way Australia was clearly constructed, comparatively recently; or in other words, that the proportion of subaërial to sub-aqueous deposits must diminish as we recede in geologic time, inasmuch as the area of sea, *i.e.* of water-covered surface, increases.

In this statement of the gradual shrinking of the earth there is little that is new, and if it accounted for all the facts I should not have troubled you with another letter. It has been taken for granted hitherto, if I be not mistaken, that areas of subsidence and upheaval are scattered about the world in a sporadic manner, with as little order and aim as plums in a pudding; that the earth being in process of shrinking, areas of subsidence occur at any point where the earth's crust is weak; but the evidence which I have collected and which I hope the Geographical Society will publish, goes far to show that these areas are not sporadic but continuous, and further, that the foci of upheaval are in the circumpolar regions. That it is there where we meet with proofs of current and rapid upheaval almost at every step, and the farther we go north or south from the equator the more rapid does the rise seem to be, while in the equatorial regions the land masses are to a great extent quiescent; we cannot resist the conclusion that the earth is stretching itself in the direction of its shortest axis, that its periphery is being thrust out in the direction of the Poles. Now as we have shown that the earth is absolutely shrinking and that when any local uprising occurs it is due to the lateral pressure caused by a subsiding area, it becomes interesting to inquire what kind of strain upon the earth would produce a squeezing of it out in the direction of the Poles. I can see only one explanation, namely, that the strain is being applied in the way of a stricture about the world's equatorial region, that it is girdled in that region by some force which is tightening upon it, and this tightening produces a partially compensating protrusion of the two polar regions. I conceive that in a spheroid constructed of partially elastic materials, the effect of such a stricture will cause, besides a sensible diminution of the whole periphery of the sphere, a lateral thrust at right angles to the pressure applied, and thus only can I account for it. This would, if I am not mistaken, have another effect, and this a very important one; it would induce magnetism in the earth, and that magnetism would have its poles in the regions of upheaval, and this is in fact so. The magnetic poles are strictly, so far as our evidence goes, in the very foci of upheaval of the circumpolar regions. This correlation of terrestrial magnetism with the force that is causing a tension about the earth's equator, if sustained would surely go far to explain that crux of physical science referred to by Sir William Thomson in his address to the British Association at Edinburgh, namely, the cause of the earth's magnetism; but my letter has already outgrown reasonable limits, and I must ask you to allow me to continue the subject in another. HENRY H. HOWORTH

Derby House, Eccles, Jan. 2

Vivisection

IT has been suggested that the study of Huxley's "Elementary Physiology" is likely to make children indulge in cruelty. Allow me to give the experience of the father of five boys on the subject.

Those old enough to be taught from that book are so; and have attended the professor's lectures and seen some of his experiments. The impression left on their minds, from the reverent and touching treatment of the subject by the able professor, has led to an improved and exalted respect for the rights and life of the meanest thing that crawls.

Although these boys are now at what may be called the "predatory age," the interest and respect they evince for animal life is mainly to be attributed to the beautiful and refining lectures of the worthy and humane Huxley.

G. W. COOKE

London, E.C., Jan. 5

Moraines

MR. FRY, writing in NATURE (vol. ix. p. 103), says that "a glacier which has retreated from its terminal moraine is always the source of a stream of water, and this stream always cuts through the terminal moraine." He infers from this that a lake cannot be formed by a moraine damming up a valley.

I can assure him that this is a fact which at least admits of exceptions. The valley of the Kander in the Bernese Alps is, in its upper part at least, full of the moraines of extinct glaciers, now mostly overgrown with pine forest. One of these dams up a side valley and forms the beautiful Oeschinen Lake. The lake is fed from the glaciers of the Blumlis Alp, and its water is consequently muddy. Except in most unusual floods, it has no outlet above ground, but the side of the dam farthest from the lake is one mass of springs of water as clear as the celebrated streams of Lauterbrunnen, which are evidently fed by the water of the lake filtering through the dam. The dam, being a moraine, is of porous material. JOSEPH JOHN MURPHY

Old Forge, Dunmurry, Dec. 24, 1873

Indian Snakes

I HAVE just had the opportunity of examining the cobra mentioned in my letter dated 12th inst., together with a very handsome one belonging to another snake charmer. This latter cobra also devoured a frog in the space of a minute or two after it was placed in the basket, the frog croaking audibly about half a minute after it was swallowed.

I append the description of these cobras for the benefit of those interested in such matters.

Naja tripudians.—Specimen A.—Colour above very pale olive with pair of conspicuous white, black-edged spectacles. A pair of black H-shaped marks on 12th, 13th, and 14th series (transverse) corresponding to spectacles. Posterior edges of hood above, dark olive. Blackish band 17th to 21st ventral and corresponding scales—rest of belly mottled with dark spots.

Lower anterior temporal in contact with three (3) other temporals.

Ventrals 182, sub-caudals 51, scales 23 series.

Specimen B.—Colour above, olive brown, with numerous pale olive irregular transverse bands and blotches. Belly mottled and barred with blackish. A pair of snow-white, black-edged spectacles. Interstitial skin of anterior central portion of hood pure white, scales pale olive; that of posterior portion and margins black, scales dark olive; colour of hood extending across back in strong contrast to the paler hue of the body.

A pair of white dark-edged spectacles beneath the hood, corresponding to pair above, but the white portion very much wider. Central spots below oval, black, situated on 10th, 11th, and 12th series of scales.

Scales of head pale olive, anterior margins of vertical, supraciliary and occipital shields dark olive, forming a double band across the head. Posterior margins of occipitals dark olive. A vertical infra-orbital streak of dark olive.

Lower anterior temporal in contact with three (3) other temporals. The following ventrals blackish, forming distinct bands 17th to 31st, 24th to 30th, 35th to 38th, 48th to 51st, 61st to 64th all inclusive. Beyond these there are dark bands but the ventrals composing them are not as a rule black throughout.

Ventrals 185, sub-caudals 53, scales 23

Sept. 17, 1873 E. H. PRINGLE

The use of Terms in Cryptogamic Botany

IT seems to me that there is a very perplexing want of uniformity in the names employed by different authors to indicate the reproductive organs of cryptogamic plants.

To a private student this want of formality in the nomenclature of homologous organs is very bewildering; especially when he happens to meet with a term which no botanical work or glossary within his reach explains.

In reading the Rev. M. J. Berkeley's "Introductiou to Cryptogamic Botany," I have come across a term which I cannot find used in the same sense in any botanical work I have consulted.

In the division of algæ called Rhodospermeæ, he says, in speaking of the fruit, "indefinite spores in distinct nuclei."

In *Callithamnion corymbosum* he calls the expanded wall of the mother cell from whose endochrome the walls have been produced by cell division, the nucleus.

In some other genera, he calls the cluster of naked spore-threads the nucleus. In other genera the spore threads arising from a placenta, together with the conceptacles containing them are called a nucleus.

In *Wrangelliaceæ* it is stated that the nucleus is composed of pyriform spores arising from the endochromes of the terminal cells of the spore-threads.

I had first settled in my mind that nucleus was used by Mr. Berkeley as a general name iu this disvision of algæ, for an indefinite cluster of spores.

On re-consideration it seemed to me that the term nucleus in the division *Gongylospermeæ* was not applied to the clusters of spores, but to the expanded wall of the mother-cell, or walls of the mother-cells, whose contents had been transformed into spores; and in the great division *Desmiospermeæ* to the spore-threads from whose cells the spores are produced. Having at length given up this supposition as untenable, it then occurred to me that "nucleus" did not mean the expanded walls of the mother-cells alone, or the clusters of spores alone, or the spore-threads alone; but was a general term applied to the fruit consisting in some cases of spores and spore-threads, in others spores, spore-threads and conceptacles, and in others of the expanded walls of the mother-cells and their contained spores.

When, however, I again read that in *Wrangelliaceæ* the nucleus is composed of radiating pyriform spores, I gave up all attempts at a solution satisfactory to myself.

Can any of your readers inform me what, in this division of algæ, is meant by the term "nucleus," and why it is only used in this division? Did the term not occur in a book written by so high an authority in Cryptogamic Botany it might be passed over as a piece of affectation on the part of the writer. D. R.

POLARISATION OF LIGHT*
III.

WE now proceed to the consideration of the colours produced by plates of crystal when submitted to the action of polarised light. A crystal very commonly used for this purpose is selenite or sulphate of lime, which is readily split and ground into flat plates of almost any required thickness. If such a plate be placed between the polariser and analyser when crossed, it will be found that there are two positions at right angles to each other, in which, if the selenite be placed, the field will remain dark as before. The selenite is, in fact, a doubly refracting crystal, and the positions in question are those in which the plane of vibration of the ordinary ray coincides with that of the polariser (or analyser), and that of the extraordinary ray with that of the analyser (or polariser). In every other position of the selenite, and notably when it has turned through 45° from either of the positions before mentioned, or neutral positions as they may be called, light passes through, and the field becomes bright. If the thickness of the selenite be considerable, the field when bright will be colourless; but if it be inconsiderable, say not more than three millimetres, the field will be brilliantly coloured with tints depending upon the thickness of the plate.

Supposing however that, the selenite remaining fixed, the analyser be turned round, we shall find that in the first place the colour gradually fades as before; until when the analyser has been turned through 45°, all trace of colour is lost. After this, colour again begins to appear; not however the original tint, but its complementary; and in fact, there is no more sure way of producing colours complementary to one another than that here used. A general explanation of this change of colour is already furnished by our former experiments. Doubly refracting crystals generally, in the same way as Iceland spar, divide every ray, and consequently every beam of light which passes through them, into two, so that of every object seen through them, or projected through it on to a screen, two images are produced. These two, being parts of one and the same beam of light, would, if recombined, reproduce the original beam; and the same is, of course, the case with the two images. This may be rendered visible by using the double-image prism as an analyser, and throwing both images on the screen together. As the prism is turned round, it will be seen that, just as when no selenite was interposed, the images are alternately distinguished; but that when both are visible, their colours are complementary. And if the distance of the prism be so adjusted that the images overlap, it will be found that, when both are visible, the part where they overlap is always white, whatever be the thickness of the plate used.

An instructive experiment may be made by interposing an opaque object in the path of the beam of light, so that its shadow may fall upon the part of the field common to the two images. The shadow will of course intercept the light forming each of the images, and will consequently appear double. Suppose that the two images are

* Continued from p. 169.

coloured red and green respectively; then one of the shadows will be due to the shutting off of the red light, and the other to that of the green. But in the first case the space occupied by the shadow will be still illuminated by the green light, and in the second by the red. In other words, neither of the two shadows will be black, one will be green, and the other red. If in any part of their extent the two shadows overlap, the part common to the two, being deprived of both red and green light, will be black.

But in order to explain how it comes to pass that colour is produced at all, as well as to find a more strict proof that the colours of the two images are complementary, we must have recourse to some considerations based upon the wave theory of light. And first as to the mode in which waves may be produced.

Consider a row of balls lying originally in a horizontal straight line. Let the balls start one after another and vibrate at a uniform rate up and down. At each moment some will be at a higher, others at a lower level, at regular intervals in a wave-like arrangement; the higher forming the crests, the lower the hollows of the waves. The distance from crest to crest, or from hollow to hollow, is called the wave length. The distance from crest to hollow will consequently be half a wave-length. This length will be uniform so long as the vibrations are executed at a uniform rate.

Each ball in turn will reach its highest point and form a crest; so that the crests will appear to advance from each ball to the next. In other words, the waves will advance horizontally, while the balls vibrate vertically.

If the row of balls were originally arranged in a wave form, and caused to vibrate in the same way as before, those on the crests would vibrate wholly above, and those in the hollows wholly below the middle line. When the balls originally on the crests rise to their highest points, those in the hollows will fall to their lowest positions, and the height of the wave will consequently be doubled. When the balls originally at the crests fall, those in the hollows will rise, both to the middle line; and the wave will consequently be annihilated. The first of these corresponds to a condition of things wherein the crests of the new wave motion coincide with those of the old, and the hollows with the hollows; the second to that wherein the crests of the new coincide with the hollows of the old, and *vice versâ*.

Hence, when two sets of waves are coincident, the height of the wave or extent of vibration is doubled; when one set is in advance of the other by half a wave length, the motion is annihilated. The latter phenomenon is called *interference*. When one set of waves is in advance of the other by any other fraction of a wave-length, the height of the wave, or extent of vibration, is diminished, but not wholly destroyed; in other words, partial interference takes place. The distance whereby one set of waves is in advance of another is called the *difference of phase*.

The Wave Theory of Light consists in explaining optical phenomena by vibrations and waves of the kind above described. And according to that theory the direction in which the waves move is the direction of propagation of the ray of light.

The intensity of light depends upon the extent of the vibrations or the height of the waves; the colour upon the number of vibrations executed in a given interval of time. And since throughout any uniform medium the connection of the parts and the rate of propagation may be considered to be uniform, it follows that the waves due to the slower vibrations must be longer than those due to the more rapid. Hence the colour of the light may be regarded as depending upon the wave length.

The substance to the vibrations of which light is supposed to be due, is an elastic fluid or medium pervading all space, and even permeating the interior of all bodies. A full statement of the reasons which have led philosophers to make this hypothesis would involve considerations derived from other sciences besides optics, and would be out of place here. But it may still be pointed out that one strong argument is furnished by the fact of the transmission of light from the sun and from the fixed stars through space, where no atmosphere or known gases can be conceived to exist. That the light so traversing interstellar space must be transmitted by a material substance, is a fundamental proposition of mechanical philosophy; and the hypothesis of the ether simply consists in attributing to the substance or medium the property of elasticity (a property possessed in a greater or less degree by all known bodies), without assuming anything else whatever as to its nature or relation to other substances.

In the illustrations of wave motions given above, the balls would represent successive portions or molecules of the ether; and the means whereby the motion of one molecule is transmitted to its neighbour, is the elastic cohesion attributed to the whole medium in the hypothesis above mentioned.

The difference between ordinary and polarised light has been explained above; and the mechanical contrivances devised for representing wave motion always have reference only to polarised light. But as this is the subject with which we are here concerned, the limitation in question is not of consequence. A variety of instruments have been constructed for showing the effects of compounding vibrations or waves under different circumstances. The best with which I am acquainted is that by Sir Charles Wheatstone.

In plane polarised light, such as is produced by tourmalin plates, by double refraction in Iceland spar, &c., the vibrations are rectilinear, and are executed in one and the same plane throughout the entire length of the ray. In circularly polarised light the vibrations are all circular, and the motion is performed in the same direction. In elliptically polarised light the vibrations are all elliptical, the ellipses are all similarly placed, and the motion is in the same direction for the entire ray. These are the only known forms of polarisation, and indeed they are the only forms compatible with the usual, simplest assumption respecting the elasticity of the ether.

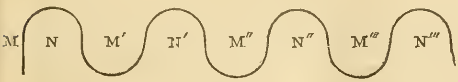
These general considerations being premised, we are in a position to trace the course and condition of a ray of light issuing from the lamp or other source, and traversing first the polarising Nicol's prism; secondly, the plate of doubly refracting crystal; thirdly, the analysing Nicol.

The vibrations of the ray on leaving the polariser are all restricted to a single plane. On entering the plate of doubly refracting crystal, every ray is divided into two, whose vibrations take place in planes perpendicular to one another. The angular position of these planes about the axis of the beam of light is dependent upon the angular position of the crystal plate about its centre. The two sets of rays traverse the crystal with different velocities, and therefore emerge with a difference of phase. The amount of this difference is proportional to the thickness of the plate. On entering the analyser the vibrations of each pair of rays are resolved into one plane; and are then in a condition to exhibit the phenomena of interference. If the plane of vibration of the analyser be parallel to one of those of the plate, that ray will be transmitted without change; the other will be suppressed. In any other position of the analyser those monochromatic rays (spectral components of white light whose difference of phase most nearly approaches to half a wave-length, will be most nearly suppressed; and those in which it approaches most nearly to a whole wave-length will be most completely transmitted. The amount of light suppressed increases very rapidly in the neighbourhood of the ray whose difference of phase is exactly

a half wave-length; so that with plates of moderate thickness a single colour only may in general terms be considered to be suppressed. This being so, the beam emergent from the analyser will be deprived of that colour, and will in fact consist of an assemblage of all others; or in other words will be of a tint complementary to that which has been extinguished.

Next, as regards the colours of the two images, that is, the two which are formed either simultaneously by a double-image prism or successively by a Nicol in two positions at right angles to one another. In the first place it is to be remembered that the two sets of vibrations into which the selenite has divided the polarised ray are at right angles to one another; secondly, that one set is retarded behind the other through a certain absolute distance, which is the same for every ray, and consequently through a distance which is a different fraction of the wave-length for each colour; thirdly, that these two are re-combined or "resolved" in a single direction in each image by the analyser.

This being so, bend two wires in the following form:—



and place them at right angles to one another about their middle line M N M′ N′ . ., so that the points M of the two wires coincide, and likewise N, and so on. This will represent the condition of the vibrations as they emerge from the selenite, when the plate is of such a thickness as to cause a retardation equal to one or to any whole number of wave-lengths. Turn the wires about their middle line M N M′ N′ until they meet half way, *i.e.* in a position inclined at 45° to their original directions; this will represent the vibrations as resolved by the analyser in one image. Turn the wires about their middle line as before, but in reversed directions, until they meet in a position at right angles to the former; this will represent the vibrations as resolved by the analyser in the other image. On looking at the wires when so brought together, it will be found that in one case the crests fall upon the crests and the hollows upon the hollows, so that the vibrations combine to increase the intensity of the light. In the other case the crests fall upon the hollows and the hollows upon the crests, so that the vibrations interfere and completely neutralise one another.

The same principle would obtain if we shifted one wire along the middle line so that the points M of the two wires no longer exactly coincide. This would represent the condition of the vibrations as they emerge from the selenite when the plate is of such a thickness as to cause a retardation of a fraction of a wave-length equal to the amount of shift. And on turning the wires as before, we should find that in one image the waves partially combine, and that in the other they partially interfere. The shifting of the wires would represent either the effect of plates of different thickness upon waves of the same length, *i.e.* rays of the same colour; or that of a single plate on waves of different lengths, *i.e.* on rays of different colours. From these considerations we may conclude that the rays which are brightest in one image are least bright in the other; or, in other words, that the colours of the two images are complementary.

It has been remarked that the colour produced by a plate of selenite depends upon the thickness of the plate. In fact, the retardation increases with the thickness, and consequently, if, for a given thickness, it amounts to a half wave-length of the shortest (say violet) waves, for a greater thickness it will amount to a half of a longer (say green) wave, and so on. And if, instead of a series of plates of different thicknesses, we use a wedge-shaped plate, the entire series of phenomena due to gradually increasing retardation will be produced. This is easily seen to consist of a series of tints due to the successive extinction of each of the rays, commencing with the violet and ending with the red. And the tints will consequently have for prevailing hues the colours of the spectrum in the reverse order. This series of colours will be followed by an almost colourless interval, for which the retardation is intermediate between a half red-wave length and three half violet-wave lengths. Beyond this again the series of colours will recur; and the same succession is repeated as the wedge increases in thickness. It will, however, be observed that the colours appear fainter each time that they recur, so that when the thickness reaches a certain amount (dependent upon the nature and retarding power of the crystal) all trace of colour is lost.

It is not difficult to account for this gradual diminution in the intensity of the colours if, by means of a diagram, we examine the mode in which the waves of various lengths interfere with one another; but spectrum analysis furnishes an explanation which is perhaps more easy of general apprehension. If the light emerging from the analyser be examined by a spectroscope, it will be found, in the case of a plate giving the most vivid colour, that the spectrum presents a dark band indicating the colour which has been extinguished. On using thicker and thicker plates the band will be found to occupy positions nearer and nearer to the red end of the spectrum, until the band finally disappears in the darkness beyond the least refrangible rays that are visible to the eye. If the analyser be turned round the band will gradually lose its characteristic darkness, until, when the angle of rotation has reached 45°, the band will have disappeared altogether. The spectrum is then continuous, and when recompounded will give white light. This corresponds to the fact noticed before, that when the analyser is turned round, the colour given by a selenite plate fades and finally disappears when the angle of rotation amounts to 45. If the rotation be continued a band reappears, not, however, in its original position, but in the part of the spectrum complementary to the former.

If the thickness of the plate be further increased, two bands will be seen instead of one; with a still greater thickness there will be three bands, and so on indefinitely. The total light then of which the spectrum is deprived by the thicker plates is taken from a greater number of its parts; or in other words, the light which still remains is distributed more and more evenly over the spectrum, and consequently at each recurrence of the tints the sum total of it approaches more and more nearly to white light.

The following experiment will be found very instructive. Take two wedges of selenite or other crystal, and having crossed the polariser and analyser, place the two wedges side by side in the field of view so as to compare the tints produced by the two. Then place one over the other, first with the thick end of the one over that of the other; next with the thick end of the one over the thin end of the other. If the two plates are exactly similar, the combination in the first instance will be equivalent to a single wedge whose refracting angle is double that of a single wedge; and the number of bands produced will consequently be doubled. In the second combination the angles of the wedges will compensate one another, and the result will be equivalent to a uniform plate whose thickness is equal to the sum of the mean thicknesses of the wedges. The field will then be coloured with a uniform tint, viz., that due to a plate of the thickness in question.

By making use of the principle that the colour produced depends upon the thickness of the plate, selenites have been cut of suitable shapes and thicknesses, so as to produce coloured images of stars, flowers, butterflies, and other objects.

W. Spottiswoode

(*To be continued.*)

*ON THE MOTION AND SENSATION OF SOUND**

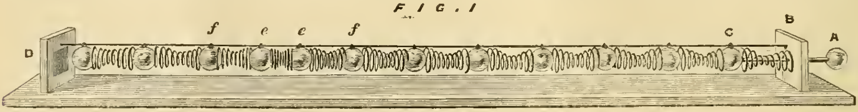
LECTURE I.

IT is needless for me to say to the ladies and gentlemen who honour these lectures with their presence, that they are intended more especially for the instruction of boys and girls. As in all other cases where it has fallen to my lot to teach others, I shall endeavour, while avoiding superficiality, to strip the subject of all unnecessary difficulty, and of all parade of learning, and to present it in simplicity and strength to the youthful mind.

The title of the lectures is, The Motion and Sensation of Sound. Now every boy knows what I mean when I speak of the sensation of sound. The impression, for example, of my voice at the present time upon the organ of hearing is the sensation of sound. But what right have I to speak of the motion of sound? This point must be made perfectly clear at the beginning.

For this purpose I will choose from among you a representative boy, or allow you to choose him, if you prefer doing so. This boy, whom you may call Isaac Newton, or Michael Faraday, will go with me to Dover Castle, make the acquaintance of the general commanding there, Sir Alfred Horsford, and explain to him that we wish to solve an important scientific problem. He is sure to help us: he will lend us a gun, and an

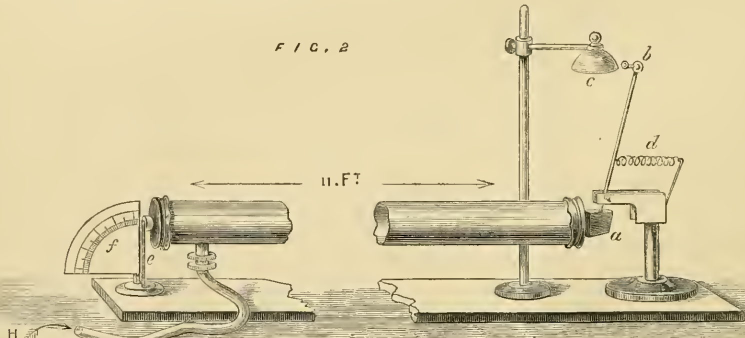
FIG. 1



intelligent artilleryman; and we will make arrangements with this man to fire the gun at certain times during the day. We set our watches together; and now, before quitting him, we ask the artilleryman to fire one shot. We are close at hand, and we observe the flash and listen to the sound. There is no sensible interval between them. When we stand close to the gun flash and sound occur together.

Well, we quit the artilleryman, warning him to fire at the exact times agreed upon. Let us say that the first shot is to be fired at 12 o'clock, the second at 12.30, and so on every half hour. We quit our artilleryman at half-past eleven, descend from the castle to the sea-shore, where a small steamer is awaiting us. We steam out a little better than a mile from the place where we have left the artilleryman; and now we pull out our watches and wait for 12 o'clock. Newton at length says, "In exactly half-a-minute the gun ought to fire;" and, sure enough, at the exact time agreed upon, we see the flash of the gun. But where is the sound which occurred with the flash when we were on shore? We wait a little, and precisely five seconds after we have seen the flash we hear the explosion; the sound having required this time to travel over a little better than a mile.

FIG. 2



We now steam out to twice this distance and wait for the 12.30 gun. We see the flash, but it requires ten seconds now for the sound to reach us; we treble the distance, it requires fifteen seconds; we quadruple the distance, and find the sound requires twenty seconds to reach us. And thus, if the day were clear, we might go quite across to the coast of France and hear the gun there. In all cases we should find that the flash appeared at the precise time agreed upon with the artilleryman, which proves that light reaches us in so short a time that our watches fail to give us any evidence that the light requires any time at all to pass through space, while the sound reaches us later and later the farther we go away. I think these experiments give us every right to speak of the "Motion of Sound."

But they also inform us how the velocity of sound has been actually determined. The most celebrated experiments on this subject have been made in France and Holland. Two stations were chosen ten or twelve miles apart; guns were fired at each station, and the interval between the flash and the report was accurately measured by the observers at the other station. In this way it was found that when the air is at the temperature of freezing water, the velocity of sound through it is 1,090 feet a second. On different days we should find it travelling at different speeds—as the weather grows warmer the sound is found to travel faster.

But I must not let you go with the idea that light re-

* Royal Institution Christmas Lectures, 1873—4, by Professor Tyndall, D.C.L., LL.D., F.R.S. These lectures have not been written out, much less intended for publication. At the request of our Reporter, Dr. Tyndall has consented to their appearance in NATURE.

quires no time at all to pass through space. This great problem has also been solved; and we now know that while sound moves at the rate of 1,090 ft. a second, light passes over the almost incredible distance of 186,000 miles in the same time. Hence at the distances employed in our observations, our watches were entirely unable to inform us that light required any time at all to pass through space.

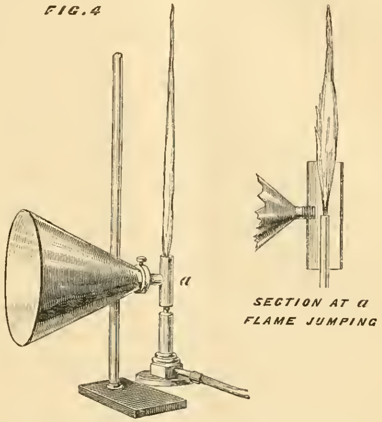
But if I stopped here, your next question would be—What is this thing which passes through the air with a velocity of 1,090 ft. a second, and which, when it reaches us, makes us hear an explosion? We must give a thorough and complete answer to this question, but to do this we need a little preparation. Like sailors going into battle, we must clear our decks for action; and here I must ask you to give me your patient and resolute attention.

In order to know how sound is propagated through the air, we must first know something regarding the air itself. Let us examine the air.

First, the air has weight. It presses upon a single square foot of this table with the weight of nearly a ton ($144 \times 15 = 2,160$ lbs.). I have here a glass cylinder covered at the top with a sheet of india-rubber. The air presses on that surface with the weight of nearly 900 lbs. But then you will ask how the india-rubber bears it. Why is it not pressed in? Because air is on both sides of it, and the pressure on the inside is exactly equal to that on the outside. But if I take away the air from the inside of the cylinder, you will soon see the india-rubber pressed down by the weight of air above it.

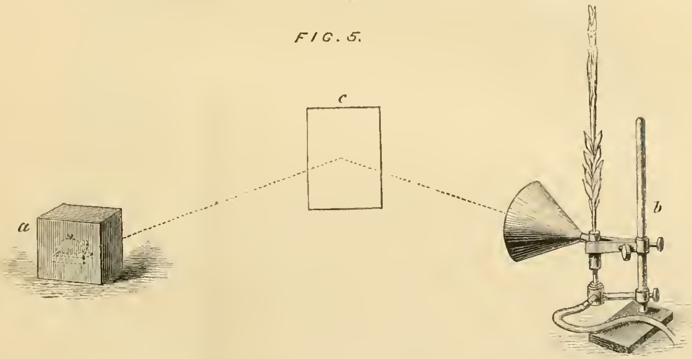
[A tube from an air-pump was then attached to a pipe communicating with the interior of the cylinder,

FIG. 4



which stood on a brass plate, to which its edges were ground parallel; the pump was set in action, and the

FIG. 5.



india-rubber diaphragm at once sank down, in the end clinging to the sides of the glass, forming a deep vessel lining the inside of the cylinder.]

When the air is let in again, you observe the rubber returns slowly to nearly its primitive position; it would entirely, but that the india-rubber is a little over-stretched.

We have thus seen the effect of removing the pressure from the inside. What would occur if we took the outside pressure away? The india-rubber would expand. Instead of trying to remove the whole of the air from this room, which is impossible, I will cover these two slack and collapsed bladders with this glass vessel, fitting accurately on to the plate, over which they are suspended; and then draw off by the air-pump the air surrounding them. See how they gradually blow out; the folds are now nearly abolished; now they have become quite smooth.

Why is this? Because the air particles have the power of pushing one another apart, and thus take up sufficient space to fill the bladders when the external pressure is removed. The air in this room is pressed upon by the weight of the whole atmosphere. The repelling force which the air particles exert upon each other is called the elastic force of the air.

Now we have to consider how the sound of the gun is propagated through air. Does the gun fire anything through the air? No. We may in a rough way represent the particles of air by the solitaire balls arranged in a row close together in this groove. I take the first one and roll it against the second. You observe the row does not move, only the end one goes away. The first delivers up its motion to the second, and then stops, the second delivers its motion to the third, the third to the fourth, and so on until the last, which, meeting no resistance, flies off. In this way we may figure the motion as transmitted from particle to particle of the air.

A still better idea may be derived from this model (Fig. 1), which has been devised by the ingenuity of my assistant, Mr. Cottrell.

In my hand I hold a stem (A), passing through the upright (B), by which a shock can be sent from a ball (C) through a spring to another ball, thence through another

spring to another ball, and so on, until at last the shock reaches the last ball, which is projected against the india-rubber pad at the end (D), placed there to represent in a rude mechanical way the drum of the ear. I press the stem (A), with a sudden motion of my hand, and you see that though the ball (C) only moves to and fro, yet it sends forward a kind of pulse (*f e e f*), which travels along the line, and ultimately causes the last ball to give a smart stroke against the pad (D).

If you could creep into the tube of the ear you would find, a little way in, a beautiful fine membrane called the tympanum, or tympanic membrane. The shock of the pulses of air falling on this membrane causes it to shiver; its tremors are transmitted to the auditory nerves, and by them are conveyed to the brain and cause you to have the sensation which we call sound.

You ought to be able now to figure the way in which the explosion of this pop-gun is transmitted through the air. I place a ramrod in the tube, there is a cork in the other end, and pushing the rod towards the cork, I cause a crowding together of the particles of air, this they resist, as I can feel by the force I am compelled to exert, and at last their combined resistance takes effect by blowing out the cork at the other end with a sort of explosion.

The suddenly expanding air communicates its motion to the air adjacent to it; this again to the air farther off; finally the condensed pulse strikes the tympanum of your ears, and you hear the noise.

I can show you the passage of a pulse through air in another way. We have here a tube 11 feet long, and about 4 inches wide, its two ends are closed by thin sheet india-rubber. Against the india-rubber surface at one end a cork gently presses (as in Fig. 2, *a*), to the cork a slender stem is attached having a little hammer at its upper end (*b*), kept from striking the bell (*c*), against which it abuts by a slender wire spring (*d*). If now a pulse be sent from the other end of the tube the india-rubber will drive away the cork, and will drive the hammer against the bell. A dull push will not ring the bell at the farther end. The particles of air are very mobile and readily slip round one another, so that it requires a sharp shock to generate a sound wave in the tube and make the bell ring outside the tube. I tap sharply with my fingers on the india-rubber and the sound of my tap and the blow of the hammer upon the bell at the other end of the tube are audible at one and the same time. This tube is 11 feet long, sound travels through air of the temperature of this room at about the rate of 1,100 ft. per second; the time therefore taken by the sound wave in traversing this tube is $\frac{1}{110}$th of a second, an interval of time far too minute to be measured by our ears.

Air is therefore a carrier or transmitter of sound. Suppose we remove the air from about a sounding body, will it then be heard? This experiment was made by Mr. Hawksbee a great many years ago (1705). A bell with a hammer worked by clock-work is placed under a glass globe. From the globe we will pump as much of the air as we can. At present you hear the sound with perfect distinctness, the pumping has at first apparently little effect upon the sound, but very soon it dies away, and now you see the hammer thumping away upon the bell, without producing any noise. It is doing its work in perfect silence. I allow the air to re-enter the glass globe, the tinkling sound of the bell is soon heard, and quickly grows up into the usual musical ring.

We have therefore proved that when the air is removed we have no sound, and when the air returns the sound returns also.

We will now follow the matter up a little further. Prof. Leslie found that when a little air was in the chamber surrounding the bell, and you could hear a little sound, that if the space from which the air had been taken was filled up with hydrogen, that the hydrogen quenched the sound. Now Prof. Stokes has shown us that to create a sound-wave in hydrogen a sharper tap is necessary than in air, so that the shock that produces a sound-wave in air does not suffice to produce a sound-wave in hydrogen (which is a much lighter and less dense gas).

My assistant, Mr. Cottrell, has devised the experiment I am about to show you to demonstrate this effect.

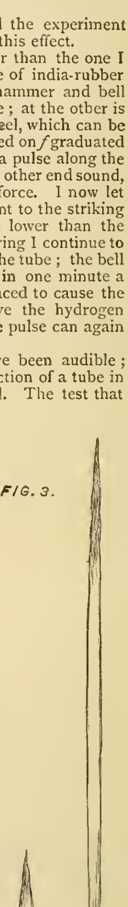
I have a long tin tube (Fig. 2) narrower than the one I used just now, but having like it a piece of india-rubber stretched over each open end, with a hammer and bell arranged against one of them, as before; at the other is a cork hammer fixed to a thin strip of steel, which can be drawn back to any given distance (measured on a graduated card). I have thus the means of sending a pulse along the tube as before and making the bell at the other end sound, but I now do it by a stroke of measured force. I now let hydrogen into the tube at the end adjacent to the striking cork (by the tube H), which is a little lower than the other end, and while the hydrogen is entering I continue to send pulses of measured strength along the tube; the bell continues to sound for a little while, but in one minute a sufficient amount of air has been displaced to cause the bell to cease ringing. When we remove the hydrogen you again hear the bell, showing that the pulse can again be carried from end to end of the tube.

Up to this point our illustrations have been audible; I now wish to render visible to you the action of a tube in preventing the dissipation of the sound. The test that I propose to use is a flame. I have behind the table a good-sized gas-holder, by which gas can be forced through a steatite burner. I light it, and we have that long pointed flame (Fig. 3 *a*), and we shall find that that flame is very sensitive. Chirrup to it, and see how rapidly it answers; a great part of the length of the flame is abolished instantly when the sound wave reaches it (Fig. 3 *b* and *c*). I rattle money, tap two keys, and this flame jumps in response to each jingle that I make. The current of air in the room, owing to our care for your comfort in the matter of fresh air, prevents these phenomena showing themselves as well as they do when the theatre is empty; but they are perfectly manifest. No one in this room can hear my watch ticking; but if I hold it near the flame you can distinctly hear the flame give a little roar, and see it suddenly shorten for each tick of the watch. The regularity with which it jumps indicates the regularity with which my watch is ticking.

And now observe the action of a tube in preventing the dissipation of sound. Using a less sensitive flame as the sound-test, I take off the india-rubber ends from our 11-foot tube, and place the flame at the end farthest from myself. The tapping of these two keys together does not affect the flame; but now, my distance from the flame being as great as before, I tap them opposite the open end of the tube, and each tap is rendered, by means of the flame, as visible to your eyes as it is audible to your ears.

Through the unconfined air this small bell does not affect the flame when set ringing; but when I place it at the extremity of the tube the flame dances to each stroke. Speaking-pipes possess their value solely from their preventing the dissipation of

FIG. 3.



the sound pulses; they act precisely as this tube does.

As you know, light cannot well get round a corner; neither can sound, though it does so more easily than light. This little bell acts automatically. I wind it up and start it. At a few feet distance the flame answers to each stroke. Placed behind a board, the flame becomes tranquil. I again bring it out from behind the board, and the flame jumps to each movement of the hammer. (For this experiment the sensitive flame was arranged as in Fig. 4, with a large glass funnel having its tubular end opposite the root of the flame; the board was held about 10 feet distant from the mouth of the funnel.) Sound therefore can be shaded off in the same way that light can be.

In this box, which is well padded, is a bell which I can set ringing at pleasure. The only way by which the sound can get out is this small square opening at one side of it. The bell is now ringing without affecting the sensitive flame (arranged as in Fig. 4); but when this box is turned round, so that its opening faces the quiet flame, we have it dancing and jumping as before.

In other respects also there is a similarity between the mode ot action of sound and light.

When a beam from the electric lamp is allowed to fall upon the glass mirror in my hand, it is reflected from the mirror, and the track of the beam being marked by the dust floating in the room, you can see the direction which it takes. This is in accordance with a well-known law, namely, that the angle of incidence is equal to the angle of reflection. It is perfectly plain to you that a line drawn so as to fall at right angles upon this mirror would divide that large angle formed by the two beams of light into two equal angles.

I hope now to make visible to your eyes the reflection of sound in obedience to the same law.

At one corner of the lecture table I place our sensitive flame (*b*), at the opposite corner the padded box containing the electric bell (*a*) with its opening directed in the path taken a moment ago by the beam of light, and I will hold this board (*c*), when everything is ready, where I before held the glass mirror. My assistant will now set the bell ringing. You observe that the flame is uninfluenced by it, but when I bring the board forward, the shortening of the flame at each stroke of the bell, proves that the law of the reflection of sound is the same as the law of the reflection of light: the angle of incidence is equal to the angle of reflection. In this case the flame is knocked down by an echo.

We have thus considered the reflection of sound from a plane surface; let us now see if it behaves like light when reflected from plane surfaces.

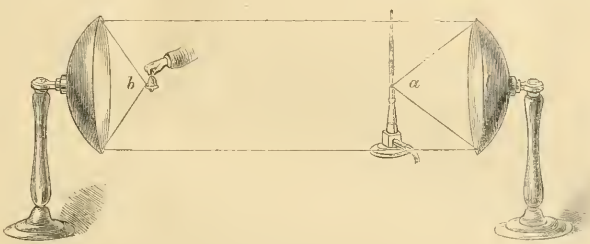


FIG. 6.

The beam of the electric lamp is now directed upon the concave mirror. You can see the band of light marked in the fine dust floating in the air; as soon as it strikes the polished surface it is thrown back, but the rays no longer pursue parallel paths, they are converged, thrown together into one spot. By holding a piece of tracing paper at the point where they meet, termed the focus, the brilliant little star of light caused by their convergence is made visible.

Substitute for the lamp a small bell, and for the tracing paper at the focus of the mirror our sensitive flame, and the conditions are the same as in the previous experiment, sound-waves taking the place of the waves of light. You cannot see the track of these aërial pulses as you could the luminous ones, but their obedience to the same law of reflection is very manifest by the shortening of the sensitive flame as each sound wave reaches it. The flame when out of the focus of the mirror is unaffected; replace it in the spot when the sound waves are crowded together, and it responds to each stroke. Move the bell so that the sound pulses, though only having the same distance to travel to the flame, no longer fall on the mirror: the flame remains perfectly quiet.

We may go further still. Here are a pair of mirrors, the curvature and size of which is the same. They are arranged so as to face one another. A light is placed in the focus of one, that its rays which fall divergent upon the curved surface are reflected from it parallel, they travel to the opposite mirror, and are again converged; a piece of tracing paper held at the focus of the farther mirror shows the spot of light as before (Fig. 6).

Sound is reflected in precisely the same way, and the sensitive flame when carefully manipulated can be used as a means of proving this fact. For these experiments it is essentially necessary that the flame be reduced to the proper pitch of sensitiveness. By reducing the pressure of the gas we can regulate the flame so that it will not respond unless strongly agitated. The flame is placed in the focus of the mirror (*a*), and when the bell is rung, not being in the focus of the conjugate mirror, there is no action. I now bring it into the focus (*b*) and the flame shows a very strong action.

By other modes of experimenting it has long been ascertained that sound was thus reflected from plane and curved surfaces; but never before have these phenomena been made visible. Hitherto these effects have been investigated by the sense of hearing; I have now been able to prove them by appealing to your eyes.

(*To be continued.*)

SCHOLARSHIPS AND EXAMINATIONS FOR NATURAL SCIENCE AT CAMBRIDGE, 1874

THE following is a list of the Scholarships and Exhibitions for proficiency in Natural Science to be offered at the several Colleges in Cambridge during the present year :—

TRINITY COLLEGE.—One or more of the value of about 80*l.* per annum. The examination will commence o

April 10, and will be open to all undergraduates of Cambridge and Oxford, and to persons under twenty who are not members of the Universities. Further information may be obtained from the Rev. E. Blore, Tutor of Trinity College.

ST. JOHN'S COLLEGE.—One of the value of 50*l.* per annum. The examination (in Chemistry, Physics, and Physiology, with Geology, Anatomy and Botany) will be in December, and will be open to all persons who have not completed a term of residence at the University, as well as to all who have entered and not completed one term of residence. Natural Science is made one of the subjects of the college examination of its students at the end of the academical year, in May; and Exhibitions and Foundation Scholarships will be awarded to students who show an amount of knowledge equivalent to that which in classics or mathematics usually gains an Exhibition or Scholarship in the college. In short, natural science is on the same footing with classics and mathematics, both as regards teaching and rewards.

CHRIST'S COLLEGE.—One or more, in value from 30*l.* to 70*l.*, according to the number and merits of the candidates, tenable for three-and-a-half years, and for three years longer by those who reside during that period at the college. The examination will be on March 24, and will be open to the undergraduates of the college, to non-collegiate undergraduates of Cambridge, to all undergraduates of Oxford, and to any students who are not members of either University. The candidates may select their own subjects for examination. There are other Exhibitions which are distributed annually among the most deserving students of the college. Further information may be obtained of Mr. John Peile, Tutor of the College.

GONVILLE AND CAIUS COLLEGE.—One of the value of 60*l.* per annum. The examination will be on March 24, in Chemistry and Experimental Physics, Zoology, with Comparative Anatomy and Physiology, and Botany, with Vegetable Anatomy and Physiology; it will be open to students who have not commenced residence in the University. There is no limitation as to age.—Scholarships of the value of 20*l.* each, or more if the candidates are unusually good, are offered, for Anatomy and Physiology, to members of the College.—Gentlemen elected to the Tancred Medical Studentship are required to enter at this College; these Studentships are five in number, and the annual value of each is 100*l.* Information respecting these may be obtained from Mr. B. J. L. Frere, 28, Lincoln's Inn Fields, London.

CLARE COLLEGE.—One of the value of 60*l.* per annum, tenable for two years at least. The examination (in Chemistry, Chemical Physics, Comparative Anatomy and Physiology, Botany with Vegetable and Animal Physiology, and Geology) will be on March 24, and will be open to students intending to begin residence in October.

DOWNING COLLEGE.—One or more of the value of 40*l.* per annum. The examination (in Chemistry, Comparative Anatomy, and Physiology) will be early in April, and will be open to all students not members of the University, as well as to all undergraduates in their first term.

SIDNEY COLLEGE.—Two of the value of 40*l.* per annum. The examination (in Heat, Electricity, Chemistry, Geology, Zoology and Physiology, Botany) will be on March 24, and will be open to all students who intend to commence residence in October.

EMMANUEL COLLEGE.—One of the value of 70*l.* The examination on March 24 will be open to students who have not commenced residence.

PEMBROKE COLLEGE.—One or more of the value of 20*l.* to 60*l.*, according to merit. The examination in June, in Chemistry, Physics, and other subjects, will be open to students under 20 years of age.

KING'S COLLEGE.—One of the value of about 80*l.* per annum. The examination, on April 14, will be open to all candidates under 20, and to undergraduates of the college in their first and second year. There will be an examination in elementary Classics and Mathematics, in addition to three or more papers in Natural Science, including Physics, Chemistry, and Physiology.

Although several subjects for examination are in each instance given, this is rather to afford the option of one or more to the candidates than to induce them to present a superficial knowledge of several. Indeed, it is expressly stated by some of the colleges that good clear knowledge of one or two subjects will be more esteemed than a general knowledge of several.

Candidates, especially those who are not members of the University, will, in most instances, be required to show a fair knowledge of Classics and Mathematics, such, for example, as would enable them to pass the previous examination.

There is no restriction on the ground of religious denominations in the case of these or any of the Scholarships or Exhibitions in the Colleges or in the University.

Further information may be obtained from the Tutors of the respective Colleges; and the names, with certificates of character, date of birth, &c., must be sent to the Tutor of the College, in each case, several days before the examination.

It will be observed that in several instances the time of the examination is the same, certain of the Colleges having combined together so as to hold one or two examinations instead of each College holding a separate examination.

Some of the Colleges do not restrict themselves to the number of Scholarships here mentioned, but will give additional Scholarships if candidates of superior merit present themselves; and other Colleges than those here mentioned, though they do not offer Scholarships, are in the habit of rewarding deserving students of Natural Science.

It may be added that Trinity College will give a Fellowship for Natural Science, once, at least, in three years: and that most of the Colleges are understood to be willing to award Fellowships for merit in Natural Science equivalent to that for which they are in the habit of giving them for Classics and Mathematics.

*ASTRONOMICAL ALMANACS**

X.—*Remodelling of the "Nautical Almanac" and the "Jahrbuch."*

NEARLY all the reforms which concerned astronomy were realised by Encke in the *Jahrbuch* for 1830, which appeared in May 1828. The appearance of this volume created an enormous sensation in England. The contest between Young and his opponents was then at its height. Strengthened by the help which had come to it from Berlin, the Astronomical Society redoubled its complaints and renewed its action; but the death of Thomas Young (May 10, 1829) soon occurred to simplify matters. In order that the question might not be hastily decided, the Society got the *Nautical Almanac* provisionally entrusted to the care of the Astronomer-Royal, J. Pond; at the same time it appointed a commission of forty members, composed of the directors of all the observatories and the principal astronomers and mariners, English and foreign.†

At last, at its annual meeting in February 1830, the Society awarded to Encke its gold medal for the great service which he had rendered to astronomy. "It would be superfluous," said Sir James South, President of the Society, in the address which he gave on that occasion, "for us to enlarge upon the merit of this well-known work, which, beyond all rivalry, ought to be regarded as the only ephemeris on a level with the requirements of

* Continued from p. 49.

† Struve took part in this commission.

Science, as the manual and guide of practical astronomy, wherever it may be cultivated."

But if the English are impartial and generous towards strangers, they could not bear to be for any time inferior in the various services which touch upon their interests. The sub-committee * charged with preparing the plan for reorganising the *Nautical Almanac*, presented its report to the Society at the meeting of November 19, 1830, a report which was adopted by the Council and immediately approved by the Admiralty. The results of this beneficial agitation were of immense value to astronomy and navigation, and the improvements introduced were such that, even from an astronomical point of view, the *Nautical Almanac* easily surpassed the *Jahrbuch*, and from a maritime stand-point it has not yet been equalled.

First of all, it should be stated that the Commissioners laid down as an absolute rule, a rule which has ever since been scrupulously followed, that the *Nautical Almanac* ought to appear four years in advance of the year for which it is calculated. Moreover, the direction of the *Nautical Almanac*, while continuing under the jurisdiction of the Admiralty, was entrusted thenceforth to a single person, the Superintendent of the *Nautical Almanac* Office.

The *Nautical Almanac* has been from that time in reality a special scientific institution, having its offices and its library established in a separate building. The salary of the superintendent was fixed at 500*l.*, and the annual parliamentary allowance was made amply sufficient to permit of the employment of calculators numerous enough to insure the greatest possible accuracy in the results. The first superintendent of the *Nautical Almanac* office was Lieut. S. Strafford, well known for the part which he took in the publication of Baily's "Zodiacal Catalogue."

The first volume of the new almanac, the *Nautical Almanac and Astronomical Ephemeris for the Year* 1834, appeared in July 1833. It embodied *all* the reforms which we have already mentioned; it would therefore be useless to indicate its contents in detail. We shall content ourselves with adding, that all the calculations relative to the principal planets were made under the direction of Schumacher of Altona, and those relating to the telescopic planets by the celebrated Encke. Moreover, as it is absolutely essential that a single list of stars of the moon should suffice navigators of all nations, the Royal Society came to an understanding with Encke on this subject. The stars of the moon ("moon's culminating stars"), ceased from that time to figure in the *Jahrbuch*, and the *Nautical Almanac* obtained the monopoly of this useful publication, a monopoly which it has since preserved.

The tables employed were nearly the same in the *Jahrbuch* and the *Nautical Almanac*. For the sun there were the new tables of Carlini, with the corrections of Encke and Bessel; for the moon the tables of Burckhardt; for Mercury, Venus, and Mars, the tables of Von Lindenau, with the corrections of Schumacher; for Jupiter, Saturn, and Uranus, the tables of Bouvart; for the satellites of Jupiter, the new tables of Delambre, with the corrections of Jenkins and Woolhouse.

XI. *The "Connaissance des Temps" since* 1832.

While this great work of reform and renovation was being carried on, the Bureau des Longitudes of France did not remain inactive. "The Bureau have recently appointed a commission, chosen from its own members, to examine some modifications which it would be expedient to introduce into the *Connaissance des Temps*. In considering this object, the commission has not lost sight of the fact that it is dealing with a work specially designed for mariners, with which they have been familiar for many years, and of which it was, above all, desirable that the price should not be increased." *

On the one side maritime necessities required that the *Connaissance des Temps* should, like the *Nautical Almanac*, appear four years in advance; although for long it has been published on an average only a year and a half before its date, being a delay of two years and a half. On the other side, the ephemeris then published by the *Connaissance des Temps* was evidently insufficient for French astronomers; the following modifications were therefore adopted, and were completely embodied in the *Connaissance des Temps* for 1835.

The mean time was the only time used (although astronomers needed the equatorial co-ordinates of the sun for true noon); the co-ordinates expressed in time were given at $0^{s}\cdot01$, and those in arc, $0''\cdot1$; the latitude and longitude of the moon were given for midnight and noon of each day; to the lunar distance were added those of the planets Venus, Mars, Jupiter, and Saturn; lastly were given for every tenth day, the apparent positions of sixty-four fundamental stars (the *Nautical Almanac* gave 100).

On the other hand, as it came to be seen that the solar tables of Delambre were defective, the Bureau invited Savary to amend them, but all he did was to remedy errors here and there by means of the corrections of Bessel. Moreover, Delambre's tables of satellites having been discontinued till 1840, Damoiseau was ordered to continue them. But all this was so insufficient, that the *Connaissance des Temps* could not be more serviceable to astronomers.

Thus, in 1838, the positions of the planets, which were given until then for every tenth day, were calculated to a minute of time and of arc; every third day for Mercury; every sixth day for Venus and Mars; every seventh day for Jupiter; every tenth day for Saturn; every fifteenth day for Uranus; and the value of the radius vector was added to the other elements. This was very far behind the *Nautical Almanac*, which gave the positions for every day to $0^{s}\cdot01$ and $0''\cdot1$.

In 1849, the number of fundamental stars whose apparent positions were given was carried to 115, and the apparent position of α Ursæ Minoris, was given for every day in the year. The *Nautical Almanac* had given those of α and δ Ursæ Minoris for 1834.

In 1854, M. Mathieu was specially appointed to the editorship of the *Connaissance des Temps*. Very soon after he entered upon his duties he had to sustain an attack which recalls that already referred to between Young, Baily, and Sir James South. For some years a sharp controversy was maintained between M. Mathieu and M. Leverrier, and at length the *Connaissance des Temps* of 1862 published for the first time the positions of the moon for every hour, with the differences for 10 minutes. "This innovation," the learned editor said, "is valuable to mariners; it simplifies the calculations of interpolation, and now sailors will be able to make use of the ephemeris of the moon with as much ease as that of the sun." The calculations of the moon are, moreover, made according to the tables of M. Hansen,† which the *Nautical Almanac* had employed since 1858. Lastly, in the same year, are given the positions of δ Ursæ Minoris for every day.

In the following year the ephemeris of the planets was improved, and there were given for every day the heliocentric and geocentric positions at mean noon of Mercury, Venus, Mars, Jupiter, and Saturn; for Uranus and Neptune the positions were calculated only for every fourth day. This was in imitation of a modification suggested by Mr. (now Sir G. B.) Airy to the superintendent of the *Nautical Almanac*, and applied by him from 1857 (*Almanac* for 1861). But, since 1839, besides the pre-

* Composed of Sir James South, president, F. Baily, reporter, C. Babbage, Capt. F. Beaufort, J. F. W. Herschel, J. Pond, Rev. Dr. Robinson, Lieut. S. Strafford, W. Struve.

* Advertisement of the *Connaissance des Temps* for 1832.

† "Tables of the moon constructed according to the Newtonian law of Universal Gravitation," by P. A. Hansen, Director of the Ducal Observatory of Gotha. (Printed at the expense of the British Government, 1857.)

ceding information, the *Nautical Almanac* gave, first for every day, and from 1861 for every two days, the ephemerides of all the planets for the time of their passing the meridian of Greenwich, information which French astronomers would have been happy to find in the *Connaissance des Temps* for the meridian of Paris. Let us add, moreover, that the positions of Neptune were only given in the *Connaissance des Temps* in 1861 (for 1863), while they were in the *Nautical Almanac* from 1857 (for 1861).

It was also in this same year, 1863, that the *Connaissance des Temps* gave for the first time the values of the constants of Bessel, intended to transform into apparent positions the mean positions of the stars given by the catalogues ; as well as the elements of the occultations, according to Bessel, in a form which enabled voyagers to calculate, for the very place where they happened to be, the principal circumstances of the phenomena. The *Nautical Almanac* had published all this since 1834.

In 1864, the positions of the sun, which for many years were calculated with the tables of Delambre, reconstructed in part by M. Mathieu, were published according to the tables of M. Leverrier ; the same was done for the positions of Mercury, and in the following year for those of Venus and Mars. The *Nautical Almanac* had used the tables of M. Leverrier since 1860 for the sun and Mercury (*Almanac* for 1864), since 1861 for Venus (*Almanac* for 1865), since 1862 for Mars (*Almanac* for 1866). On the other hand, the *Connaissance des Temps* for 1864 appeared in February 1863, and consequently six months after the *Nautical Almanac* for 1866. Finally, the *Connaissance des Temps* for 1864 contained the rectilinear co-ordinates of the sun referred to the plane of the equator ; they are found in the *Nautical Almanac* from 1849.

This collection of reforms raised considerably the value of the *Connaissance des Temps*, which, it was unanimously agreed, had fallen very low as compared with foreign ephemerides. The reform accomplished in France in 1864 was analogous to that of the *Jahrbuch* in 1829 and of the *Nautical Almanac* in 1830. But even at the present time the *Connaissance des Temps* does not contain any ephemeris of Ceres, of Pallas, of Juno, nor of Vesta, which has appeared in the *Nautical Almanac* and the *Jahrbuch* since 1830 ; nor of any of the numerous small planets discovered since 1845, for which the other two works publish a supplement each year. Yet for a long time past the continued observation of these telescopic planets has formed one of the most important occupations of most of the observatories.

In 1870 the direction of the *Connaissance des Temps* passed into the hands of Puiseux, who, however, kept it for only a very short time. His period of office, nevertheless, was marked by an important improvement. He indicated, by a figure in the proper place, the day on which, in consequence of the difference of length between the sidereal day and the mean solar day, each star passed twice across the superior meridian of Paris. This was a sad omission ; such an indication is found in the *Nautical Almanac* for 1822.

At present the direction of the *Connaissance des Temps* is entrusted to M. Lœwy ; Mr. Hind has been superintendent of the *Nautical Almanac* Office since 1853, and Herr Fœrster succeeded, in 1864, the celebrated Encke in the direction of the *Jahrbuch* of Berlin.

TELEGRAPHING EXTRAORDINARY

AT the Telegraph Office, Washington, on Dec. 11, 1873, an experiment was carried out in the presence of Mr. Creswell, the Postmaster-General of the United States, the practical results of which will be of immense importance as regards the future of telegraphy throughout the world.

On that occasion the president's last annual message of 11,500 words was transmitted from Washington to New York, a distance of 290 miles, over a single wire in 22½ minutes, the speed obtained being over 2,500 letters per minute.

At New York the message was delivered from the automatic instrument printed in bold type in presence of the Postmaster of New York. This achievement in telegraphy is the more remarkable as the principle involved is not new, but was well known in 1848. The experiments made at that date were practically without result. By the new American combination of chemistry and mechanism the speed is apparently almost unlimited, messages at the rate of 1,200 words, or 6,000 letters, a minute being afterwards transmitted with equally satisfactory results.

Hitherto the speed attainable over circuits of similar length in this country by the Wheatstone automatic system, at present in use for the "high speed" service by the Postal Telegraph Department, does not exceed 200 letters a minute.

The new American instrument has a great advantage in the extreme simplicity of its construction, mechanical detail giving place to chemical action. One important result of this experiment is that it demonstrates that hitherto the speed of transmission of electric currents through a metallic conductor has been restricted from mechanical imperfections in the mechanism of the recording or receiving instrument, and that by the substitution of chemical decomposition for mechanical action, an almost unlimited speed of transmission may be obtained. It is to be hoped that this new transmitting and recording instrument may be the agent by which our present tariff of 1*s.* for twenty words, may be reduced to 6*d.*, or less, for a similar message. Scientific progress, practically applied, is an heirloom to a nation.

NOTES

MR. HENRY LONSDALE is preparing a biography of John Dalton, the great chemist, and would be glad of any letters or other aid in his important work.

AT the meeting of the Paris Academy of Sciences held on Monday, January 5, M. Fremy was elected president for the ensuing year, and MM. Chasles and Decaisne were elected to serve on the central committee.

A COMMITTEE, consisting of Lord Cathcart, Mr. C. Whitehead, Mr. Jabez Turner, Mr. Wakefield, Mr. Brandreth Gibbs, Mr. J. Bowen-Jones, Mr. W. Carruthers, F.L.S., and Mr. J. Algernon Clarke, appointed by the Royal Agricultural Society to carry into effect the suggestions of the judges of the potato disease essays held a meeting on Monday at Hanover Square. They will recommend the Council to offer three prizes of 100*l.* each for disease-proof potatoes. Competitors will probably be required to send in one ton of each variety by the middle of February. Each sample will be distributed among growers in many different parts of England, Wales, Scotland, and Ireland ; and the produce of potatoes which resist disease during the first year's trial will be tested for two years longer. With a view of encouraging the production of new varieties, handsome prizes are to be offered also for disease-proof sorts raised from potato plums to enter into competition in the spring of 1879. The terms and conditions will be decided upon at the next meeting of the Council.

THE INDIAN MUSEUM, as it now stands, situated on the highest story of the India Office, has been found to be useless for all the purposes for which it was intended. It has therefore been resolved to erect on the plot of vacant ground in Charles-street, directly opposite the India Offices and facing St. James's Park, a new museum and public library. To this building,

which will be very handsome and commodious, all the treasures exhibited in the present museum, as well as those now stowed away for want of space, will be removed. The public library and reading-room will form a marked feature in the new building, and will be constructed more especially with a view to the wants of those preparing for competition in the Indian Civil Service Examinations.

A STATEMENT, drawn up by the Council of the Trades Guild of Learning describes at great length the objects which are contemplated by the organisation. It states that its purpose is to provide education for workmen (1) in the sciences underlying their respective industries, and (2) in various branches of higher education; and that it has sprung spontaneously from the workmen of this country, and its responsible direction will devolve in the main on them, with the support of others who can undertake to advise and help in their educational work. It will accept of no aid from the State, but will make use of the National Universities as the best source of general education for the people of the great towns, enabling them to acquire, not only the results of scientific research, but the most thorough and scientific methods of teaching. By means of branches, which it proposes to establish in the large towns, it hopes to supply what is required to render the work already begun by the University of Cambridge continuous and permanent. It will endeavour to form local Boards, consisting mainly of workmen, who will be responsible for the preliminary formation of classes and the collection of the funds necessary in order to obtain University teaching.

DR. SMALLWOOD, one of the oldest meteorological observers in Canada, and Professor of Meteorology in McGill University, died on December 22. He had carried on observations for more than thirty years; in the first instance at St. Martin's, and afterwards, under the auspices of McGill University and the Canadian Government, in Montreal.

THE Geological Parties of the Canadian Geological Survey and the Boundary Commission have now returned from the West, bringing much material of scientific interest. One of the most important practical results appears to be the establishment of the existence of very large and valuable beds of coal and lignite in various parts of the Canadian territory, between Red River and the Rocky Mountains. This must greatly promote the settlement of these territories and the extension of railway communication into them.

THE *XIX^e. Siècle* announces that one of the most distinguished officers of the French navy, as well as an eminent explorer, M. F. Garnier, has been assassinated by the Chinese rebels of Tonquin. It would appear that M. Garnier was in the month of November last engaged in an expedition in Tonquin, his object being to enforce the treaties by expelling from the country a Frenchman who had supplied arms to the people of Yun-nan. M. Garnier had captured a town and made prisoners, who are now on their way to France. It is possible that he fell in a subsequent engagement, but the telegram distinctly states that he was assassinated. On this point full details are expected to arrive on the 18th or 20th inst. M. Garnier was only 35 years of age, having been born at St. Etienne on July 25, 1839. Appointed a midshipman in 1860, he was attached in the same year to the staff of Admiral Charner, and in that capacity he made the campaigns of China and Cochin China. Three years later he was appointed Inspector of Native Affairs, and soon afterwards he published a pamphlet in which he propounded an elaborate scheme for an exploring expedition into the interior of Indo-China, with a view to the opening up of commercial communications between Southern China and the French possessions. M. de Chasseloup, at that time Minister of Marine, nominated a scientific commission to carry out this expedition, the importance of which he fully appreciated. On June 5, 1866, an expedition, under the command of Capt. de Lagrée, and comprising among other officers Lieut. Garnier, left Saigon, went up the river Me-Kong, explored Indo-China, and proceeded as far as Yunnan. After the death of his chief, Lieut. Garnier assumed the command of the expedition, which he brought back to Saigon, along the Blue River. This voyage of exploration, one of the most important which has been accomplished in the present century, occupied two years and a few days. The death of this young and intrepid traveller is an irreparable loss for France and for the whole scientific world.

LAST Thursday, Sir Bartle Frere, speaking at Glasgow on Dr. Livingstone, said that he was often asked what benefit and practical result he expects from Dr. Livingstone's labours. "I answer," Sir Bartle Frere said, "that the geographical problems alone which he will have solved must exceed in importance and interest those of any other explorer since the days of Columbus. But apart from all questions of geographical science, I believe that the commercial, political, and moral consequences must prove far more important than anything of the kind which has been effected since the discovery of the New World."

THE members of the Cambridge Natural Science Club concluded their fifth series of meetings on Saturday, December 6. Each member in turn brings some subject of scientific interest before the notice of the club, in the form of a paper or otherwise, and the discussions which follow have been in many cases both lively and prolonged. The following subjects were discussed during the October Term, 1873:—"Mechanics in Nature," by Mr. A. F. Buxton (Trin. Coll.); "Zoological Colonies," by Mr. A. J. Jukes Browne (St. John's Coll.); "The Magnetism of Crystals," by Mr. J. E. H. Gordon (Caius Coll.); "Some Transformations of Energy," by Mr. C. T. Whitmell, B.A. (Trin. Coll.); "The Neocomian Strata," by Mr. J. J. H. Teall, B.A. (St. John's Coll.); "Cone in Cone-structure in the Lower Silurian Rocks," by Mr. R. D. Roberts (Clare Coll.); and a paper on "The Continuity of the Chalk," read by Mr. P. H. Carpenter.

IN the last number of the *Journal* of the Scottish Meteorological Society is a paper by Prof. Mohn on "Certain Effects of Currents on the Temperature of the Sea and Air," of which the following are the results:—1. That the surface of the sea in currents in narrow sounds in summer is colder than in neighbouring places, where there is a wider sheet of water. 2. That an effect of the reverse kind takes place in winter, but in a much smaller degree. 3. That both effects together diminish the yearly range of the temperature of the surface of the sea. 4. That these circumstances influence the temperature of the air in the same direction at such places, and that hereby a part of the anomalous, strongly-marked oceanic character which places in such situations exhibit, is accounted for. Other papers in this number are—"Letter on some Meteorological Questions requiring Investigation," from Mr. Robert Tennent; and a valuable paper on "Atmospheric Ozone and its Sources," by Dr. T. Moffat.

MESSRS. MACMILLAN have issued a cheap "Special Edition for Schools," of Edward Clodd's "Childhood of the World," in the style of the "Science Primers."

THE Meteorological Committee of the Royal Society have considered Mr. Meldrum's "Notes on the form of Cyclones in the Southern Indian Ocean, and on some of the rules given for avoiding their Centres," of so much practical importance, that they have thought it right to print and circulate it in a separate form as a non-official paper.

WE can do little more than name the following books which have been sent us:—Professor Blackie's neat little volume "On

Self-Culture, Intellectual, Moral, and Physical, a Vade-mecum for Young Men and Students" (Edinburgh: Edmonston and Douglas), contains many old and valuable truths forcibly expressed, and is calculated, we believe, to benefit the class for whom it is intended.—"Darwinism and Design; or, Creation by Evolution" (Hodder and Stoughton), is an attempt to show that although "Evolution is true, the Design argument remains unshaken;" that indeed "Evolution is the method of Creation." —"From January to December; a book for Children" (Longmans), is a miscellany consisting of stories, poems, papers on natural history, &c., arranged, for no reason that we can see, under the twelve months of the year. We fear even grown-up children will find the visits to Kew, the Zoological Gardens, and other papers, dull; besides, it is a great blunder to send forth a book like this without a single illustration.—"The Alps of Arabia; Travels in Egypt, Sinai, Arabia, and the Holy Land," by William Charles Vaughan (King and Co.), goes over well-trodden ground, and tells us nothing new; though those who contemplate a similar journey will find the book u eful, fresh, and interesting.—"The Expanse of Heaven; a Series of Essays on the Wonders of the Firmament," by R. A. Proctor, B.A. (King and Co.), is sufficiently described by its title.

"GEOLOGICAL Sketch of the Province of Cadiz," by J. McPherson, is an abstract of a similar work written by the author in Spanish, and is printed at Cadiz. It is a valuable study of the subject, and is illustrated by well-executed maps and sections.

WE take the following from *Ocean Highways*:—Captain Heaviside, R.E., of the Great Trigonometrical Survey of India, is completing the work of Captain Basevi by forming a base station for the India pendulum operations, at the Kew Observatory. With this object he is now engaged in swinging Captain Kater's original convertible pendulum; and a re-measurement of its length will be undertaken probably at the Ordnance Survey Office at Southampton, by Colonel Clarke, the highest authority in England, and probably in Europe, as regards the measurement of standards.

THE Dublin College of Physicians, the *Lancet* says, has opened its portals to female aspirants for its degrees, a lady holding the M.D. of Zurich having been exempted from the first half of the examination for the L.K.Q.C.P. The College is also said to be willing to confer its midwifery diploma on all ladies who may, under certain regulations, apply for it.

WE have received an Italian publication by A. Manzone, on the fossils of Monte Titano in the republic of San Marino, their age and mode of origin. It is published at Florence by G. Barbèra.

THE principal papers in the last number of Petermann's *Mittheilungen* are, a Memoir of Colonel Eemel von Sydow a long account, by Prof. Nordenskiöld, of the Swedish Expedition to the North-east of Spitzbergen, from April 24 to June 15, of last year, an account of the Exploration of North-west Texas, by an expedition sent out in 1872 by the Texas Land and Copper Association, and a summary of the work of the *Challenger* Expedition in the North Atlantic. The last two are illustrated by well-executed maps.

THE additions to the Zoological Society Gardens during the past week include a Lioness (*Felis leo*) from Kattywar, presented by Mr. J. Humfrey, of the Bombay Staff Corps; three common Marmosets (*Hepale jacchus*) from S.E. Brazil, presented by Le Chevalier d'Albuquerque; a Crested Ground Parrakeet (*Calopsitta novæ-hollandiæ*) from Australia, presented by Vice-Admiral Wallis Houston; and a Drill (*Cynocephalus cucophæus*) from W. Africa, purchased.

SCIENTIFIC SERIALS

The Monthly Microscopical Journal, for this month, contains four papers, besides the notes, record of the progress of Microscopical Science and the Proceedings of the Royal Microscopical Society.—Mr. S. J. McIntire, in Notes on so called *Acarellus*, discusses the point whether the specimens described and named *A. muscæ* and *A. pulicis*, by Mr. Tatem, are related to a form known by him as a parasite on *Obisium*, and elsewhere; and whether it is one of the early forms of *Gamasus*, as thought by Mr. Tatem and Dujardin, though not by himself. —A second paper by Mr. W. H. Dallinger and Dr. J. Drysdale, contains further researches into the life-history of the Monads. The importance of prolonged study of the same form is insisted on, and this shows that the method of multiplication is not, as generally supposed, entirely by fission, but sometimes by an absorption into one of two individuals, the resulting mass clearing like an ovum, and giving rise, somewhat as in *Gregarina*, to a multitude of new individuals. Sometimes more than two, as many as four or six, were observed to unite.—Prof. E. Hull describes the microscopic structure of a granitoid quartz-porphyry from Galway, in which "the silica has consolidated into individual sub-crystalline grains before the other minerals, whereas in all true granites the silica has been the last to consolidate. The presence of aqueous (?) vapour during the consolidation of this rock is shown by the existence of numerous fluid cavities, and is another feature in which it resembles true granites."—Mr. G. W. Morehouse's paper on the structure of the scales of *Lepisma saccharina*, is reprinted from the *American Naturalist*.

Poggendorff's Annalen der Physik und Chemie, No. 8, 1873. —In this number, M. Riess criticises four different methods for determining the duration of discharge of a Leyden battery; that of Wheatstone, with rotating mirror; that of Lucas and Cazin, with rotating slitted disc; the electrical thermometer; and the electro-dynamometer. He shows, from experiments with the first two, that the light-duration of the spark consists of two time-parts; the discharge-time of the battery, and the duration of the after-glow of particles of metal present in the spark. These two parts vary, sometimes in the same direction, sometimes in opposite directions. Thus the duration of the discharge and the luminous duration of the discharge-spark stand in no fixed relation to each other.—In a paper on polarisation of electrodes in the voltaic arc, M. Herwig obtains results different from those of Grove on the same subject. His final mode of experiment was with a ball of pure silver as one electrode, and a plate of copper as the other; the ball being moved from point to point over the plate. Only the silver was here pulverised and any repeated action on what of it passed to the plate was prevented. M. Herwig found that the waste of silver was not even remotely equivalent to the quantity of hydrogen developed in the voltameter.—Dr. Rink has a paper on the velocity of sound, in which he raises some objections to the conclusion to which M. Regnault was led by experiments with the gas and water pipes of Paris, viz., that the velocity of sound is dependent on its intensity, and that a weak wave is propagated less quickly than a strong one.—A lengthy article by M. Riecke treats of the magnetisation of soft iron. He gives experimental determinations of the functions of magnetisation for different kinds of iron (by which is meant the induced magnetic moment divided by the magnetising force).—In a note on the relations between capillary and electric phenomena, M. G. Lippmann describes a capillary electrometer and an electro-capillary motor (with illustrations). In the latter, two bundles of fine glass tubes, dipping in separate vessels of mercury, are moved up and down alternately through the changes of form the mercury surface undergoes from polarisation with a galvanic current; and this motion is converted into rotary by a system of levers.—M. Bergh proposes an application of solar heat as a motor force, —vaporising sulphurous acid contained in vessels on the roof of a workshop. He would add to the solar machine, Natterer's apparatus for condensing carbonic acid; the force thus stored up might be used when solar heat was deficient.—M. Leyser describes a new form of Holtz's machine; and among the remaining subjects treated in this number are, heat relations and decompositions in solution of mixed salts in water (Winckelmann), absorption of heat by pulverised carbon (Vierordt), determination of the relation of specific heat to the velocity of cooling of certain gases(Kohlrausch).

SOCIETIES AND ACADEMIES

London

Royal Society, Jan. 8.—"On the Brom-Iodides," by Dr. Maxwell Simpson, F.R.S., Professor of Chemistry, Queen's College, Cork.

"Contributions to the History of the Orcins.—No. IV. On the Iodo-derivatives of the Orcins," by Dr. John Stenhouse, F.R.S.

"A Memoir on the Transformation of Elliptic Functions," by Prof. Cayley, F.R.S.

"On Electro-torsion," by George Gore, F.R.S.

This communication contains an account of a new phenomenon, of rods and wires of iron becoming twisted whilst under the influence of electric currents; and a full description of the conditions under which it occurs, the necessary apparatus, and the methods of using it.

The phenomenon of torsion thus produced is not a microscopic one, but may be made to exceed in some cases a twist of a quarter of a circle, the end of a suitable index moving through a space of 80 centimetres (= 31 in.). It is always attended by emission of sound.

The torsions are produced by the combined influence of helical and axial electric currents, one current passing through a long copper-wire coil surrounding the bar or wire, and the other, in an axial direction, through the iron itself. The cause of them is the combined influence of magnetism in the ordinary longitudinal direction induced in the bar by the coil-current, and transverse magnetism induced in it by the axial one.

The torsions are remarkably symmetrical, and are as definitely related in direction to electric currents as magnetism itself. The chief law of them is—*A current flowing from a north to a south pole produces left-handed torsion, and a reverse one right-handed torsion, i.e.* in the direction of an ordinary screw. Although each current alone will produce its own magnetic effect, sound, and internal molecular movement, neither alone will twist the bar, unless the bar has been previously magnetised by the other. Successive coil-currents alone in opposite directions will not produce torsion, neither will successive and opposite axial ones.

Signs of electro-torsion were obtained with a bar of nickel, but not with wires of platinum, silver, copper, lead, tin, cadmium, zinc, magnesium, aluminium, brass, or German-silver, nor with a thick rod of zinc, or a cord of gutta-percha.

Zoological Society, Jan. 6.—Dr. A. Günther, F.R.S., vice-president, in the chair.—Dr. A. Leith Adams exhibited and made remarks on the horns of a feral race of *Capra hircus*, from the Old Head of Kinsale. The horns were very remarkable for their large size and very close resemblance to those of *Capra ægagrus*.—Mr. P. L. Sclater, F.R.S., read a synopsis on the species of the genus *Synallaxis*, of the family *Dendrocolaptidæ*. The specimens of this difficult group in nearly all the principal collections of Europe and America had been examined, and the existence of 58 species ascertained, beside three of which the types were not accessible, and which were considered to be doubtful.—Mr. George Busk, F.R.S., read a paper on a new British Polyzoon, proposed to be called *Hippuria egertoni*, after Sir Philip Egerton, who had discovered it growing upon the carapace of a specimen of *Gonoplax angulatus*, dredged up at Berehaven in the course of last summer.—Mr. Alfred Sanders read a series of notes on the myology of *Phrynosoma coronatum*.—A communication was read from Dr. J. E. Gray, F.R.S., containing a description of the Steppe-cat of Bokhara, which he proposed to designate *Chaus caudatus*.—Sir Victor Brooke, Bart., read a paper on Sclater's Muntjac and other species of the genus *Cervulus*. In pointing out the distinctions which characterise the three existing species, *Cervulus muntjac*, *C. sclateri*, and *C. reevesii*, the author showed *C. sclateri*, the species of most northern range, to be intermediate in specific characters and size between the two others. Sir Victor pointed out an advance in the specialisation of the tarsus of *Cervulus* not hitherto observed. In this genus the navicular, cuboid and second and third cuneiform bones were anchylosed together and formed one single bone, the first cuneiform being represented by a very small and separate bone.—A second paper by Sir Victor Brooke contained the description of a new species of deer from Persia, a pair of horns of which he had received from Major Jones, H.B.M. Consul at Tabreez in Persia, and which he proposed to call *Cervus mesopotamicus*.—Major H. H. Godwin Austin read a paper on some birds obtained by him in 1872-73 along the main water-shed of the Brahmaputra and Irrawaddy Rivers. Of these ten were considered as new to Science, viz.:—*Sitta Nagensis*, *Garrulax galbanus*, *G. albosuperciliaris*, *Trochalopteron cinera-ceum*, *T. virgatum*, *Actinodura waldeni*, *Layardia robiginosa*, *Prinia rufula*, *Cisticola munipurensis*, *Munia subundulata*.—Mr. Garrod made some remarks upon the morbid symptoms presented by the Indian rhinoceros that had lately died in the Society's Gardens, and upon certain points in its anatomy.—Mr. Edwin C. Reed communicated a paper on the Chilian species of the Coleopterous families *Cicindelidæ* and *Carabidæ*.

Royal Microscopical Society, Jan. 7.—Chas. Brooke, F.R.S., in the chair.—Mr. Chas. Stewart gave an interesting *résumé* of a paper contributed by Dr. H. D. Schmidt of New Orleans on the origin and development of red blood-corpuscles in the human embryo, and illustrated his remarks by black-board diagrams enlarged from a number of most beautifully executed drawings which accompanied the paper.—A discussion followed, in which Dr. Lawson, Dr. Matthews, Mr. Stewart, and the president took part.—A paper was also read by Mr. Alfred Sanders on the Zoosperms of crustacea and other invertebrata.—The secretary read a paper by the Rev. W. H. Dallinger, giving a description of his method of preparing drawings of microscopical objects for class illustration, &c.—Mr. Richards exhibited a new arrangement for a tank microscope for the examination of objects under water to a depth of eight inches; and some beautiful slides of diatoms were shown under the society's instruments sent up by Capt. John Perry of Liverpool, containing the following species, viz.:—*Aulacodiscus formosus*, *Aulacodiscus margaritaceus*, and *Auliscus racemosus*, all recent.

Society of Biblical Archæology, Jan. 6.—Dr. Birch, F.S.A., president, in the chair. The following papers were read:—"The Sallier Papyrus containing the Wars of Rameses Meriamun with the Khita," translated with Annotations by Prof. Lushington.—This well-known text was supplemented by a fragment from the Raifet Collection; it contains perhaps the most vivid picture of a pre-Homeric battle extant: the king himself, the chief actor, frequently speaking in the first person. The two finest passages, the prayer of Rameses to his father Amun, and the defeat of the Hittites, possessing peculiar beauty, in addition to the interest attaching itself to a people who, about 1,200 B.C. were formidable enemies to the Egyptians themselves.—"On some illustrations of the Book of Daniel from the Assyrian Inscriptions," by H. Fox Talbot, F.R.S.

Manchester

Literary and Philosophical Society, Dec. 16, 1873.—"On the Destruction of Sound by Fog and the Inertness of a Heterogeneous Fluid," by Prof. Osborne Reynolds, M.A. The paper commences—That sound does not readily penetrate a fog is a matter of common observation. The bells and horns of ships are not heard so far during a fog as when the air is clear. In a London fog the noise of the wheels is much diminished, so that they seem to be at a distance when they are really close by. On one occasion during the launch of the *Great Eastern* the fog was reported so dense that the workmen could neither see nor *hear*. It has also been observed that mist in air or steam renders them very dull as regards motion. This is observed particularly in the pipes and passages in a steam engine. Mr. D. K. Clark found in his experiments that it required from 3 to 5 times as much back pressure to expel misty steam from a cylinder as when the steam was dry. The author then proceeds to explain these phenomena and to show that the particles of water do not, as it has sometimes been supposed, break up the waves of sound by small reflections in the same way as they scatter the waves of light, but that the destruction of sound is due, like the dulness of motion, to the fact that when foggy air is accelerated or retarded the drops of water move through the air and expend energy in fluid friction. He points out, as a well-known fact, that when foggy air is at rest under the action of gravity the drops of water are not at rest, but descend through the air with a velocity proportional to the square root of their diameters, and that consequently the energy destroyed in a given time is proportional to the square root of the diameters of the drops. He then shows that exactly the same is the case when the fog is subjected to a uniform acceleration and a somewhat similar effect when the acceleration is irregular or alternating. He says, This then fully explains the dulness with which foggy air acquires motion. In the passages of a steam engine the steam is subjected to continual accelerations and retardations each of which requires more force in the manner

described with misty than with dry steam, and at each of which the particles of water moving through the steam destroy energy in creating eddies. Although not so obvious, the same is true in the case of sound. The effect of waves of sound traversing a portion of air is first to accelerate and then to retard it. And if there are any drops of water in the air these will not take up the motion of the air so readily as the air itself. They will allow the air to move backwards and forwards past them, and so cause friction and diminish the effect of the wave as it proceeds, just as a loose cargo will diminish the rolling of a ship. He then proceeds to examine the relation between the size of the drops and their effects, always supposing the same quantity of water to be present. He says—I do not know that it has ever been noticed whether a fine or a coarse mist produces the most effect on sound; it does not appear, however, that rain produces the same effect as fog, and considering rain as a coarse fog we must come to the conclusion that a certain degree of fineness is necessary. If we examine theoretically into the relation between the size of the drops and the effect they produce, always assuming the same quantity of water in the air, we find in the first place that if the air is subjected to a uniform acceleration, which acts for a sufficient time for the drops to acquire their maximum velocity through the air, the effect of the drops in a given time—that is to say, the energy dissipated in a given time—is proportional to the square root of the diameters of the drops. This appears from the action of gravity. As previously stated, the maximum downward motion of the drops, and hence the distance they wi'l have fallen in a given time and the energy destroyed, is proportional to the square root of their diameters. Hence where the acceleration acts continuously for some time, as would be the case in a steam-pipe, the effect will increase with the size of the drops. This effect may be represented by a parabolic curve in which distances measured from the vertex along the axis represent the size of the drops and the corresponding ordinates represent their effect in destroying energy. If on the other hand the acceleration alternates very rapidly then there will not be time for the drop to acquire its maximum velocity, and if the time be very short the drop will practically stand still, in which case the effect of the drops will be proportional to the aggregate surface which they expose. And this will increase as the diameter diminishes, always supposing the same quantity of water to be present. This latter is somewhat the condition when a fog is traversed by waves of sound, so long as the drops are above a certain size; when, however, they are very small, compared with the length of the waves, there will be time for them to acquire their maximum velocity. So that starting from drops the size of rain, their effect will increase as their size diminishes, at first in the direct proportion, then more and more slowly until a certain minuteness is reached, after which, as the drops become still smaller, their effect will begin to diminish, at first slowly, but in an increasing ratio tending towards that of the square root of the diameter of the drops. This effect may be represented by a curve which coincides with the previously described parabola at the vertex, but which turns off towards the axis, which it finally approaches as a straight line. This completes the investigation so far as I have been able to carry it. The complete mathematical solution of the equations of motion does not appear to be possible, as they are of a form that has not as yet been integrated. However, so far it appears to me to afford a complete explanation of the two phenomena, and further to show, a fact not hitherto noticed, that for any note of waves of sound there is a certain size of drop with which a fog will produce the greatest effect.

Edinburgh

Botanical Society, Jan. 8.—The following communications were read:—Obituary Notice of Dr. J. Lindsay Stewart, by Dr. Cleghorn.—Note on a Station for *Primula veris* in Coldingham Bay, Berwickshire, by Sir Robert Christison, Bart.—Notes of a visit to Messrs. Dickson and Turnbull's Nurseries, Perth, with remarks on arboricultural subjects, by James M'Nab, V.P.—Note on the destruction by frost of seedling ash trees in Mr. Robertson's nursery ground, near Fettes College, in May 1873, by Alexander Buchan, M.A.—Notice of botanical excursions in 1873, by Prof. Balfour.—Notes on some British fungi, by Prof. Dickson and Mr. John Sadler. Specimens were exhibited.

Victoria

Microscopical Society, Oct. 30, 1873.—Mr. W. H. Archer, the president, occupied the chair.—Mr. T. S. Ralph addressed the society relative to a fungus affecting the rye-grass, which has been brought before the notice of the society. He regarded its botanical position as uncertain, but was inclined to think it belonged to a lower form of fungus than *Clavaria*. In a specimen which he had prepared, the mycelium or network of the thread of the fungus would be observed penetrating the cells of the rye-grass, thus robbing the cells of the materials intended for the nourishment of the plant. These mycelial threads travelled through the cells, and ultimately coming to the surface of the leaf, produced the peculiarly reddish film which attracted the eye of the observer, besides the withering of the leaf of the plant.—Mr. F. Barnard exhibited some foraminifera, collected from various parts of the colony and in Queensland, some of which were unnamed and new to recent observers.—The President (Mr. Archer) brought forward living specimens of the polyp *Tyrcha viridis*, and of some freshwater polyzoa, the latter being apparently a new species, and allied to Fredericella, of which he had found species in a pool on the banks of the Yarra.

Paris

Academy of Sciences, Jan. 5—M. Bertrand in the chair. This being the first meeting of the year the members proceeded to elect a vice-president. [See Notes.] M. de Quatrefages, the retiring president, then read his report, after which the Academy proceeded with its usual business—the following papers were read.—On the conductibility of magnetic tensions, by M. Jamin.—On a new and simple form of the pro-embryo of echinoderms Stelleridæ (*Asteriscus verruculatus*), by M. H. de Lacaze-Duthiers. A mechanical interpretation of the laws of Dulong and Petit, and Wœstyn on specific atomic heats, by M. A. Ledieu. This paper contained a number of mathematical data in relation to the recent papers of MM. Lockyer, Dumas, and Berthelot.—Remarks on the relations between specific heats and atomic weights in simple and compound bodies, by M. A. Pissis. The author states that these relations tend to show that there is no distinction really existing between simple and compound bodies, but that on the contrary the so-called elements behave to a certain extent like binary compounds.—On ammoniacal urine, its dangers, and the means of preventing it, by MM. Gosselin and Robin. M. Pasteur observed in connection with this subject, that it would be of great importance to ascertain if this characteristic of urine is not connected with the presence of an organised ferment.—The perpetual secretary read a note from M. Poey on the connection between sun-spots, earthquakes in the Antilles and Mexico, and volcanic eruptions throughout the world.—Researches on the conditions under which a conoid of a given curve exhibits a contact of a determinate order, by M. Painvin.—An answer to M. Faye's remarks on terrestrial waterspouts, by M. Th. Reye. M. Faye made some remarks in reply.—On the variable period in the closing of a voltaic circuit, by M. A. Cazin. This was an answer to M. Blaserna's remarks.—On the conditions necessary for the formation of octahedral borax, by M. de Gernez.—On the geological conditions of the islands adjacent to the African shore from Morocco to Tunis.—On a Marine Carboniferous flora discovered in the neighbourhood of l'Ardoissière in the valley of Lichon (Forez).—On the geographical distribution of the ferns of New Caledonia, by M. Eng. Fournier.—On the pluvial law of the torrid zone, in the basin of the Atlantic Ocean, by M. V. Raulin.

CONTENTS

Erratum.—Vol. ix. p. 132, 1st col. line 19, for "Mr. J. D. Painter" read "Mr. J. D. Sainter."

THURSDAY, JANUARY 22, 1874

SCIENCE AND INDUSTRY

IS England rapidly losing that commercial and manufacturing supremacy which she has held before all the world for generations past? Is she going the way of Venice, of Florence, of Holland? If so, is it because she feels blindly secure that "what hath been, will be," neglecting the means on which success in commerce and manufactures in these days depends—means which are being so industriously used by rival nations, that they are rapidly shooting ahead of England on England's own ground?

Such would seem to be the drift of the utterances which have come from three different quarters during the past week. In Lord Derby's address at the inauguration of the Society for the Promotion of Scientific Industry; in the correspondence in the *Times* of the past few days; and in the statements of the Society of Arts' deputation last Saturday to the Lord Chancellor with respect to the Patent Museum, it is more or less distinctly hinted that the industries of England are perishing from lack of knowledge. Other countries, but especially Germany, we are told, are distancing us, and we fear the proofs of the statement are too convincing to be resisted. To all appearance, Germany is destined to step into the honourable position as an industrial nation, which all the world has hitherto acknowledged as belonging to England. In short, in Commerce as in Science we are losing ground.

One correspondent in Monday's *Times* tells us that in the East "the Germans are carrying everything before them;" "by their energy and enterprise they have gone ahead of their easy-going English neighbours . . . whatever be the causes, there can be no question that they are outstripping us in the race for commercial prosperity in the East." This is in confirmation of what a correspondent in a previous number of the *Times* had stated from observation as to the rapid ascendency of the Germans in commerce. Another correspondent, an "Ex-president of the Liverpool Chamber of Commerce," states in Monday's *Times*, without hesitation, that young Germans make the best business men. Dr. Lunge, in his recent address to the Newcastle-on-Tyne Chemical Society (see NATURE, vol. ix. p. 113), states that in the matter of the applications of chemistry, "foreign countries are taking the wind out of our sails very fast in that line, and that both their rate of progress and the means of attaining it are very much superior to ours," because a better career is open to chemists there than with us. Lord Derby says that if we don't take care we shall find ourselves in the position of a man who succeeds to a ready-made business, and who "does not get up as early nor work as hard as his father, who had to make it." Perhaps, had Lord Derby said all that he thought, he would have put the case much stronger against us.

What are the causes which have led to this state of things? How is it especially that Germany is getting so rapidly ahead of us? All who have inquired into the question, attribute it to the difference between the methods of education in England and in Germany, and the greater appreciation of Science in the former country. The mere fact of the establishment of the Society for the Promotion of Scientific Industry, shows that the eminent men who compose it feel that energetic measures should at once be taken to enlighten the multitudes on whom the success of our industries depend. Lord Derby, in his speech at Manchester, said:—

"If we mean to keep our old position as the industrial leaders of the world we must throw away no chance, and leave no stone unturned. No doubt, in applied science, whatever discoveries are made or inventions brought into use by one country will soon extend to all. Still there is an obvious advantage in getting the lead; and that advantage we ought, if possible, to secure. . . . We are shut up therefore to one or two conclusions—either we must acknowledge ourselves beaten, or we must contrive to make every day's labour of a man more productive than it has been hitherto by the more general, or by the more skilful use of mechanical and chemical science.

He then goes on to state that:—

"Now it is the belief of the promoters of this new society that a great deal may be done for technical training without interfering with that training of the workshop which is, in one sense, the best of all. They believe, moreover, that there are innumerable investigations of an experimental kind, having for their object the perfecting of industrial processes, which being everybody's business are nobody's business, which would in their results enormously benefit the trade or industry which they concern, but which individuals are slow to undertake, because they do not bring any certain return of profit to the person who spends time and labour upon them."

Hitherto the vast majority of those connected with our industries have done their work by mere rule-of-thumb, without anything like a scientific knowledge of the material or the machinery on which they are employed. This will no longer do; herein lies our weak point; in this direction it is that the Germans are rapidly excelling us. The secret of the growing success of the Germans in commercial and manufacturing industries lies not only in their thoroughly organised and scientific system of education, in their "Realschule" and their technical training-schools, but in the general interest taken in the advancement of knowledge, the development of new methods. In the Realschule the young German gets a thorough liberal and scientific education, not a mere rule-of-thumb technical training. The literary training is at least as good as that which can be obtained at our best public schools, with the advantage of a thorough instruction in the principles and facts of physical science, *without any narrow views as to their future practical application.* "The consequence is," says a German writing to Monday's *Times*,

"That the 'Realschule' trains thorough gentlemen who in future life are able to make themselves useful as bankers, merchants, and manufacturers. Many of my friends have acquired such positions; several of them are well-known inventors and chiefs of enormous trading and manufacturing concerns. This system of education produces a class of men who take a warm interest in all practical matters, and find as much pleasure and amusement in the invention and rivalry of machinery, or the production and quality of merchandise, as the young men in England find in horses and billiards. Go among a parcel of young Germans of that class, and though you find them ready for all amusements of youth, you will at the same time perceive that they can talk of a great many

useful things in a spirit of enlightenment which has nothing mean in it, but displays a fitness for cosmopolitan life of which we see the practical results. Besides the 'Realschule,' there are throughout Germany a number of 'high schools of commerce,' where young men enter to learn office-work and technicalities."

This German hits the right nail on the head, when he says that—

"The English Government would do well to establish such schools upon some definite plan as to unity of teaching. Young Englishmen are quite as well disposed as Germans; in many matters their character is even more stable, but you must give them the opportunity of learning what the Germans do. Proprietary schools will never succeed in this; and no breach of the liberty of the subject would be committed if your Government were intelligent and far-seeing enough to recognise the need of such a system of schools, supernatant on the elementary education."

As another *Times* correspondent says, the maintenance of our commercial prosperity is pretty much a schoolmasters' question. No "association for the promotion of scientific industry" will ever be able to remedy our shortcomings in this respect unless there be a career for men of Science, in which case it will be studied, and unless Science be properly taught. Unless this country is to be entirely outstripped by other nations in the very direction in which we have hitherto prided ourselves as being supreme, Government must take the matter up and see that there is put within the reach of all who are in any way to carry on our industries the means of making themselves thoroughly acquainted with the sciences and scientific principles upon which these industries rest. Let us also, like the Germans, have well-organised Realschule and technical training-schools; and for this purpose let Government take the advice of the deputation which waited on the Lord Chancellor last Saturday, and make haste to appoint a responsible Minister of Education, whose duty it will be to see that our educational machinery in all departments, both in extent and in efficiency, is kept up to the wants of the age. The establishment of mere technical schools is not sufficient; these will be of but little avail unless those who wish to take advantage of them have had a previous thorough training in the scientific principles on which the arts are founded. Thanks to Mr. Cole's wise foresight, there are now tens of thousands of our artisans who have had such a training.

No better instance could be afforded of the evil consequences which arise from the want of a responsible Minister of Education, than the disgraceful condition of the Patent Museum. In a dark rusty iron shed at South Kensington are huddled together so as to be practically inaccessible for purposes of study, the paltry collection which represents the genius of that nation which has been foremost in mechanical invention. Let us hope that the object of the Society of Arts' deputation will be granted, and that no time will be lost in arranging in a suitable building everything necessary for the comprehension of Science applied to our various industries, in such a manner that anyone who wishes may study historically all the improvements that have been made in any department; and that, as in the French "Conservatoire des Arts et Métiers," lectureships will be established, thus furnishing a most efficient means for training the men who are to carry on our industries. If this were done, and if local museums were established in suitable centres throughout the country, and if Government take steps to put within the reach of all a thorough general scientific education, and do besides, what no "society for promoting scientific industry" can do, provide means for carrying on unremunerative scientific research, England will soon regain her industrial supremacy, or at least be placed beyond any danger of being outrivalled.

BELT'S "NATURALIST IN NICARAGUA"

The Naturalist in Nicaragua: a Narrative of a Residence at the Gold Mine of Chontales; Journeys in the Savannahs and Forests; with Observations on Animals and Plants in reference to the Theory of Evolution of Living Forms. By Thomas Belt, F.G.S., Author of "Mineral Veins," "The Glacial Period in North America," &c. With Maps and Illustrations. (London: Murray, 1874.)

MR. BELT is a close, an accurate, and an intelligent observer. He possesses the valuable faculty of wonder at whatever is new, or strange, or beautiful in nature; and the equally valuable habit of seeking a reason for all that he sees. Having found or imagined one, he goes on to make fresh observations and seeks out new facts, to see how they accord with his supposed cause of the phenomena. He is a man of wide experience; having travelled much in North and South Amer[illegible] nd in Australia, as well as in many parts of Europe—and always with his eyes open—before visiting Nicaragua. He is a geologist and an engineer, and knows how to overcome obstacles whether caused by the perversity of man or the forces of nature.

The book we are noticing has, therefore, a value and a charm quite independent of the particular district it describes. As a mere work of travel it is of little interest. The country and the people of Nicaragua are too much like other parts of Spanish tropical America, with their dull, lazy, sensual inhabitants, to possess any novelty. There is little that can be called adventure, and still less of geographical discovery; and the weakest and least interesting parts of the volume are the detailed descriptions of the daily route in the various journeys across the country. We have here and there good illustrations of Spanish American character, as when staying for the night at a ruinous farm-house, the proprietor, Don Filisberto, informed him that he was busy building a new residence. On asking to see it, "He took me outside and showed me four old posts used for tying the cows to, which had evidently been in the ground for many years. 'There,' he said, 'are the corner posts, and I shall roof it with tiles.' He was quite grave, but I could not help smiling at his faith. I have no doubt that, as long as he lives, he will lounge about all day, and in the evening, when his wife and children are milking the cows, will come out, smoke his cigarette, leaning against the door-post of his patched and propped up dwelling, and contemplate the four old posts with a proud feeling of satisfaction that he is building a new house. Such a picture is typical of Nicaragua."

Mr. Belt has done perhaps more than any other

traveller to support the theory originated by Mr. Bates of the purpose and cause of what is termed "mimicry" in the animal world, since it was he who first directly observed insectivorous birds reject the Heliconii and allies as food. In Nicaragua he found that a tame monkey, which was extremely fond of insects, and would greedily munch up any beetle or butterfly given to him, would never eat the Heliconii. He would sometimes smell them, but invariably rolled them up in his hand and dropped them quietly after a few moments. One large spider used to drop them out of its web when put into it, but another spider seemed to like them, showing that the smell and taste is not universally, although very generally, displeasing to their enemies. The Lampyridæ, among beetles, which are almost as frequently mimicked as the Heliconidæ, were rejected by monkeys and fowls, as they are known to be rejected by insectivorous birds. Among the new cases of mimicry observed by our author was a longicorn beetle, which most deceptively resembled a hairy caterpillar—a kind which it is well known are never eaten by insectivorous birds. More remarkable is the account of the behaviour of a green leaf-like locust among insect-eating ants. "This insect stood immovably amongst a host of ants, many of which ran over its legs without ever discovering that there was food within their reach. So fixed was its instinctive knowledge that its safety depended on its immovability, that it allowed me to pick it up and replace it among the ants, without making a single effort to escape. This species closely resembles a green leaf, and the other senses, which in the Ecitons appear to be more acute than that of sight, must have been completely deceived. It might easily have escaped from the ants by using its wings, but it would only have fallen into as great a danger, for the numerous birds that accompany the army of ants are always on the look-out for any insect that may fly up, and the heavy locusts, grasshopers, and cockroaches have no chance of escape."

The view that conspicuously coloured creatures, and those that seem to court observation, have some special protection, and that the gay colouring is a warning signal to their enemies not to touch them, was first applied by myself to explain the brilliant colours of many caterpillars. It is now, however, found to have a very wide application, and Mr. Belt is so convinced of its truth that he is able successfully to predict the behaviour of other animals towards an unusually conspicuous species. Most frogs are of more or less protective tints—green or brown according as they live among foliage or on the ground. They feed only at night, and they are all preyed upon by snakes and birds. One species, however, found by Mr. Belt, was of a bright red and blue colour, and hopped about in the day-time without any attempt at concealment. He was at once convinced, theoretically, that this frog must be uneatable. He accordingly took it home, but neither fowls nor ducks would touch it. At length one young duck was induced to pick it up, but instead of swallowing it, instantly threw it out of its mouth, and went about jerking its head as if trying to throw off some unpleasant taste. The skunk, whose offensive secretion is universally dreaded, is a similar instance among mammalia. Its white tail laid back on its black body makes it very conspicuous in the dusk, when it roams about, so that carnivora may not mistake it for other night-roaming animals. When we consider that such cases as these are probably very numerous; that instances of clearly protective colouring are still more so; that both these kinds of colouring may vary almost infinitely, and that there is certainly some unknown influence which tends to produce certain colours in certain localities; and when we further consider that all these causes have been in a continual state of change with changing conditions of existence, organic and inorganic, and have acted and combined with each other in countless ways for untold generations, we have some ground for concluding that colour in nature may have been produced with less assistance from sexual selection than Mr. Darwin thinks is due to that undoubtedly powerful agent.

A very full and interesting account is given of the leaf-cutting ants (Œcodoma sp.), and though these have been so often described, our author has much that is new to tell about them. In his mining operations he cut through some of their subterranean galleries, and from his examination of these he arrives at the conclusion that the ants do not feed on the leaves which they gather in such enormous quantities, but that they use them to form beds for the growth of a minute fungus on which they and their young live. These ants are so destructive to certain plants by entirely destroying their foliage, that many species cannot be cultivated without constant care and protection. It becomes an interesting point, therefore, to determine by what means many of the less vigorous or less abundant species are preserved. It has long been known that there is a very close connection between certain trees and ants. Many Melastomas have a kind of pouch at the base of each leaf, which serves as a habitation for small ants. These have been described by Mr. Spruce, as well as others on the leaves of species of Chrysobalaneæ and Rubiaceæ, &c., in a paper read before the Linnæan Society but not yet published; and he arrived at the conclusion that these structures had become hereditary through the adaptation of the plant to the constant parasitism of the insect, although he did not consider that the ants were of any actual service to the plant. Mr. Belt figures the leaf of a Melastoma possessing these pouches as well as a curious thorny Acacia, the thorns of which are very large and hollow, and are tenanted by ants. In this case the constant attendance of the ants is secured by a provision of food in the shape of little stalked fruit-like glands on the leaves, which the ant feeds on. The hollow stems of the Cecropias are also infested by ants, and they always abound on Passion-flowers, feeding on the honey glands of the flower. Now Mr. Belt believes, and apparently with good reason, that in all these cases the ants are protectors of the plant against herbivorous insects, such as caterpillars, cockroaches, earwigs, &c., but especially against the leaf-cutting ants; and that on account of this service the plants have in many cases become specially modified so as to supply food or shelter to the ants which are so useful to them. It is a suggestive fact that introduced trees and shrubs are more subject to the attacks of the leaf-cutting ants than native species. They do not possess either the disagreeable juices or the insect protectors that the latter have in the course of ages acquired. We have here an altogether new view of the inter-relations of plants and insects, which may, in

some cases, help botanists to account for the presence of the many curious and apparently useless glands and appendages plants often possess.

Among other natural history information in this work, we find some excellent observations on reasoning power in insects, a good description of the habits of a monkey, and some judicious remarks on the mode of action of

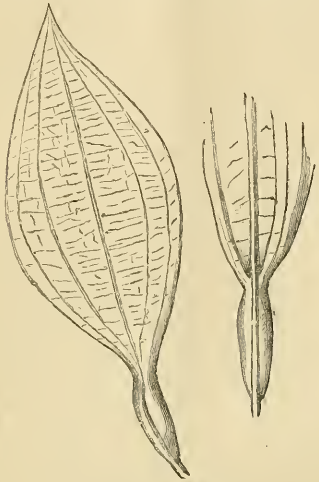


Fig. 1.—Leaf of Melastoma.

natural selection; although the idea that the hairless breed of dogs has been produced because hair favours the increase of *pediculi* and other parasites, is hardly one that will be accepted, seeing that hairless forms, of carnivora at all events, are quite unknown in a state of nature. On the subject of the fertilisation of flowers by insects Mr. Belt remarks, that besides the special adaptations for

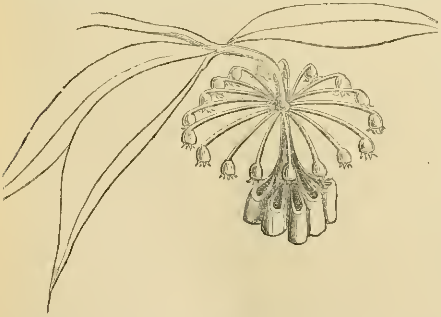


Fig. 2.—Flower of Marcgravia nepenthoides.

fertilisation by certain insects, there are often other adaptations for the express purpose of preventing useless insects from robbing the flowers of the attractive nectar, and he illustrates this by a description of our common foxglove. He also furnishes, what I believe are new and very curious cases of fertilisation by birds. In the *Marcgravia nepenthoides* (Fig. 2) there is a group of pitchers below the flowers, containing a sweet liquid which attracts insects; and numerous insectivorous birds come to feed upon these insects, and in doing so necessarily brush off the pollen and convey it to other flowers. In a species of Erythrina having a sword-shaped flower which will only admit very minute insects to the nectary, two species of long-billed humming birds probe the flowers in search after the insects, and in doing so get the pollen on their heads and carry it to other flowers. In this case the nectar is protected by a thick fleshy calyx, which effectually prevents bees and wasps from breaking in and stealing the attractive liquid.

As a geologist our author contributes some important facts on the great question of an intertropical glacial period. He found at from 2,000 to 3,000 feet above the sea, an extensive formation of boulder clay, full of great angular blocks, which he has not the slightest hesitation in pronouncing to be of glacial origin. He decides that this formation must be due to land glaciers and not to icebergs, because the latter would imply a depression of the country fully 3,000 feet, which would have produced a wide channel connecting the Atlantic and Pacific, and have caused more intermingling of the faunas of the two oceans than actually exists. It may, however, be argued, on the other hand, that if there has been no recent communication between the two oceans, then scarcely a single species of fish or mollusc should be common to the two. Yet no less than 48 species of fishes are absolutely identical; and as to the molluscs, Mr. P. P. Carpenter says that, besides those undoubtedly identical (about 40), more than 30 others may be identical, and that 40 more, although distinct, are very close representative species. We have, therefore, over 100 species of molluscs so nearly identical in the two oceans, that we cannot suppose their separation to date longer back than the Pliocene period. It may be fairly argued that this amount of community proves a connection between the oceans at a recent date, and that the number of species in common is quite as great as we can expect, when we consider—firstly, that migration into an already fully stocked area is by no means so easy and rapid a process as was once supposed; and secondly, that the presence of icebergs depositing their loads of clay and gravel in the straits themselves would, perhaps, destroy most forms of marine life, or drive them away to some distance. Mr. Belt further advocates, what seems a very untenable theory, that the glacial period of the northern and southern hemispheres was at its greatest severity at the same time, and that the glacial deposits of Central America and Brazil are synchronous. To get over the enormous difficulty as to what became of the exclusively tropical forms of insect and bird life that abound in such overpowering luxuriance in tropical America, he has recourse to the increased area of low land caused by the lowering of the ocean owing to the vast amount of water abstracted in the form of ice. But Mr. Andrew Murray's map of the 100 fathoms line of soundings shows that the tropical part of South America would not be materially increased in area by a depression of 600 ft., and another 600 ft. would add proportionately less. Besides, if astronomical causes have produced glacial epochs, it is certain that they would occur alternately in each hemisphere;

and this would enable us far better to understand how the tropical forms of life continued to flourish by migrating north or south away from the colder pole. The subject of glacial periods is rendered vastly more difficult by the discovery of signs of glaciation so far within the tropics, and all facts proving such glaciation are of the greatest importance. It seems most probable that the solution of the problem will be only possible by admitting a succession of glacial periods of unequal intensity; so that while in the tropics we have the traces of one of the more ancient and intense period of cold, in the more northern regions we see the results of successive glaciations and intervening denudations.

Much more satisfactory as well as more original, is Mr. Belt's theory of the cause of whirlwinds and cyclones. He well remarks that there is a complete gradation, from the little eddy which whirls up the dry leaves, through the moderate whirlwind, up to the most destructive hurricane; and that a great philosophical mistake has been committed in forming theories to explain the larger phenomena without ever having studied the smaller. The few pages devoted to this subject are well worth reading, and would alone stamp the author as an acute observer in physics as well as in natural history. He gives good reasons why all the received theories of the cause of cyclones are incorrect, and substitutes one founded on observation of the smaller and more easily observed phenomena which is very ingenious, and which appears to have received the provisional approval of the Astronomer Royal, but which would occupy too much space to give an account of here.

We have now sufficiently shown that most of the readers of NATURE will find matter of interest in this volume; and we sincerely trust that the author may soon find himself in a position to work more systematically at some of those branches of science which he has here touched upon. So clear-sighted and intelligent a student will probably make important discoveries.

ALFRED R. WALLACE

PETTIGREW'S ANIMAL LOCOMOTION

Animal Locomotion; or, Walking, Swimming, and Flying. By J. Bell Pettigrew, M.D., F.R.S. (London: Henry S. King and Co., 1873)

PROGRESSION on land, in water, and in air, are phenomena so intimately connected with everyday life, that all of a thoughtful and observant turn of mind cannot help becoming acquainted, unassisted, with most of the details and much of the principle of their production. Many will therefore open a new work on the subject with a wish to have explained to them some of the more difficult and obscure problems connected with it, which are too intricate or uncommon to be within the limits of ordinary powers of observation; and to have the fundamental principles on which the subject is based, fully expounded. With such a feeling we took up the book under consideration, especially as Dr. Pettigrew's name has been always held up as that of the British exponent of the phenomena of flight, and the combatant of the French school. Imagine our disappointment on finding that, instead of the work being by the hand of a master, its author is deficient in the knowledge of the first principles of physics, and of the undoubted meaning of some of the most simple terms employed in the science; his argument, if it may be so called, being but little more than a long series of vague and fanciful analogies, incorrectly stated physical facts, and untenable theories.

In the introduction, and more minutely in a special chapter, the subject of aëronautics is discussed, and the false hope perpetuated that it is quite within the range of human possibility to construct a flying machine, capable of sustained suspension; for we are told that "in order to construct a successful flying machine . . . all that is required is to distinguish the properties, form, extent, and manner of application of the several flying surfaces;" no mention being made of the true difficulty of the problem, which is, that it is at present impossible to obtain from any form of fuel, a sufficient percentage of the potentiality which it possesses for doing work, to work an engine sufficiently compact and light for the wings which it has to drive. In the chapter on progression through the air, one of the paragraphs commences with the astonishing title, "Weight, Momentum, and Power, to a certain extent synonymous in flight," which follows an equally extraordinary and oft-repeated statement that "weight, when acting upon wings, or what is the same thing, upon elastic twisted inclined planes, must be regarded as an independent moving power." After such indications of imperfect knowledge, nothing in the way of mechanical theories could cause surprise, and we are therefore not astonished to find it laid down as the fundamental principle of flight, that the up-stroke of the wing aids in propulsion, and that in the down-stroke the inferior surface of the wing is directed *downwards* and *forwards.* "I repeat downwards and forwards; for a careful examination of the relations of the wing in the dead bird, and a close observation of its action in the living one, supplemented by a large number of experiments with natural and artificial wings, have fully convinced me that the stroke is invariably delivered in this direction," the wings being said to act like a boy's kite during both the down and up stroke. Who can see any close relation between the flight of birds and that of a kite? Dr. Pettigrew seems to forget that a kite needs a string, and yet, backed by his false analogy, he has the presumption to quote the experimental verifications and opinions of such able and ingenious thinkers as Borelli and Marey, the authors of the true theory of flight, only to reject them; bringing forward in opposition such evidence as "from accurate examination, I am fully convinced," and the like, against the sound mathematical arguments and superbly conducted experiments of the two abovenamed physicists.

Another favourite notion which Dr. Pettigrew reiterates is that "the efficiency of the wings is greatly increased by the fact that when it ascends it draws a current of air up after it, which current, being met by the wing during its descent, greatly augments the power of the down-stroke. In like manner, when the wing descends, it draws a current of air down after it, which, being met by the wing during its ascent, greatly augments the power of the up-stroke. . . . The wing is endowed with this remarkable property, that it creates the currents on which it rises and progresses." This would

be all very true, if the problem were as simple as here put; but it is evident that these induced currents are of no real service in flight, because in their production there is as much force lost as there may be gained from their subsequent employment on the reversal of the action of the wing, if the bird's body has not advanced sufficiently far to be in each stroke beyond the range of their action, which is probably the case.

Physiologists will also be considerably startled by a novel hypothesis of Dr. Pettigrew's, which we cannot give better than in his own words:—"Hitherto, and by common consent, it has been believed that whereas a flexor muscle is situated on one aspect of a limb, and its corresponding extensor on the other aspect, these two muscles must be opposed to and antagonise each other." We are not ashamed to say that such has always been, and still is, our idea, notwithstanding the author's remark that "This belief is founded on an erroneous assumption, viz., that muscles have only the power of shortening, and that when one muscle, say the flexor, shortens, it must drag out and forcibly elongate the corresponding extensor, and the converse. This would be a mere waste of power. Nature never works against herself. There are good grounds for believing . . . that there is no such thing as antagonism in muscular movements. . . . Muscles are, therefore, endowed with a centripetal and centrifugal action."

In conclusion, we must say that we expected better things of Dr. Pettigrew, and regret that he has not, before now, learned that there are errors in his methods and his results that cannot be tolerated by a thinking public, which prefers accurate reasoning rather than dogmatic statement, and well-grounded fact to fanciful analogy.

A. H. GARROD

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.]

The Famine in India and Meteorology

OUT here in India our attention has been of late called to consider the best means of warding off the effects of one of Nature's laws, that threatens the lives of numbers of our fellow-creatures,

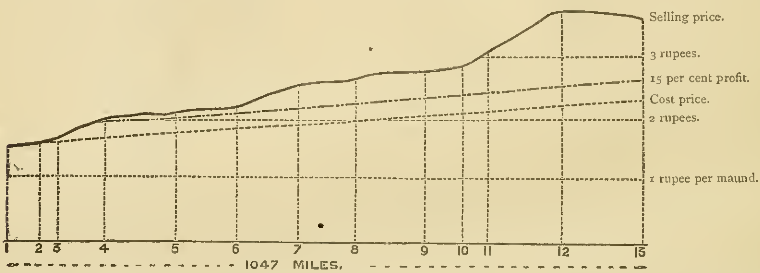


FIG. 1 shows the cost of Wheat per maund at the following Stations on the line of Railway in November 1873:—1, Umritsur; 2, Jullunder; 3, Loodiana 4, Umballa; 5, Meerut; 6, Allyghur; 7, Etawah; 8, Cawnpore; 9, Allahabad; 10, Mirzapore; 11, Benares; 12, Dinapore; 13, Bhaugulpore.

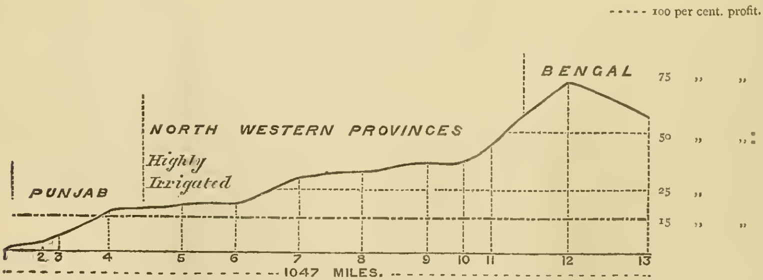


FIG. 2 shows the present profits by the sale of Wheat at the following Stations:—1, Umritsur; 2, Jullunder; 4, Loodianah; 4, Umballa; 5, Meerut 6, Allyghur; 7, Etawah; 8, Cawnpore; 9, Allahabad; 10, Mirzapore 11, Benares; 12, Dinapore; 13, Bhauguulpore.

for at this present moment the millions of Bengal are threatened with famine.

The study of the meteorological effects and changes of climate in India is very interesting, but I have not time to go into the question how one portion of the air laden with moisture moves up the Bay of Bengal, sweeps along the coast of Burmah and Asam; how it begins to part with the moisture in Burmah about the middle of May, continually advancing along the valley of the Ganges, till about a month later it reaches Simla, which is on the ridge which separates the drainage of the Ganges from that of the Indus.

Up the Indus valley another current of air from the Indian Ocean also moves northwards parting with large quantities of its moisture along the western coasts of Madras and Bombay, and

then passes up the valley of the Indus, but without watering that large extent of desert lying between Scind and the Punjab, so it is not till within a short distance of the hills that the body of air begins to part with its moisture.

I say this is all a very interesting subject to study, but it is not my intention at present to go into it, but simply to state that this season Bengal has not had its average rainfall, while in the Punjab the rains were later than usual in setting in, yet the general fall has been on the whole seasonable, for though the cotton crop is a failure compared with other years, yet the cereals have been plentiful, and hence grain is cheap.

In Fig. 1 I have tried to show the price of grain along the line of the railway from Umritsur to Bhaugulpore, a distance of 1,047 miles. The full black line shows the actual prices at which grain is now selling in all the several districts through which the railway passes, it being least at Umritsur, which is in the centre of the Punjab, and greatest at Dinapore, in the Patna district of Bengal. At the right-hand side is a scale of rupees showing the cost per maund, which can be easily reduced to English values by considering a manud equal to $\frac{3}{4}$ cwt. and a rupee equal to 2*s*. This will approximately give the present English value of wheat during November last as published in the several gazettes. The lower dotted line shows how the price of this grain goes on increasing by the distance transported. The usual railway rate was $\frac{1}{4}$ pice per maund per mile, which by a late order of Government has been reduced to half this rate, or approximately 3*s.* 6*d.* for 100 tons a mile.

If to this be added 15 per cent. profit to meet losses and deterioration, the thick dotted line indicates what grain could probably be sold at by Government without any loss, if it became a large dealer; and, as before said, the upper full line shows the actual prices with the large margin there is for profits.

Fig. 2, however, shows this much clearer, and proves that the demand must be greater than the supply; or, in other words, that as much as over some 2,000 tons daily of grain, which was grown more than 700 miles away from the point where the famine is most severe, along the line of railway, is sent down from the Punjab, and the highly irrigated lands of the North-West Provinces, enough to sustain in life as many as there are inhabitants in London, or some four million souls; for $1\frac{1}{4}$ lbs. for each man, woman, and child, is considered enough to sustain the life of a native of India.

But what is this to the millions of Bengal that are now threatened with famine? It is hardly one-seventh, I am led to understand. So with all our canals and railways, and the great good they are doing in the present state of things, yet there is a larger demand than can be supplied, or the profits could never mount up to 70 per cent., as at Dinapore.

Though the subject of this letter may not be considered exactly a fit one for the pages of NATURE, yet I feel sure that those who study Nature in her works and effects, will be interested in the facts now given.

T. LOGIN
Sup. Engineer, Punjab

Umballa, Dec. 12, 1873

Dr. Tyndall and Sensitive Flames

IN the last number of NATURE a report is given of the first of Dr. Tyndall's Christmas "Lectures to Juveniles," on the Motion and Sensation of Sound. In that lecture Dr. Tyndall shows how the reflection of sound can be made manifest to an audience by means of a sensitive flame; and, according to the closing words of your report, Dr. Tyndall states,—"Never before have these phenomena been made visible. Hitherto these effects have been investigated by the sense of hearing; I have now been able to prove them by appealing to your eyes."

In the *Illustrated London News* a short notice is also given of the same lecture, and there Dr. Tyndall is reported to have said, that no philosopher had ever before witnessed the reflection of sound until that afternoon. I presume, therefore, that the report you have given accurately represents Dr. Tyndall's words. And this being so, will you permit me simply to place the following facts before your readers. In January 1870 I published an article in the *Quarterly Journal of Science* on the "Analogy of Light and Sound." In that article I stated how a sensitive flame can be used as a delicate *phonoscope*, to reveal perfectly well the decay, the absorption, and the reflection, and (less perfectly) the refraction of sound-bearing waves. A sketch is there given precisely the same as that which appears in Dr. Tyndall's lecture (Fig. 6), wherein a sensitive flame is placed in the conjugate focus of a pair of parabolic mirrors. This experiment was shown at a lecture I delivered on January 3, 1868, before the Dublin Royal Society. A copy ot my paper in the *Quarterly Journal of Science*, and of the printed ab stract of my lecture before the Dublin Society, I myself sent to Dr. Tyndall a few days after they appeared, and if I mistake not, drew his attention to these experiments.

Since 1868 I have so frequently shown to my own class and to large audiences the reflection of sound by a sensitive flame, that I have no doubt many of your readers will have been astonished when they heard or read Dr. Tyndall's assertion which I have quoted. Indeed, probably Dr. Tyndall himself will be able to recall the foregoing facts, and will gladly put his memory right on this matter.

W. F. BARRETT

Royal College of Science, Dublin, Jan. 19

The Potato Disease

SINCE October 1872 I have been growing potatoes, healthy and diseased, under test conditions, principally with a view to a further insight into the winter and subterranean life of the *Peronospora* and also in the hope of meeting with the (to me) apocryphal *Artotrogus*. The figures of the latter referred to by Mr. Berkeley, I am well acquainted with, as I have engraved them three times, once to illustrate Mr. Berkeley's own paper in the *Gardener's Chronicle*. I therefore well knew what to look for in the corroded cellular tissue of my diseased potatoes. I by no means wish to assert (or indeed asserted) that *Volutella ciliata* is positively the same with Montagne's *Artotrogus*, for I have never seen a specimen of the latter, (I know no one who has except Mr. Berkeley), and as far as I am aware no one has met with it since the time of its original publication between twenty and thirty years ago. As no one now (including Mr. Berkeley) ventures to suggest more than the "possible" or "probable" nature of *Artotrogus*, my note was meant to suggest another reasonable direction for future observation.

In my experiments, I have from the first been forcibly struck with the presence of *Volutella* with its mycelial threads, not only outside and just within spent potatoes, but also within the corroded cellular tissue. I have no doubt that the plasma of *Volutella* is equally disorganising with the plasma of *Peronospora* itself, and that the threads belonged to the former plant I have no manner of doubt, as I constantly traced young to mature specimens of *Volutella* from it, and that too from positions within *buried* potatoes. The strong external resemblance between some states of *Volutella* and the figures referred to by Mr. Berkeley, suggested to me that this "will o' the wisp" *Artotrogus*, might perchance eventually turn out to be no other than some condition of *Volutella*.

So far from its being my desire to draw attention from *Artotrogus*, the paragraph in my first letter was written with a view to draw attention to it. Berkeley himself always speaks doubtfully of its nature, and Carruthers, in his recent paper on *Peronospora*, published by the Royal Agricultural Society, has not even referred to it.

Returning for a moment to the principal subject of my first note, viz. the failure of the essays submitted in answer to the offer of a prize on the part of the Royal Agricultural Society for the best essay on the potato disease and its extirpation. In NATURE, vol. ix. p. 212, I observe that the committee are now disposed to view the desired destruction of the potato disease from a different standpoint, and propose to offer three prizes of 100*l.* to dealers, who are to send in a ton each of "disease-proof" potatoes.

It appears to me as unreasonable to advertise for a "disease-proof" potato as for a "death-proof" man. Surely all organised bodies are liable to deviation from health, and though certain organisms may be made (by art) to more or less throw off or resist the attacks of disease, yet none can be said to be in themselves "disease-proof." As regards potatoes, I think I may say, without fear of contradiction, that at present no varieties whatever are either proof against the *Peronospora* or able to resist its attacks, neither is it at all likely that any such varieties will ever arise.

WORTHINGTON G. SMITH

*ON DIFFRACTION SPECTRUM PHOTOGRAPHY, AND THE DETERMINATION OF THE WAVE-LENGTHS OF THE ULTRA-VIOLET RAYS**

ILLUSTRATED BY AN ALBERT-TYPE PLATE.

THERE are, as is well known, two methods by which spectra may be obtained: (1) by the action of a prism; (2) by a system of closely-ruled lines. In the latter case it is convenient to speak of the contrivance employed as a grating, and of the spectrum as an interference or diffraction spectrum. A casual inspection shows that there is a great difference between the spectra produced by these two methods, and close investigation proves that the diffraction spectrum is by far the more suitable for accurate scientific work. For this reason it has seemed desirable to make a trustworthy map of those parts of the solar diffraction spectrum which can be photographed on collodion, and to attach to it a scale for reading the wave-lengths of the rays.

The plate accompanying this memoir is from collodion photographs made by myself, transferred to a thick piece of glass, the latter process being known as the Albert-type. For the entire success of this transfer I am indebted to my friend Mr. E. Bierstadt, the owner of the patent in America. The glass is then used in a printing press in the same manner as a lithographic stone. The spectrum is absolutely unretouched. It represents therefore the work of the sun itself, and is not a drawing either made or corrected by hand.

The picture consists of two portions: first, the upper, which gives all the lines of the spectrum from near G to O, or from wave-length 4350 ten-millionths of a millimetre to 3440. Above that is placed a scale, which is a copy of Angström's from just below G to H_2, with the same-sized divisions carried out from H_2 to O. The second, or lower, is a magnified portion of the same negative, having H_1 and H_2 about its middle, and extending from wave-length 4205 to 3736.

It follows therefore that the lines in the solar spectrum are correctly represented in their relative positions. The only errors are those which may have arisen from maladjustment of the scale. The precautions that were taken to avoid such errors will be described. With a certain correction, to be mentioned hereafter, it may also be stated that the relative shadings and intensities are preserved.

The value of such a map depends on the fact that it not only represents parts of the spectrum which are with difficulty perceived by the eye (though they may be seen by the method of Stokes and Sekulic), but also that even in the visible regions there is obtained a far more correct delineation in those portions which can be photographed. In the finest maps drawn by hand, such as those in the celebrated "Spectre Normal du Soleil" of Angström, the relative intensity and shading of the lines can be but partially represented by the artist, and a most laborious and painstaking series of observations and calculations on the part of the physicist is necessary to secure approximately correct positions of the multitude of Fraunhofer lines. Between wave-lengths 3925 and 4205, Angström shows 118 lines, while my original negative has at least 293.

For such reasons many attempts have been made to procure good photographs of the diffraction spectrum. The earliest were by my father, J. W. Draper; his results were printed in 1843-44 in a work entitled "On the Forces which produce the Organisation of Plants." This memoir was accompanied by plates drawn from his daguerreotypes, and the wave-lengths, which he first suggested as the proper indices for designating the Fraunhofer lines, were used as a scale.

Since that time the most important experiments in this direction have been by Mascart and Cornu. These eminent physicists have, however, resorted to the plan of taking portions of the spectrum on a small scale and subsequently making enlarged drawings therefrom. This course introduces the defects of handwork, and the artistic difficulties of copying intensity and shading, as well as the omission of fine lines.

In the photographs of the spectrum which I have taken I have tried to get as large a portion as I could at once, and on as large a scale as possible. I have usually obtained images from below G (wave-length 4307) to above O (wave-length 3440) of about 12 inches (·305 metre) long. I have succeeded, however, in photographing from near *b* (wave-length 5167) to T (wave-length 3032) by resorting to a ruled speculum plane and a concave speculum mirror, but the photographic and optical difficulties in securing an enlarged spectrum of that length are great.*

Of course, in such a research as this an essential is a finely and evenly ruled plane of glass or other material. Those which I have used were made by a machine devised and constructed by Mr. L. M. Rutherfurd, whose beautiful lunar and prismatic spectrum photographs are so well known to the scientific world. The plate generally employed is of glass ruled with 6481 lines to the inch; the ruled part is $1\frac{8}{100}$ inch (·027 metre) long, and $\frac{64}{100}$ inch (·016 metre) wide. It is unquestionably much more nearly perfect than similar gratings made by Nobert and others, for the character of the photographs and the uniformity of the orders on either side of the normal, together with its behaviour under a searching examination, show that it leaves little to be desired. As it is on glass, and gives a bright transmitted spectrum, I have constructed the remainder of the optical apparatus of glass achromatised, according to the plan used by J. W. Draper in 1843, except that I have not silvered the ruling, and therefore have used the refracted, and not the reflected beam. The slit is $\frac{8}{10}$ of an inch (0·2 metre) long, and $\frac{1}{110}$ of an inch (·00023 metre) wide; the jaws are of steel, and there is not only a micrometer screw for separating them, but also one for setting them at an angle. Occasionally I have taken photographs with the jaws $\frac{1}{90}$ of an inch (·00028 metre) apart at the top, and $\frac{1}{130}$ (·00019 metre) at the bottom, so as to obtain different intensity in the two edges of the spectrum.

Most of the photographs have been of the spectrum of the third order, which has certain conspicuous advantages. In the first place it is dilated to such an extent as to give a long image, and yet one not too faint to be copied by a reasonable exposure of the sensitive plate; and in the second place, the spectrum of the second order overlaps it in such a way that D falls nearly upon H, and *b* upon O. These coincidences are serviceable in determining the true wave-lengths of all the rays.

The only point of special interest in connection with the photographic part of the operation, is the device for avoiding the unequal action on the sensitive plate of different rays of the spectrum. It has been commonly supposed, until the recent memoirs of J. W. Draper, that there are in the spectrum three different types of force in three different but overlapping regions. Heat was supposed to be principally found at the less refrangible end, light in the middle, and actinism at the more refrangible. But he showed that this error has partly arisen from using prismatic spectra, which condense the red end and dilate the violet, and do not present the rays in the

* From the *American Journal of Science and Art*, Dec. 1873. Communicated by the author.

* Since writing the above I have succeeded in photographing the lines of the visible spectrum from *b* downward, and the picture comprises not only the regions including E, D, C, B, *a* and A, but also the ultra-red rays. The great groups, α, β, γ, below A, discovered by my father in 1843, are distinctly reproduced.

true order of their wave-lengths, and partly from the nature of our ordinary photographic substances. He proved that actinism, or the power of chemical decomposition, does not particularly belong to the violet end of the spectrum, but is found throughout its whole length. But bromide and iodide of silver, as used in collodion photography, are more readily decomposed by vibrations of certain lengths and periods than by others, and hence the excess of action seen at the violet end is a function of certain silver compounds, and not of the spectrum. Other substances, as carbonic acid, show maxima elsewhere, as in the yellow region. The solar beam is therefore not compounded of three forces, light, heat and actinism, but it is a series of ethereal vibrations, which give rise to one or other of these manifestations of force, depending on the surface upon which it falls.

In order to provide against this excess of action in certain parts of the spectrum, I introduced a system of diaphragms placed in the vicinity of the sensitive plate, and removed at suitable times during the exposure. The region from wave-length 4000 to 4350 only requires about one-tenth of the time demanded by that from 3440 in 3510. In the negative which produced the accompanying plate, the line O had 15 minutes and G $2\frac{1}{2}$ minutes, and the former is under-exposed. These exposures seem at first sight unusually long for a wet collodion surface, but it must be remembered that the slit used was only $\frac{1}{110}$ of an inch wide, and that the diffraction grating gives an almost complete circle of spectra round itself, amongst which this thin band of light is divided. A beam $\frac{1}{110}$ of an inch (·00023 metre) wide is spread out in this case into a streak about 78 ft. (23·77 metres) long.

After the production of spectra that were in focus from end to end, it was next necessary to attach a scale to them by which the wave-lengths might be read. At first I tried, by reducing Angström's maps to the proper dimensions, to accomplish this object, but the undertaking proved to be difficult, and was unsuccessful, because, though the original drawing on the stone was undoubtedly correct, the paper proof of it which I had, had stretched unequally in printing, and on applying a photographic reduction to my spectra, coincidence could not be obtained. As, however, the subject of dividing a scale for these diffraction spectra is of prime importance in giving value and precision to the wave-lengths presented in this memoir, I propose to describe fully the method eventually employed in fitting a scale to the photograph.

The wave-lengths of the ultra-violet rays have never as far as I know, been either determined or published except by J. W. Draper in 1844, Mascart in 1866, and Cornu in 1872. J. W. Draper's memoir has a steel engraving of some of the principal lines, from which the wave-lengths may be approximately read.

The large plate which accompanies Mascart's long and valuable memoir is of the prismatic spectrum, but he furnishes in addition the following table of wave-lengths :—

L	3819·0
M	3728·8
N	3580·2
O	3440·1
P	3360·2
Q	3285·6
R	3177·5

These numbers do not entirely coincide in all cases with my photograph, as I will show farther on.

The detailed results of M. Cornu have not appeared in any publication that has reached me.

I have used as a basis the numbers given by Angström for the rays D_2, b_4 and G, and if there should be any small error in his determination, my scale will require a proportionate correction, which can easily be effected. At first sight it seemed better to take G and H as fixed points, but the line H is so broad, and has so many component lines, that its position is uncertain, and moreover, being almost at the limit of visibility in Angström's apparatus, it was more open to errors of measurement. These reasons led me to take advantage of the fact that the second spectrum overlaps the third, the ray D of the second being near H of the third, and *b* of the second near O of the third. It is obvious that we have thus the means of ascertaining the wave-lengths of three points, one at each end, and one in the middle of my photograph. As the rays D and *b* cannot impress themselves on collodion by any length of exposure that it is convenient to give, and as in my method of working the ultra-violet rays could not be seen simultaneously with them, it was necessary to resort to the following device :—I placed in front of the sensitive plate and close to it two fine steel points, one of which was carefully adjusted to the position of D_2 of the second order, and the other to b_4 of the second order. When, therefore, after a suitable exposure to the ultra-violet spectrum of the third order, the collodion picture was developed, there were two sharply-defined images of the steel points superposed on the spectrum. The point which had been coincident with D_2 of the second order was then found to have cast its shadow on H_2 of the third order, and the point at b_4 of the second order had impressed itself near O of the third order.

By a simple calculation it was thus rendered evident that a given ray in the compound line H_2 was of the wave-length 3930·1 ten millionths of a millimetre, and that another line near O had the wave-length 3444·6. By looking at the photograph, the reader will see that 3930 falls upon a fine division in H_2, which is beautifully shown in both the spectrum with the scale and the enlarged proof below. Of course, the ray G of the third order, the wave-length of which is known, had impressed itself photographically on the collodion.

Having thus ascertained the wave-lengths of three fixed points in the photograph, the next step was to apply a scale reading to a single ten-millionth of a millimetre, and, if possible, fractions thereof. After many abortive attempts to use that part of Angström's map which lies between G and H, and to attach thereto an additional length of scale sufficient to extend to the end of the ultra-violet region, I was compelled to resort to a linear dividing engine, and rule a scale which was about twice the length of the photographic reduction shown in the accompanying plate. Of course this necessitated drawing in by hand the same systems of lines and lettering as are shown on Angström's chart, and this I did as carefully and faithfully as I could.

It only remained to reduce this divided scale to the proper size to fit the spectrum photograph ; after many trials it was accomplished.

It is proper in this place to make a criticism on my scale, and to point out a small error, which may be due, however, to an incorrect determination of the wave-lengths that I have used as fixed points. Taking the distance from G (wave-length 4307) in the photograph to the fixed line 3930 in H_2, and dividing it into 377 parts, and then prolonging these divisions toward O, it was found that the third fixed point was not attained, but that there was an error of about two divisions. But if the position of D_2 in Angström's determinations should be incorrect to the extent of one ten-millionth of a millimetre, or if this small error should be partly attributed to D_2, and partly to G, my scale would be correct. Future measures of the wave-lengths of these rays, and of b_4, can alone settle this delicate point, for the determinations of Mascart and Angström and Thalen differ nearly to the extent mentioned above. The same remark is true of Angström compared with Ditscheiner, while the difference between Angström and van der Willigen is more than

three times the amount necessary to remove my discrepancy. In any case the photograph is correct, as it is the work of the sun, and is only open to errors arising from imperfect flatness in the field of a fine lens, and that field only subtending an angle of about 4°. The angular aperture of the lens, viewed from the sensitive plate, is 20 minutes. I trust, therefore, that the photograph may be of permanent value to physicists, for any one can affix another scale if this be slightly erroneous.

An examination of the photographed spectrum shows many points of interest, some of which are best seen in the spectrum with the scale above, and some in the portion enlarged below. The latter is magnified about twice, and comprises the region from wave-length 3736 to 4205. I have also made photographs on the same scale as Angström's map, but have not as yet printed them. The capital letters which are attached to the region above H are according to the nomenclature of Mascart, although the wave-lengths assigned by him to those letters do not coincide exactly in all cases with the lines in my photograph; for instance, the line L, which he regards as single, is in reality triple, and does not correspond to 3819, but to 3821; M is correctly designated by 3728, but it is double; N is really at 3583, and not 3580. It has been suggested that it would be proper to return to the old nomenclature of Becquerel and J. W. Draper, who simultaneously discovered these lines in 1842-43, but the designation of position by wave-length in reality renders the letters unnecessary.

The spectrum above H, when compared with the region from G to H, is marked by the presence of bolder groups of lines, and most conspicuous are those between 3820-3860, 3705-3760, 3620-3650, 3568-3590, 3490-3530. The first of these groups is strikingly shown in the enlarged photograph. I am not as yet able to offer an opinion as to the chemical elements producing these groups, for almost all the photographs of the ultra-violet spectra of metalline vapours that I have thus far made were produced by a quartz train, and have not yet been reduced to wave-lengths. Indeed, that is a separate field of inquiry, and could not be comprised in a memoir of this length. I have also tried to utilise the photographic spectra of the late Prof. W. A. Miller, published in the "Transactions" of the Royal Society for 1862, but for some reason, probably insufficient intensity of the condensed induction spark, his pictures do not bring out the peculiarities of the various metals in the striking manner that is both necessary and attainable. The diffraction spectra of metalline vapours that I have made are not yet ready for use.

The probabilities are that each of these groups will be found to be due to several elements, as is plainly seen in the group H. This compound line, which is commonly spoken of as being caused by calcium, iron, and aluminum, is in reality much more complex, for there can readily be counted in it more than fifty lines in the original negative, and a careful inspection of the accompanying paper picture shows a large proportion of them. This observation leads us to a more general statement. *The exact composition of even a part of the spectrum of a metal will not be known until we have obtained photographs of it on a large scale.* The coincidences which were so thoroughly examined by Mr. Huggins (Trans. Royal Society, Dec. 1863) will only disappear when we can, in addition to the position of a line, have a clear idea of its size, strength, and degree of sharpness or nebulosity. The eye is not able to see all the fine lines, or even if it does, the observer cannot map them with precision, nor in their relative strength and breadth. For example, in Angström's justly celebrated chart, of which the G-H portion is copied in this plate, and in the construction of which the greatest pains were taken by him, many regions are defective to a certain extent. The region from 4101 to 4118 is without lines, yet the photograph shows in the enlarged copy seventeen that can easily be counted, and the original negative shows more yet. The reader of course understands that a paper print of a collodion picture is never as good as the original; the coarseness of grain in the paper, want of contact in transferring, &c., effect such a result. Moreover, the Albert-type process depends on a certain fine granulation which is given to the bichromated gelatine, and this forbids the use of a magnifier upon these paper proofs. It is only just, however, to Mr. Bierstadt to state, that without his personal supervision, such sharp and fine-grained proofs could not have been obtained, and that no other printing-press process that I know of could have accomplished this work at all.* As an illustration of the difficulty of depicting the relative intensity of lines, we may examine 3998, which in Angström's chart is shown of equal intensity with 4004, while in reality it is much fainter, and instead of being single, is triple, as is well seen in the enlarged spectrum.

When, however, we compare Angström's chart with the photograph, it requires, as the above remarks show, a critical examination to detect defects, and we have a striking confirmation of the surprising accuracy of the Swedish philosopher.

So also in comparing Mascart's excellent map of the prismatic spectrum with the photograph, the difficulty of depicting all the fine lines is seen. In the group L he shows twelve lines, while even in the Albert-type copy of my photograph twenty-five can be counted, and in the original negative many more. From H to L he exhibits seventy lines; in my plate 138 can be observed, besides many unresolved bands.

In the earlier part of this memoir it was stated that the relative intensities of the lines in the spectrum were correctly represented if a certain allowance was made. If an unshielded collodion plate were presented to the image of the spectrum, there would be produced a stain very dense from G to H, fainter above H, and still fainter below G. But this stain would not represent the actinic force of the sun; it would merely be the index of the decomposability of a mixture of iodide and bromide of silver. I have for this reason adopted the idea of J. W. Draper, that force is equally distributed through the spectrum, and have tried to produce a photograph of equal intensity throughout. This has been accomplished, as I have before stated, by suitable diaphragms. But whether this view be correct or not, lines which are not far distant from one another are presented virtually without any interference by diaphragms, and must therefore be correct both as to shading and intensity.

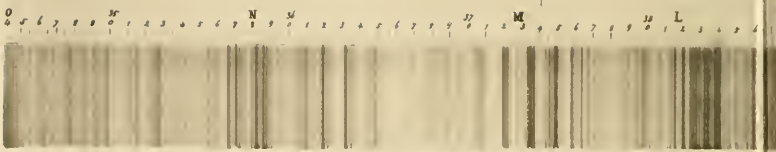
Besides the points above mentioned, there are many theoretical considerations suggested by the photograph which it does not seem expedient to enter upon fully at present. Among such is the possibility of arriving at an estimate of the sun's temperature, by interpreting the apparent bands, such as those near G and H, by the aid of Lockyer's researches on the temperature of dissociation of compounds. No one has yet ascertained whether there are or are not unresolvable bands in the solar spectrum. If they do exist, the compounds to which they belong, and the necessary temperature for dissociation, remain to be determined.

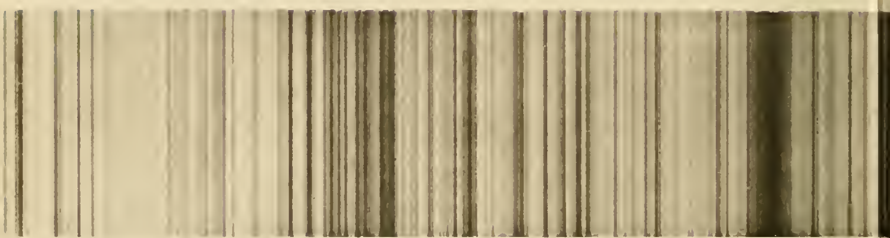
It would seem also to be possible to find out whether, as asserted by Zöllner, there is a liquid envelope around the sun, by a search for more diffused bands in its photographed spectrum.

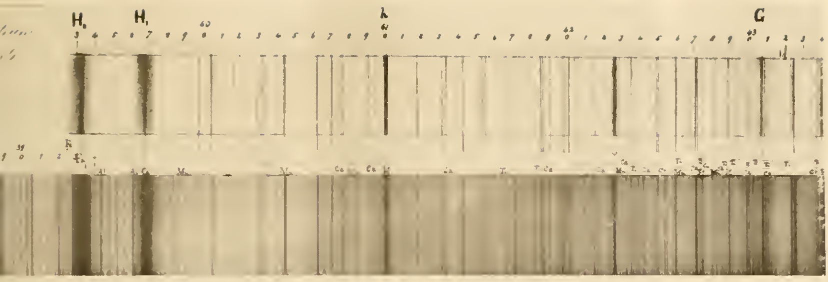
In the hope that this photograph may prove to be of value to scientific men for further investigations upon the sun and the elements, I have caused a number of extra copies to be printed, and shall be glad to present them to anyone who can make use of them.

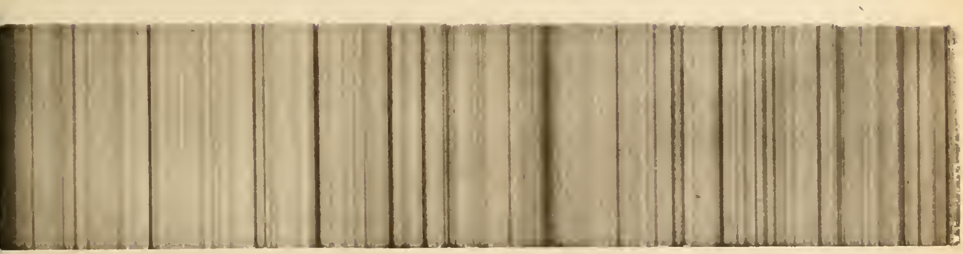
HENRY DRAPER

* From the original negative of the spectrum 12,000 copies have up to the present been printed, and it is not in the slightest degree injured as yet.

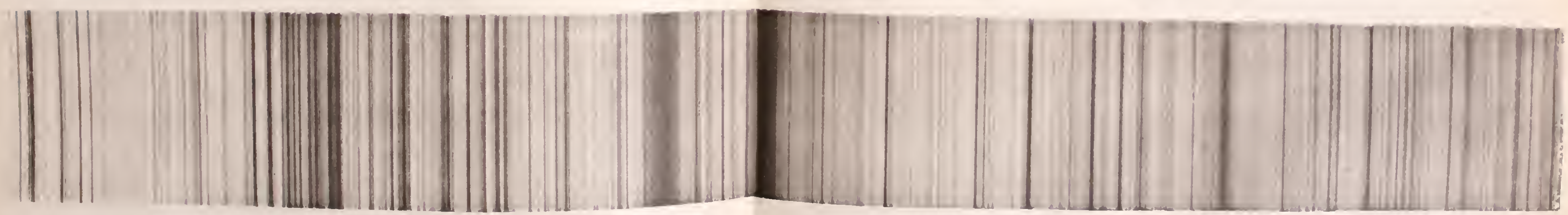

O
N
M
L




H
H
h
G




N
M
L
G



THE "BRONTOTHERIDÆ," A NEW FAMILY OF FOSSIL MAMMALS

VERY nearly a year ago Prof. O. C. Marsh, of Yale College, announced the discovery of a new order of Mammalia, the Dinocerata, huge elephantine forms, with three pairs of horns and large canine teeth, from the Eocene deposits of the country to the east of the Rocky Mountains, including the states of Dakota, Nebraska, Wyoming and the "Bad Lands" of Colorado, which was described and one of its species figured in this journal at the time (NATURE, vol. vii. p. 366). This same able zoologist has the opportunity of adding still another unexpected group of animals, this time from the Miocene beds of the same district, which, though Ungulate and

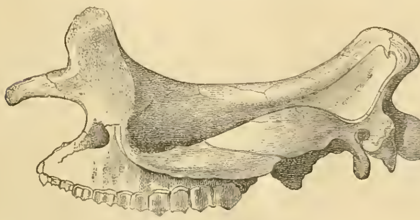


FIG. 1.—*Brontotherium ingens*, Marsh.

almost certainly Perissodactylate, are very different from any known form.

Brontotherium ingens is the name given by Prof. Marsh to the animal, the upper and side view of whose skull are shown in the accompanying drawings, copied from his paper in the *American Journal of Science and Art* for this month. The specimen here figured is 36 in. long, and 20 in. between the tips of the two horn-cores. The

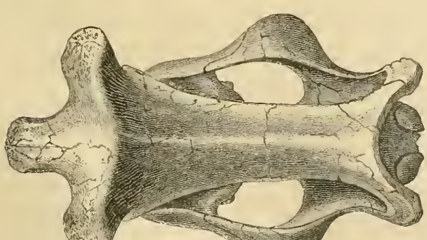


FIG. 2.—*Brontotherium ingens*, Marsh.

proportions of the skull are peculiar, the whole being elongate and very slight in depth. The high zygomatic arches, without any well-marked postorbital processes on them, or on the frontal bones, to divide off the temporal from the orbital fossæ, also add to the uncomplicated general appearance of the skull, whose aspect is rendered more abnormal by the development of a huge pair of horn-cores, which spring almost entirely from the firmly "coössified" nasal bones, which make the anterior region of the face exceptionally broad and heavy. The upper part of each horn-core is rugose and the base contains large air cells.

The teeth present many points of interest. The dental formula is $i. \frac{2}{2}\ c. \frac{1}{1}\ p.m. \frac{4}{3}\ m. \frac{3}{3} = 38$. The upper incisors are quite small, and so are the lower. The canines are short, stout, and not removed from the premolars by any interval. The premolars are much smaller than the molars, those of the lower jaw being very Palæotherium-like. The lachrymal foramina are small, and the infraorbital foramina are peculiarly large, as are the occipital condyles. The cervical and most of the dorsal vertebræ are distinctly opisthocœlous. The atlas is much expanded transversely; the odontoid process of the axis is stout and conical. The epiphyses of the vertebræ are, in most specimens, loosely united to the centra. The caudal vertebræ give indications of the tail having been long and slender.

The limbs are shorter than in the Elephant, having the toes arranged as in the Tapir, four in front and three behind. The whole of the distal end of the humerus is occupied by the articulation; the radius and ulna are distinct. The phalanges are all short, and the terminal ones are short and tubercular, as in the elephant. The femur has a small third trochanter; the tibia and fibula are separate, and each complete. The distal facets on the tarsal naviculare are subequal.

Prof. Marsh remarks that "the wide narial opening, the rugose extremity of the nasals, and the very large infra-orbital foramen, naturally suggest that there must have been an elongated, flexible nose, possibly as extensive as in the tapir. That there was no long proboscis, as in the elephant, is indicated with equal certainty by the length of the head and neck, which renders such an organ unnecessary."

That *Titanotherium proutii* of Leidy is closely allied to *Brontotherium*, Prof. Marsh considers very probable; but the former genus was determined from a specimen which wanted the skull, and it differs in some respects. *Megacerops* of Leidy, as well as *Symborodon* and *Miobasileus* of Cope, belong to the same group, but their identification has been established on data too imperfect for complete and correct description.

We have adopted Prof. Marsh's term horn-cores for the large conical bony processes on the nasal bones; but it is not at all certain that such is the nature of these protuberances; for it seems improbable that any large horns could be efficiently employed by its owner at the free end of so elongate and flat a skull; at the same time that if they were directed forward, they would seriously interfere with the animal's power of grazing. It must also be remembered that in *Rhinoceros* the horn is not supported on any osseous core, whilst in the wart-hog (*Phacochœrus*) the wart has a conical osseous support.

The discovery of these entirely new and unexpected types of previously existing animals in the comparatively unexplored region of the Rocky Mountains must give a great stimulus to evolutionary thought; for, more than anything, it helps to illustrate to what extent the geological record is incomplete; and further, how great stress ought to be laid on the imperfection, not of the geological record—but of what seems to vary very nearly inversely as it—human palæontological information. The recent exhumation of these several fully differentiated mammals from American Eocene and Miocene beds, when considered in connection with the occurrence of equally specialised and somewhat parallel lines of development in Europe, tends to substantiate the considerable antiquity and the wide distribution of the higher members of the vertebrate subkingdom, and ought to lead to a more thorough search for prototypal forms in the higher secondary strata, other than the few at present known, so that the vast gap which at present exists in our knowledge of the pedigree of the mammalia, may be filled, partly at least, from the record of Mesozoic formations.

*ON THE STUDY OF NATURAL HISTORY**

THE value of Natural History would be more fully appreciated if its higher aims were more perfectly understood. Too many fancied that the study of natural history consisted in mere collecting and naming, and looking at pretty objects. This was, however, mere scientific play; whereas the more thorough study was real work, of use not only as an intellectual training, but also as applied to the practical life of every day. They often heard the remark that the proper study of mankind was man, but to confine their study to him would be to take the first term of a great series, and neglect all the other terms—a proceeding which could lead only to an inaccurate and one-sided view of the order of the universe.

As an illustration of the connection of one class of facts with another he would briefly describe some of the results to which he had been recently led by applying physical methods to the study of the evolution of plants. He had studied the changes that had occurred in the colouring matters in the leaves and flowers during their development from a rudimentary to a perfect state, and the connection between them and the action of light, and had found that there was apparently a most remarkable correlation. When more and more developed under the influence of light, coloured compounds were formed which are more and more easily decomposed by the action of light and air when they were no longer parts of living plants, but dissolved out from them. There was thus apparently some condition in living plants which actually reversed these reactions.

He had also found that in the more rudimentary state of the leaves of the highest classes the colouring matters corresponded with those found in lower classes, and in the case of the petals of flowers their more rudimentary condition often corresponded with some other variety, which thus appeared as if due to a naturally arrested development of a particular kind. This principle would perhaps serve to explain the greater prevalence of flowers of particular colours in tropical or colder regions and at different elevations. Now, since the effect of the various rays of light was different, it became a question of much interest to decide whether an alteration in the character of the light of the sun would produce a somewhat different effect in the case of other classes of plants in which the fundamental colouring matter differed; for example, whether light, with a relatively greater amount of the blue rays, might not be relatively more favourable to the cryptogamia than to the flowering plants. So far this was a mere theoretical deduction; but, if proved to be true by experiment, it might, at all events, assist in explaining the difference in the character of the vegetation of our globe at an earlier epoch, when perhaps our sun was in a somewhat different physical state, and the light more similar to that of Sirius and other stars of the highest and bluer type.

The practical applications of natural history were of course most varied, but he would now merely refer to such as depended upon the equilibrium between different plants and animals. The successful cultivation of useful plants in a foreign country might depend upon very complicated conditions to be learned only by accurate study. The accidental introduction of some plants or animals might prove most injurious if there were no native check to their inordinate multiplication. This was perhaps why in some cases such importations were far more injurious than in their native country, and it became of great importance to learn what means could be taken to provide some adequate check.

* From an address by Mr. H. C. Sorby at the annual *conversazione* of the Sheffield Field Naturalists' Club, January 5.

TRILOBITES

JOACHIM BARRAUDE has published a preliminary epitome (Prague and Paris, 1871, 8vo) of an intended supplement to his "Système Silurien du Centre de la Bohême."

He therein gives a list of the fossils as yet found in the Cambrian formation :—"PLANTÆ : Palæophycus, 1 species; Fucoides, 2; Archæorrhiza, 1; Halopoa, 2; Cordaites, 1; Eophyton, 2; Frœna, 1; Buthotrephis, 1; Scotolithus, 1; Oldhamia, 3; PETRIFICATA INCERTÆ SEDIS : Cruziana, 2; Lithodictyon, 1; ANIMALIA : *Vestigia*, vel Vermium, vel Crustaceorum, vel Molluscorum : Psammichnites, 4; *Spongia :* Astylospongia, 1; *Cœlenterata :* Protolyellia, 1; *Echinodermata :* Spatangopsis, 1; (doubtful Echinoderm ?), Agelacrinus, 1; *Vermes :* Micropium, 1; Spirocolex, 2; Scolithus, 4; Monocraterion, 1; Diplocraterion (Arenicolites), 4; Histioderma, 1; *Mollusca :* Dictyonema, 1; Lingula, 2; Lingulella, 1; Discina, 1; Obolus, 1; Hyolithus, 1."

Whilst this formation has only yielded 28 animals, his next epoch, his "Silurische Primordial Fauna" supplies 366 species as follows :—

Number of Genera.	Classes.	Number of Species.												Different Species.
		Central European Zone.		European.		North America.								
		Bohemia.	Spain.	Scandinavia.	England.	Newfoundland.	Canada—Vermont.	New Brunswick.	New York.	Massachusetts.	Upper Mississippi.	Texas.	Georgia.	
28	Trilobita	27	9	77	61	9	9	18	6	1	37	8	1	252
2	Ostracoda	...	1	5	4	...	...	...	...	...	...	...	...	10
2	Other Crustacea	...	...	...	1	...	...	...	...	...	1	...	...	2
5	Vermes	...	...	...	4	...	...	...	...	...	1	...	...	5
2	Pteropoda	5	...	2	7	...	3	...	...	...	1	...	...	18
1	Heteropoda......	...	...	...	1	...	...	...	...	...	...	...	...	1
2	Gasteropoda ...	...	2	...	...	...	...	...	...	...	2	...	...	4
13	Brachiopoda ...	2	6	8	12	...	5	6	2	...	9	5	...	55
4	Bryozoa	1	...	4	1	...	...	...	...	...	1	...	...	7
6	Cystidea	5	1	...	1	...	...	1	...	...	...	...	...	8
2	Spongia	...	...	...	3	2	2	...	...	...	...	...	...	7
66	TOTAL	40	19	96	95	11	19	25	8	1	52	13	1	366

The author remarks on the discordance between the picture thus offered and that which should appear to give any positive confirmation to Darwinism. He then goes on to remark on some phenomena in the development of Trilobites.

According to the Darwinian theory, the development of the individual should bear relation to the past development of the species. Now Trilobites, as they develope, increase in number of their body segments, and therefore the earliest Trilobites ought to have few such segments. But those of the primordial fauna are generally characterised by the opposite condition, while the number is left in those of the succeeding fauna.

Again, on the Darwinian theory, there ought at first to be but few types, the number increasing later. But, in fact, out of seventy-five genera of Trilobites, no less than seventy-two appear in the first two Silurian faunas, and the three others at the beginning of the third fauna. Moreover, the perfection of organisation by no means gradually increases but is quite irregular.

Once more as regards orders, there is no approximation as we recede in time. The Trilobites, Phyllopoda, and Ostracoda, are as sharply differentiated at their very first appearance as they are later, and the Trilobites of the lowest beds are not less easy to divide into genera than those of a later period. *Bohemilla* might, perhaps, be

considered as an intermediate form between *Agnostus* and *Paradoxides* (resembling the former in its segments, the latter in its head), but then its geological position is above, not below, those genera.

In the Primordial fauna no single Trilobite has been discovered which can be regarded as an intermediate connecting link between and two other genera.

Finally, no trace of a Tribolite has been found in the antecedent Cambrian formation, and yet from the number of these fossils found it is eminently likely that had they existed they would have left traces of their existence amongst the Cambrian fossils.

The author concludes that we have here a very important discord between Darwinism and facts.

NOTES

By the kindness of Dr. Draper, of New York, we are enabled to issue to our readers this week a copy, absolutely untouched, of a photograph of a part of the solar spectrum recently obtained by that gentleman by means of the reflection grating suggested by himself, and made by Mr. Rutherfurd. There is no doubt that in all such physical inquiries as those in which Dr. Draper is interested all observations will in time be permanently recorded by means of photography, and to this end the labours of Drs. Draper, father and son, will have contributed in no mean degree.

We learn from the *Athenæum* that the Gold Medal of the Royal Astronomical Society has been awarded by the Council of the Society to Prof. Simon Newcomb, of the United States, for his tables of Neptune and Uranus, and other mathematical works.

The French Academy of Sciences, at their meeting on Monday last, elected Dr. Huggins, F.R.S., and Prof. Simon Newcomb, to fill two vacancies among the correspondents in the Astronomical Section.

We regret to announce the premature death of two eminent French *savants*, Dr. Legros, who has been poisoned in the course of histological researches, and M. Fernand Papillon, well known for his physiological investigations.

Sir Samuel Baker has been appointed Rede Lecturer in the University of Cambridge for the ensuing year. Sir Samuel, upon whom the University conferred the honorary degree of Master of Arts in 1866, will deliver the lecture in the Easter Term.

Sir Samuel Baker was entertained on Monday at a banquet given by the Mayor and Town Council of Brighton, at the Royal Pavilion. In a long and interesting speech Sir Samuel Baker referred to the progress of African discovery, the resources of Africa and the future of the natives, which he does not think hopeful, and of what he did for the suppression of the slave-trade.

There has been a good deal said recently as to the fate of the Memorial to Government in favour of an Arctic Expedition; but we believe the matter stands exactly as it did when our article appeared on Dec. 11 last (Nature, vol. ix. p. 97). The uncalled-for and aggravating delay of Mr. Gladstone in answering the Memorial is only what might be expected.

From the 1st inst. there will be published daily at Copenhagen a "Bulletin Météorologique du Nord," containing the daily reports from the Danish, Norwegian, and Swedish stations. This makes the fourth such publication in Europe, the others being published in France, Russia, and in this country. In almost all other countries the reports appear at least in the newspapers.

Ornithologists will be glad to hear of the safe arrival lately in the Gardens of the Zoological Society, of a pair of very interesting new species of White Stork (*Ciconia boyciana*) from Japan, described by Mr. R. Swinhoe nearly a year ago. This new form presents points of particular interest, as in general appearance it resembles both the common European Stork (*C. alba*) as well as the Maguari Stork (*C. maguari*) of South America, and so tends to favour the impression derived from other facts—such as the geographical distribution of the *Tapiridæ*, of the *Cinclidæ*, and perhaps of the *Cervulidæ*, if, as shown by Sir Victor Brooke, *Cervus pudu* is related to them in important osteological peculiarities—that it is in that direction, and not across the Atlantic Ocean that the European continent was last in communication with the New World.

We direct the attention of our readers to the account, given in another page, of an extraordinary gigantic new form of Miocene mammals, the *Brontotheridæ*, from Colorado, discovered by Prof. Marsh of Yale College.

We are glad to observe that Mr. Dresser's excellent work on "The Birds of Europe" continues to appear with marvellous regularity, considering the amount of work involved. A double number, comprising Parts 23 and 24, is just issued, completing the second volume in fourteen months; and the author states that he has such a large amount of manuscript ready in advance, that he can with confidence promise equal punctuality with the next volume. The work continues to maintain its high character both in letter-press and illustrations. The plates representing the Spoonbill and the Snowy Owl, in the parts just issued, are charming pictures as well as accurate ornithological portraits.

A telegram from Philadelphia announces that the Siamese Twins died on Saturday at their home in North Carolina, aged 63. Eng lived two hours longer than Chang.

We learn that M. J. C. Houzeau has been investigating the directions of the major axes of cometary orbits. He has examined 233 orbits from Mädler's catalogue, but for the purposes of his investigation he has eliminated those comets of short period, having their aphelia inside the orbit of Neptune, numbering 15, and also the seven probable appearances of Halley's comet and three others whose elements are uncertain, and so reduces the number 233 to 208; he, however, adds Comet I., 1819, making 209 comets whose orbits he discusses. He finds that there is a decided tendency in the major axes of those orbits to place themselves parallel to the double heliocentric meridian 102° 20′ and 282° 20′, being only 28° from long. 254° 5′, in which the point that the solar system is approaching is situate. The major axes do not, however, show a tendency to aggregate near lat. + 57° 26′, in which the before-mentioned point lies; but he observes that it is probable that a large number of southern comets have passed unseen, and that there may be inaccuracies in the elements of the orbits.

We have received several documents relating to the School of Mines, Ballaarat, which was established in 1870, its primary object being to impart instruction in the various branches of science relating to mining, the theory and practice of mining, mine management, mining surveying, and mining engineering. It grants certificates to all classes of men connected with mining, from mining-engineers and assayers to engine-drivers, all candidates being subjected to a good testing examination. The attendance at the School has increased every quarter since it was started, the number of students in the third term of 1873 having been 59. The benefit likely to accrue to a mining country such as Victoria from an efficient school of this kind is incalculable, and

those interested in the welfare of the colony are bound to do all in their power to bring it into thorough working order, and enable it to become a national institution. The school is possessed of a good metallurgical laboratory, but its efficiency is sadly hampered for want of funds, the fees payable by the comparatively small number of students being quite insufficient to maintain the requisite staff of teachers. Government grants only 500*l*. a year, private subscription and fees amounting to about another 200*l*., but to keep up a full staff of lectures, the Council require an income of at least double what is now at their command. This is surely a case in which the industrial welfare of the whole colony is involved, and we therefore think it is certainly the duty of the Government to see that the Ballaarat School of Mines does not fall short of complete efficiency for want of funds.

AMONG Mr. Murray's announcements of new works we notice the following, which may be of interest to our readers:—"A Memoir of Sir Roderick Impey Murchison," based upon his journals and letters, with notices of his scientific contemporaries, and a sketch of the rise and progress, for half a century, of palæozoic geology in Britain, by Professor Archibald Geikie, LL.D., F.R.S. This book will be published, we understand, early in the spring. "The Moon, considered as a Planet, a World, and a Satellite," by James Nasmyth, C.E., and James Carpenter, F.R.A.S. This work will be accompanied by numerous illustrations produced from drawings made with the aid of powerful telescopes, woodcuts, &c. "The Impending Famine in Bengal: how it will be met, and how to prevent future famines in India," by Sir Bartle Frere, D.C.L., with maps, &c. "England and Russia in the East," a series of papers on the political and geographical condition of Central Asia, by Major-General Sir Henry Rawlinson, F.R.S., with a map. A new edition of "Metallurgy," by Dr. John Percy, F.R.S., Lecturer on Metallurgy at the Government School of Mines, vol. i. containing Fuel, Wood, Coal, Copper, Zinc, &c. A new edition, re-constructed and re-written, of the first volume of Prof. Phillips' "Geology of Yorkshire," comprising the coast of the county. It will contain a large number of additional illustrations and be issued in quarto size.

ANOTHER work on the threatened famine in Bengal is announced by Messrs. Trübner & Co. It is by Dr. W. W. Hunter, Director-General of Statistics to the Government of India, and will be entitled "Famine Aspects of Bengal Districts."

DR. SCHWEINFURTH's account of his travels and discoveries in Central Africa during the years 1868 to 1871 will be published by Messrs. Sampson Low & Co. in the course of a few days. This work will be translated by Ellen E. Newer, and will contain an introduction by Winwood Reade, whose work on Africa was reviewed in NATURE a few months back. It will be copiously illustrated by woodcuts from drawings made by the author, and will be issued in two octavo volumes.

IT is known that the Russian Government have made considerable preparations in view of the great astronomical event of this year. A General Assembly of the Commission charged to study the question has finally adopted twenty-seven stations, the list of which (with latitude and longitude, the instruments available at each, and the chances of good weather) may be found in the *Revue Scientifique* for 10th inst. The probable temperatures of the different stations, at the time of observation, are also estimated; they range from $-20°$ C. at Kiakhta, and $-10°$ at Omsk. to $+10°$ at Naktritchevan and Erivan. At Nertschinsk and some other stations in Eastern Siberia, for which calculations are not had, the cold is expected to be still greater. The observers for the different stations have all been appointed, and have been engaged in practising with their instruments at the observatory of Pulkowa. All the telescopes are mounted equatorially; and the equatorials are fitted with a clock-work movement and a micrometric apparatus. The personal equations of the different observers will be determined by means of an apparatus like that of M. Wolf (Paris Observatory), in which an artificial star is observed in its passage across a net-work of wire. The telegraphic determination of the longitudes of the various towns of Siberia is likely to be completed in 1875. Several of the stations chosen for this determination are also stations for the transit observations. The other transit stations will be easily connected with these by chronometric observations, and as for the stations bordering on the Caspian Sea and the Black Sea, these longitudes are already known with sufficient exactness.

PROFESSOR WHITTLESLEY has given a paper on the fluctuation of the level of Lake Superior—a subject specially studied by him many years ago, and which has as yet received but slight elucidation. In his present communication he has confined himself to the consideration of those fluctuations which are not only transient, but also occurring with the regularity of a wave—those low pendulum-like pulsations which are probably common to all the lakes, but are most noticeable in Lake Superior. Until a better theory can be found, he adopts the explanation that these undulations are caused by atmospheric movements.

THE Tower Hill Microscopical Club holds its first *Conversazione* at 3, Great Tower Street, on Tuesday, the 27th inst.

IN a letter to the *American Journal of Science and Arts*, dated Cordoba, September 18, 1873, Dr. Gould gives an account of a remarkable swarm of large grasshoppers, or locusts, recently witnessed there. Myriads filled the air, invaded the houses, and covered the ground, from which they rose like thick clouds of dust, on approach of man or beast. These, however, seem to have been merely the stragglers of the main body. Going out to observe the phenomenon more closely, Dr. Gould saw, to the eastward, what looked like a long trail of dense black smoke, extending over 160° of the horizon, and to an altitude of about 5°. A strong field-glass showed that it was no smoke, but a swarm of locusts. Its width there was no means of determining, but from the position of the focus needed for resolving the cloud at its point of nearest approach, Dr. Gould estimated that none of the swarm passed within less than three or four miles. The insects were evidently transported with the wind, which blew from the north with a velocity of ten miles an hour. This was at 10 A.M. (on August 13). The head of the column had passed far out of sight, and certainly twenty miles of its length were visible over the far-stretching pampa. They continued to pass in apparently undiminished numbers till daylight failed. On September 1 the phenomena were repeated, the insects being borne back by a south wind; and they were coming directly on the town when the wind hauled to S.E. and carried them past about six miles off. From measurements made, Dr. Gould stated that the height of the dense nucleus must have been at least 2,000 ft., its width here not more than six or seven miles; the whole environed by a penumbra of stragglers. At the time of writing, the wind had brought them on in full force "literally darkening the sun," and "there is probably not a square inch of our grounds unoccupied by them."

"CRONACO DEL VESUVIO," by Prof. Palmieri (Naples: Detken and Rochall, 1874), contains a brief summary of the principal eruptions from 1840 to 1872, by far the greater part of the work, however, being occupied with details of the outbreak on April 26, 1872, Palmieri's account of which has been already noticed in these pages. The present work contains several appendices on subjects of chemical and mineralogical interest in connection with eruptions of Vesuvius.

WE learn from the *Medical Record* that the Geographical

Society of Italy has received from Alexandria, with the news of the death of the explorer Miani, and various ethnological objects, two living individuals whom he had forwarded of the tribes of the Akka or Tikku-Tikki, and whom the learned traveller had bought of the King Munza. These individuals—of whom one is eighteen years old, and forty inches in height, and the other sixteen and thirty-one inches high—are stated by Miani to belong to the race of dwarfs described by Herodotus, and recently re-discovered by the German explorer Schweinfurth, who described them carefully. They are pot-bellied, very thin-limbed, and knock-kneed, spherical and prognathous crania, very long limbs, copper skins, and crisp, tow-like hair.

"EXTRA No. 14" (Scientific Series) of the *New York Tribune* is devoted to accounts of three scientific expeditions. The first the Hayden Expedition of 1873, an account of which is given in a letter from Prof. W. D. Whitney, and in a review by Dr. F. V. Hayden; of the progress of this expedition we have at various times given news. A "New Route to Yellowstone Park" is described in the account of Captain Jones's Expedition of 1873. The third expedition is that of the late Professor Agassiz to Brazil, the *Tribune* reproducing the six lectures delivered by Agassiz after his return in February 1867.

WE have received in a separate form two papers communicated to the French Academy by M. A. Poëy—one on the "Connection between Solar Spots and the Hurricanes of the Antilles, of the North Atlantic and the Southern Indian Ocean," and the other on the "Connection between the Solar Spots, the Storms at Paris and Fécamp, the Tempests and Sudden Storms in the North Atlantic."

WE have received from Quebec the "Transactions of the Literary and Historical Society" of that city, for session 1872-3, the longest paper in which is an interesting diary of "A Whaling Voyage to Spitzbergen in 1818," kept by Dr. James Douglas. Another paper, by Dr. H. H. Mills, contains some observations on Canadian Chorography and Topography, and on the meritorious services of Jean Baptiste Duberger, sen., who died in 1821, and who seems to have been an excellent surveyor and map-maker. The Society appears to have been in existence for many years, is in a flourishing condition as to members and income, and possesses a good Natural History Museum. We are glad to see that the Society's programme includes scientific as well as literary and historical subjects.

THE *Bulletin* of the French Geographical Society, for December, contains an account of a voyage made last autumn by M. A. Pinart along the south coast of the Aleutian Isles and the Peninsula of Alaska, illustrated by a good map; the continuation of M. J. Halévy's Journey to Nedjrân; and a very long paper by M. Dournaux-Dupéré, on the part which France ought to play in Northern Africa, advocating the complete subjection of the Sahara by France.

"ON the Geology of Western Wyoming," is a paper by Mr. T. B. Comstock, reprinted from the *American Journal of Science and Arts*.

THE additions to the Zoological Society's Gardens during the past week include two Cinereous Sea Eagles (*Haliaëtus albicilla*), European, presented by Sir Victor Brooke, Bart.; a pair of Pink-headed Ducks (*Anas caryophyllacea*) from India, new to the collection; a Nicobar Pigeon (*Calœnas nicobarica*), from the Indian Archipelago; a Cheetah (*Felis jubata*) from Africa; a White-lipped Peccary (*Dicotyles labiatus*), from South America; a Sooty Mangabey (*Cercocebus fuliginosus*), from West Africa; a Verreux's Guinea fowl (*Numida cristata*), from East Africa; a Masked Weaver Bird (*Hyphantornis personata*), from West Africa; and four Grenadier Weaver Birds (*Euplectes oryx*), from Abyssinia, purchased, or received in exchange.

NEW REMARKS ON THE NATURE OF THE CHEMICAL ELEMENTS, BY M. BERTHELOT*

THERE will be no necessity for me to remind the Academy of the great importance of the question raised at the last meeting. Between our illustrious master, M. Dumas, and the author of these lines, there should not be any difference of opinion neither on the principles of a science which he himself has taught us, nor as to the originality of his ideas with regard to the chemical elements, their relation to each other or to the organic radicles.

It is therefore more for the purpose of avoiding the reproach of an incomplete knowledge of the science than for further insisting on what I have before advanced, that I ask his permission to quote in this place, p. 280 of his "Leçons de Philosophie Chimique" a passage in which he has approached my own remarks:—

"Before commencing with any confidence to build a system upon this foundation," says M. Dumas, "it is necessary that a great number of exact experiments should increase our knowledge of it. It will therefore be of the greatest importance to study compounds in relation to their capacities for heat, for it cannot be supposed that the relation of the specific heat to the weight of the atom holds only for elementary bodies; it is also found in compounds of the same order. It would therefore be wrong to seek in this direction for a proof of the truth of the ideas which we have imagined of the bodies which appear to us to be elements, and we ought to say that the capacity of their chemical atoms tends towards equality because they are bodies of the same order, without their elementary nature necessarily following from it."

In support of these opinions M. Dumas cites the then recent experiments of Naumann on the specific heats of the carbonates of barium, strontium, calcium, iron, zinc, and magnesium, which, multiplied by their corresponding atomic weights, give a constant product of 131; while the sulphates of barium, strontium, calcium, and lead give the product 155. M. Dumas adds with reason—"For the other compounds we are in want of data sufficiently precise to enable us to make similar comparisons."

It will be seen then that in 1836 the point in question is no longer the relation between the specific heats of compounds and that of their elements, but entirely between compounds of the same order, *à fortiori* the possibility of distinguishing elements from compound bodies in general by means of specific heats was expressly discarded.

Although the specific heats of compound bodies were formerly but little known, the gap was being filled for many series by the researches of M. Regnault. But Regnault, like Naumann, confined himself to the determination of the specific heats of compounds the constitution of which was similar, without seeking to establish any more remote relation.

Wœstyn in 1848 was, I believe, the first to announce the approximate relation between the specific atomic heat of a compound and those of its elements, and the partial relations discovered by Naumann and Regnault then became a consequence of this more general law.

In applying it in my turn to the organic radicles and especially to the carbides of hydrogen, I have been led to put in evidence the difference which distinguishes their specific heats from those of the elements, whether taken individually or together, as members of a group of bodies of the same order. The carbides of the ethylene series are bodies of the same order, and present quite as many analogies amongst themselves as simple radicles such as calcium, barium, strontium, iron, zinc, and magnesium do, and the same may be said of the combination formed by these radicles. I repeat, therefore, that as the specific atomic heats of the simple radicles have the same value, and this value being known and considered in connection with their atomic weights, the simplicity of their composition results of necessity therefrom almost always, as I have already established in my preceding note. At the same time the specific atomic heats of the com-

* Translated from the *Comptes Rendus* of December 15, 1873. At the preceding meeting M Berthelot read a note on the same subject, in which he gave a more detailed description of the observed differences between the specific atomic heats of elements and compounds. The principal points were, that whilst the specific atomic heats of elements whose atomic weights are multiples of the same number, such as the S, Se, Te group, are identical, the specific atomic heats of compounds whose atomic weights are multiples of some common number, as in the group of polymerised hydrocarbons, ethylene, amylene, caprylene, &c., are multiples of each other, being proportional to their atomic weights. He concludes: "This difference is important, inasmuch as the notion of specific heat is a representation of the general molecular work by which bodies are maintained in an equilibrium of temperature with each other andt would also indicate that the decomposition of our elements, if possible, ought to be accompanied by phenomena of another kind than those which determine the decomposition of our compounds."

pound radicles are nearly always multiples of one another, and their magnitude is sufficient to establish the complexity of the radicles themselves.

The combinations of the same order formed by the simple radicles have all of them nearly the same atomic heat, as the observations of Naumann and Regnault have shown. On the contrary, combinations of the same order formed by a series of analogous compound radicles exhibit specific heats which tend to increase proportionally with the variation of their atomic weights. This, which is precisely the opposite of the relations which would have been supposed to exist between compounds of the same order at the time of Naumann's researches on the identity of the specific atomic weights of the carbonates and sulphates, is another proof of the complexity of these radicles.

To sum up, the study of the specific heats established by the most recent researches, tends to prove that there is a positive characteristic which, it seems to me, distinguishes the elements of modern chemistry from its compounds, and shows that no known compound body ought to be considered as of the same order as an actually simple one. The importance of such a characteristic cannot be doubted, and it becomes greater on account of the mechanical meaning which modern theories ascribe to specific heat. This I feel bound to put in evidence.

Nevertheless, and I ask permission to return once more to this point, exaggerated conclusions must not be drawn from such an opposition between the mechanical and physical characteristics of our simple and compound bodies.

If our elements have not as yet been decomposed and appear not to be decomposable by the forces which are at present at the command of the chemist, and which, as M. Dumas at the time of his discussion with Despretz justly remarked, have been so often tried in vain, nothing compels us to assert that they are not decomposable in another way than our compounds are; as, for instance, as Mr. Lockyer asserts, by means of the forces acting in cosmical space. Nor does anything prevent the supposition that such a discovery as that of voltaic electricity would enable the chemists of the future to overpass the limits which are imposed upon us.

The possible fundamental identity of the matter constituting our elements, and the possibility of transmuting into one another the so-called elements, can moreover be admitted into the category of more or less plausible hypotheses without it necessarily resulting that there is a single really existing matter of which our actual elements represent unequal states of condensation. In fact nothing compels us to conceive the existence of a final decomposition which shall tend necessarily to reduce our elements either to more simple bodies, from the addition of which they arise, or to multiples of a single elementary ponderable unit. The various states of equilibrium under which the fundamental matter manifests itself would exhibit certain general relations to each other analogous to those which exist between the multiple values of the same function. According to this hypothesis, an elementary body could be broken up without being destroyed in the ordinary meaning of that word. At the moment of its destruction it would suddenly change into one or more simple bodies identical with, or analogous to, our elements. But the atomic weights of the new elements would not show any simple relation to the atomic weight of the element which had by its metamorphosis produced them, the absolute weight alone would remain unaltered throughout the catena of changes.

But I do not wish to insist further on this hypothesis of a matter fundamentally identical, although multiform in its appearances, and characterised in each one of them by a peculiar mode of motion, such, in fact, that no single one of them can be definitely considered as the starting-point of all the others. Nevertheless, we shall only be too glad if Mr. Lockyer, guided by stellar spectral analysis, succeeds in shedding a new light upon these hypotheses, and continues to investigate questions which M. Dumas raised forty years ago in a book which has contributed so much to our scientific education.

R. J. F.

SCIENCE IN LIEGE

WE have received a somewhat bulky volume of Memoirs of the Royal Society of Science in Liege (1873), in which a considerable variety of subjects comes under notice; zoology and mathematics being, perhaps, the most largely represented.

An *éloge*, by Prof. Morren, on Jean Théodore Lacordaire (who died in 1870), is accompanied with a good portrait of that eminent naturalist. Lacordaire was originally destined for the law, which, however, he left for commerce. Going out to South America in a business capacity, his bias for natural research was quickly developed, and he commenced those labours to which his after life was devoted. In 1835 he became professor of zoology at Liege, where he continued till his death. Lacordaire was a voluminous writer, but his *summum opus* is the *Genera des Coléoptères*, which is remarkable for the minuteness of its details and its rigorous truthfulness.

For some years past we have heard a great deal about the services which birds render to agriculture by destroying injurious insects. The sentiment is widespread, and vigorous measures of bird protection have been taken in various countries of Europe. M. Edouard Perris here brings forward a somewhat opposite view, which he supports by many curious facts from a long experience of country life. His position is, briefly, the following:— 1. Birds are congregated in considerable numbers only in the migration time in autumn and spring, when insects are very much less numerous than in the fine season. The rest of the time they live in pairs, sparsely distributed, and rare in cultivated parts, while the insects come forth *en masse* to do their mischievous work. 2. Birds destroy insects largely, but these insects are, in great part, indifferent, others are eminently useful; and the really hurtful species destroyed are in very small proportion to the whole. Thus the birds do us little service; and they often do injury in destroying our carnivorous and parasitic insects, as well as attacking fruits and seeds. 3. The insects we have most to complain of are, some of them, big enough to brave the birds, others are too small to attract them; others prove disagreeable as food; many are nocturnal in habits, or, by their immobility, escape notice; some live underground, or in houses; and all have an astonishing fecundity which is quite baffling to human resources. 4. Larvæ and caterpillars, which do the most damage, live nearly all concealed under ground, under bark, in the deep parts of wood, in the roots of plants, in fruits, in inhabited places, &c., and furnish little tribute to the birds. Those which develop in open air are generally provided with hairs which protect them; some are nocturnal, some are extremely small. All these facts, in the author's opinion, should greatly modify the ordinary view as to the utility of birds in agriculture. He points out that certain natural influences tend to preserve an equilibrium in the insect world; such are, famine occasioned by the too great multiplication of individuals, meteorological phenomena adverse to their growth or metamorphosis, and the abundant production of parasites. M. Perris does not find fault with measures of bird protection, but objects to the undue merit which is assigned to birds. He urges upon farmers the importance of exercising more discernment in their destructive measures, and of respecting many animals they often regard as nuisances, such as hedgehogs, snakes, lizards, toads, &c.

Medical men will doubtless be interested in two teratological observations communicated by Dr. Eugene Charlier. One is that of a child inferiorly double, or a double ileadelphous monster. It is a kind of monstrosity of which Is. Geoffrey Saint-Hilaire supposed the existence, but of which he did not know any authentic case. The other monstrosity is a new variety of pygomelian chicken; the animal has two accessory limbs joined to the normal wing and leg on one side. The forms are represented in plates annexed to the notes in question.

An important mathematical paper by M. Brasseur, furnishes a "new exposition of the principles of the differential and integral calculus." The following sentences from a commendatory preface by M. Folie, will give some idea of the point of view which the author adopts. "Of all the modes of considering the differential calculus, we do not know of any more philosophical than that of Newton; but it requires, to be properly understood, a mind well trained to metaphysical speculations. We have, indeed, known good analysts who never grasped it, though they had studied at the best sources. The great difficulty of the differential calculus is that it attempts to analyse the idea of continuity; it seeks to express how a function passes in a continuous manner from one state to another; and it is this passage which has given rise to the contradictory idea of the infinitely little, to the indirect idea of limits, and to the philosophic idea of Newton. Brasseur has avoided this great difficulty; he has succeeded in rendering the method of La Grange, who only employs finite analysis, as convenient in its applications, and as rigorous, as that of limits or of fluxions. We will even say that his method has, from the educational point of view, the advantage, over that of fluxions, of not requiring any metaphysical notion; and, over that

of limits, of being much more direct, and not exposed to any attack, even specious. Instead of analysing the idea of continuity he studies two successive states of a continuous function; and continuity only comes in so far as that the difference between these two states may become as small as we choose without ever becoming *nil*, as seems to be the case in limits; or infinitely little, in the old signification of the word, a signification simply absurd."

We simply name, in conclusion, the following zoological lists, which make up the greater part of the volume:—Monography of the Malabrides, by M. de Marseul; Synopsis of the Scolytides, by M. Chapuis; and new or little known Araneides from the South of Europe, by M. Simon.

SCIENTIFIC SERIALS

Zeitschrift für Ethnologie (1873). The fifth number of the journal for last year is of less than average importance to English readers, since the principal article—a most valuable and comprehensive one on the descriptive ethnology of Bengal—is a translation of Colonel Dalton's digest of the official reports drawn up by the different Commissioners of the province, and published at the cost of the Indian Government. This work, which supplies information that can nowhere else be found in regard to the tribes occupying the Brahmaputra and Gangetic valleys, must henceforth be considered as indispensable to every student of Indian ethnology, and the editors of the *Zeitschrift* have done good service in making it known to their readers. In an article on a proposed improvement in the methods of craniometry now in use, Dr. Jhering passes in review the difference in the values of the indices, proposed by Blumenbach, Retzius, Broca, and others, for the definition of Dolichocephalic and Brachycephalic types. His three main propositions are briefly these:—1. All cranial measurements must be projected in a line that is parallel or vertical to the horizontal base of the cranium. 2. The most important maximum and minimum dimensions should be obtained *per se*, and without reference to distances from definite anatomical points. 3. For all parts not in the medial plane, the percentage of lengths and heights must be given at the points where such parts intersect these diameters. Dr. Jhering thinks that it is time finally to set aside the theory transmitted from Blumenbach, and through Retzius to the present day, that every race possesses at once a special language, and a special type of cranium. According to his view it is never possible to determine with certainty from the form of the skull the precise race from which an individual has sprung, and in his opinion the problems which ought to engage the attention of future students of craniology are the determination of the *mean* cranial type of each race; and the definition of the limits within which each special type varies among different races. Finally the author wishes to show that craniology is not competent to determine questions of race, but is merely to be accepted as an auxiliary science to anthropology. The learned missionary, Th. Jellinghaus, to whom we are already indebted for many valuable contributions to our knowledge of the languages spoken by the outlying tribes of our vast empire in India, gives in this number a short account of the language of the Munda Kohls of Chota Nagpore. The peculiarities of their tongue seem to be a distinct dual for all three persons: the formation of the plural and dual by the addition of an abbreviated form of the third personal pronoun; the insertion of the letter *p* with the vocal accent for the formation of the plural and dual of certain nouns and adjectives; the interpellation of the letter *n* in the root-syllable of the verb to form the abstract noun. The units of the Munda Kohls' numeral system are 10 and 20. The author describes these people as kind and simple in their social relations with one another. Herr Virchow draws attention to a specimen of a synostolic cranium as the form has been figured and described by J. B. Davis in his work on "Synostolic Crania among Aboriginal Races of Man" (Haarlem, 1865). As this skull belonged to a rachitic child, and similar skulls, in which the calvaria was entirely obliterated, and the cranial bones were thickened outwardly, are preserved in the Berlin and other Pathologico-Anatomical collections, and were taken from rachitic subjects, Herr Virchow considers that such forms must be held to be quite independent of ethnological peculiarities, and that their occurrence amongst savage or aboriginal races must be ascribed to the frequent presence amonst them of rachitism—a fact to which Pruner-Bey has already drawn attention. We canno close our notice of the contents of this number without mentioning an interesting communication by Dr. Brehm in regard to his experience—based on an eight years' acquaintance—of the habits of the Chimpanzee under confinement. The last individual which fell under his notice, and which died at the age of four from pulmonary disease, showed, in many respects, an aptitude of comprehension, a docility and a capability of practising the ordinary usages of daily life which made the animal an interesting and wholly unobjectionable inmate of Dr. Virchow's house, where he ran about with little more surveillance than would have been awarded to a human child of the same age. The result of the learned author's experience of this, and other individuals of the race is, that although not human, there is *very much* of the element of humanity in the Chimpanzee.

Poggendorff's Annalen der Physik und Chemie, No. 9, 1873.—This number commences with a theoretical examination, by the editor, of the action of Holtz's electrical machines of the "second" kind, those being meant which have two discs rotating in opposite directions, whereas in the "first," and more common kind, one disc rotates while the other is stationary. The author's view is, not that there is suction, by the conductors, of the electricities expanded in the insulators, as commonly supposed, but conversely, that electricities separated in the conductors, through induction, stream over to the insulators. In this way, both modes of excitation, by induction and by inflow (*Einströmung*), are explained on one principle. The same holds good for machines of the first kind.—M. Julius Thomsen continues his "Thermo-chemical Researches," investigating here the action of four agents of reduction, and seven of oxidation.—Dr. Müller describes a new tangent galvanometer and rheostat, free from the disadvantages of not being equally available for currents of all degrees of intensity, and of waste of time in use. The galvanometer differs from ordinary ones in the arrangements for reading and deadening; and, in the rheocord, to neutralise heating effects with strong currents, the wires are surrounded by distilled water.—There are four papers referring to the "horizontal pendulum;" in two of which M. Zöllner describes the instrument as he constructs and uses it, giving several observations made with it, which indicate its great sensitiveness. In a third paper he represents that the idea was first conceived by Lorenz Hengler, a writer in "Dingler's Polytechnisches Journal" in 1832; while in a fourth note on the subject, Prof. Safarik produces evidence of the same fact, and also shows that the bold idea of demonstrating the variations of gravity and of cosmic attractions by terrestrial observations in one place, had already been expressed and experimented on by Gruithuisen, some fifty-two years before Zöllner, viz., in 1817.—M. von Bezold communicates the first part of a valuable paper on the law of colour mixtures, and the physiological primary colours; and Prof. Clausius discusses a new mechanical proposition with reference to stationary motions.—In a note translated from the Italian, the question is considered by Prof. Roiti, Is the electric current an ether current? He argued that if this were the case, then the velocity of propagation of light in a body traversed by a galvanic current must be altered by the direction of this current. In his experiments he caused rays from two parallel slits to pass through two cell-divisions, respectively, of a rectangular glass vessel containing sulphate of zinc solution (the thickness of the dividing wall being equal to the interval between the slits). Interference fringes were obtained at the exit of the rays. Four electrodes being inserted, so that a current passed in opposite directions in the two cells, this had no effect in displacement of the fringes. M. Roiti concludes that if the galvanic current were an ether current, it must have a very small velocity, less than 200 metres per second, which does not agree with the phenomena of galvanic electricity.—Prof. Mach's paper on the stroboscopic determination of the pitch of tones, deserves the attention of musicians and others.

Der Naturforscher, Nov. 1873.—Among the botanical notes in this number is one on the age and mode of growth of woody plants in Greenland. M. Kraus finds that these plants often attain great age (150 years, *e.g.* in the case of some willows), but that the annual increase of thickness is extremely small, 1·5 mm. at the maximum.—Some experiments described by M. Godlewski prove that formation of starch in chlorophyll granules is not possible without access of CO_2; that the liberation of starch from these granules may occur in bright light; that we cannot, from absence of starch, infer there is no process of assimilation; and that the cause of change of form in etiolated plants does not

lie in the suppression of the assimilative process. Mr. Sorby's observations on the colour of plants are also given.—In physics and chemistry, we have an account of experiments by M. Meyer as to the influence of access of air on alcoholic fermentation, MM. Favre and Valson's researches on work done in saline solutions, those of M. Edlund on the electromotive and thermoelectric forces of metallic alloys with copper, those of MM. Mach and Fischer on reflection and refraction of sound, Prof. Maxwell's lecture on molecules, and other papers.—In a physiological paper, entitled "The internal mechanics of nerves," some additional light is thrown by M. Bernstein on the electrotonic state investigated by Pflüger, and a hypothesis is offered, to account for the phenomena. There are also biological papers on the apparatuses for production of sound in insects, and on the deep-sea fauna of the Swiss lakes.—We further note an interesting lecture by M. Sandberger, on a portion of the geological history of the *Oberrheinthal*; and a quantity of valuable information in the *Kleinere Mittheilungen*.

Journal of the Franklin Institute, Dec. 1873.—In this number are given two reports of the Committee on the mode of determining the horse-power of steam boilers. A division of opinion is indicated, a minority in the Committee holding, that the horse-power of boilers for stationary engines is properly defined as the capability to evaporate a cubic foot of water per hour from and at the temperature of 212° F. and there is no reason for modifying its normal value; while the majority (4 against 3), consider, that, in view of variations of capacity of the same boiler under varied conditions, the discontinuance of the term horse-power, as descriptive of the size and capacity of the boiler, is advisable; purchasers and makers should, instead, describe fully and in accurate terms, the evaporative capacity of boilers proposed, and the conditions under which they are worked and tested. Considerations are urged in support of each of these views.—Mr. Richards continues his "Principles of shop manipulation, for engineering apprentices;" this part treating chiefly of the various kinds of motive machinery.—A paper read by Mr. Ransome before the Franklin Institute gives an account of the improvements which he has introduced into the manufacture of artificial stone.—We also find notes on a new hydraulic railway car-brake, by Mr. Henderson, and on the stability of towers and chimneys, by Mr. Evans.—Among the "Items and Novelties" reference is made to some important results obtained by Prof. Thurston, from experiments at the Stevens Institute of Technology, as to the behaviour of metals under stress. The following deduction was repeatedly confirmed:—Metal strained so far as to take a permanent set, and left under the stress producing it, gains in power of resistance up to a limit of time, which in these experiments was about seventy-two hours, and to a limit of increase which has a value, in the best iron, of about 20 per cent., where the applied force is 80 per cent. of the ultimate breaking force.

SOCIETIES AND ACADEMIES

London

Mathematical Society, Jan. 8.—Dr. Hirst, F.R.S., president, in the chair.—Mr. J. W. L. Glaisher read a paper on the transformation of continued products into continued fractions. The paper had its origin in a remarkable continued fraction for π given by Prof. Sylvester in the Philosophical Transactions for 1869, viz.:—

$$\frac{\pi}{2} = 1 + \cfrac{1}{1 + \cfrac{1 \cdot 2}{1 + \cfrac{2 \cdot 3}{1 + \cfrac{3 \cdot 4}{1 + \cfrac{4 \cdot 5}{1 + \&c.}}}}}$$

which is there shown to be equivalent to Wallis's formulæ—

$$\frac{\pi}{2} = \frac{2 . 2 . 4 . 4 . 6 . 6 . 8 . 8 \ldots}{1 . 3 . 3 . 5 . 5 . 7 . 7 . 9 \ldots}$$

Prof. Sylvester arrived at his result by means of a complete solution he had previously found of the equation of finite differences

$$U_{x+1} = \frac{U_x}{x} + U_{x-1}$$

(a "shaving" as the discoverer remarked from his method of "reducible cyclodes") whereas the present paper arrives at the result by a direct transformation.—Prof. Clifford spoke upon the foundations of the differential calculus and of dynamics. The points dwelt upon were—all continuous quantity is expressed by lines, therefore every fluxion is really velocity or the method of fluxions and the beginning of kinematic is the same; he then dwelt upon Newton's definition of tangents and Hankel's remark, and pointed out the necessity of a modification of the definition, traced out certain analogies to the methods of Euclid and Archimedes (definition of fourth proportional and of area), and closed his remarks with a proof of the composition of velocities.—The secretary read a note from Prof. Crofton on a method of treating the kinematical question of the most general displacement of a solid in space.—Mr. Perigal made a few remarks on the subject of link trammels (in connection with Prof. Sylvester's recent paper), in the course of which he stated that Peaucillier's lozenge-trammel is a modified reproduction of Jopling's "double cranks" trammel, invented about 1822. The statement was impugned by Prof. Sylvester and Mr. S. Roberts.—The following papers were taken as read:—On Hamilton's characteristic function for a narrow beam of light, by Prof. J. Clerk-Maxwell.—Preliminary account of investigations on the free motion of a solid in elliptic space, by Prof. Clifford.

Geological Society, Jan. 7.—Prof. Ramsay, V.P.R.S., Vice-President, in the chair. The following communications were read:—1. "The Origin of some of the Lake-basins of Cumberland."—First Paper. By J. Clifton Ward, F.G.S. After referring to the fact that the question of the origin of lake-basins cannot be satisfactorily discussed unless the depth of the lakes and the heights of the mountains are brought before the mind's eye in their natural proportions, the author sketched out the physical geography of the lakes under discussion (Derwentwater, Bassenthwaite, Buttermere, Crummock, and Loweswater), and pointed out what must have been their original size and shape before they were filled up to the extent they now are. These lakes were not moraine-dammed, but true rock-basins. The belief that the present Lake-district scenery was the result of the sculpturing of atmospheric powers, such as we see now in operation, varied by climatal changes and changes in the height of the district above the sea, was enforced, and the opinion given that the work of elaboration of the lake-country scenery has been going on ever since Carboniferous or pre-Carboniferous times. When all the evidence was considered—the fact of the lake-hollows under examination being but long shallow troughs, the thickness of the ice which moved along the valleys in which the lakes now lie, the agreement of the deepest parts of the lakes with the points at which, from the confluence of several ice-streams and the narrowing of the valley, the onward pressure of the ice must have been greatest,—the conclusion was arrived at that Prof. Ramsay's theory was fully supported by these cases, and that the immediate cause of the present lake-basins was the onward movement of the old glaciers, ploughing up their beds to this slight depth.—2. "On the Traces of a Great Ice-sheet in the Southern part of the Lake-district and in North Wales." By D. Mackintosh, F.G.S. In this paper the author brought forward the evidence which seems to him to establish the existence in the southern part of the Lake-district of a "valley-ignoring and ridge-concealing ice-sheet." He gave a table of the direction of ice-marks observed by him in the Lake-district, and stated that about Windermere and Ambleside the general direction is nearly N.N.W., round Grasmere between N.W. and N.N.W., north-west and west of Grasmere in upland valleys and on high ridges about N. 30° W., south of Grasmere and in Great Langdale N. 35° W., and in the Coniston district a little W. of N. In many places he recognised an uphill march of the ice. The author also referred to the glaciation of North Wales, some of the marks of which, observed by him in a district south of Snowdon, seemed to him to indicate the southerly movement of a great ice-sheet capable of ignoring or crossing deep valleys. —3. Notes on some Lamellibranchs from the Budleigh-Salterton Pebbles. By Arthur Wyatt Edgell, F.G.S.

Linnean Society, Jan. 15.—Mr. George Bentham, F.R.S., in the chair.—Dr. Hooker, Pres. R.S., exhibited a very beautiful series of specimens of Fossil Copal, the product of *Trachylobium Hornemannianum*, some specimens of Recent Copal from the same plant, and some fruits of a *Momordica*, all fowarded from Zanzibar, by Dr. Kirk, F.L.S., for the Kew Museum.—Before proceeding to the regular business of the Society, the president again read, and explained the purport of, the alterations in the Bye-laws agreed to by the Council. The

proposed alterations were adopted by the Society. The following papers were then read, viz. :—On some Species of Japanese Marine Shells and Fishes which inhabit also the North Atlantic, by J. Gwyn Jeffreys, F.R.S. The mollusca noticed by the author were procured by Captain St. John in H.M.S. *Sylvia*, during the years 1871 and 1872, on the coasts of North Japan. His dredgings varied betweeen 3 and 100 fathoms. After passing in review the works of naturalists who had described the marine shells of Japan, and especially the "Mollusca Japonica" by Dr Lischke, with reference to those species which are common to Japan and Europe, Mr. Jeffreys proposed to record from Captain St. John's dredgings thirty-nine species, and to give the range of depth for such of them as he had obtained in the *Porcupine* expeditions of 1869 and 1870. He then offered an explanation of the occurrence of the same species in the Atlantic and Pacific Oceans, by suggesting that it was probably owing to involuntary transport by tides and currents, and not to voluntary migration. Very little is known about the direction and force of deep sea currents; but high northern species might be transported on the one side to Japan, and on the other to Europe, by a bifurcation of the great Arctic current, which has been traced as far south as the Straits of Gibraltar in the course of the *Porcupine* expeditions. The entry of northern species into the Mediterranean may be accounted for by the former existence of a wide channel, or rather an open sea between the lower part of the Bay of Biscay and the Gulf of Lyons, which has been satisfactorily proved, on geological grounds, to have been formed since the Tertiary epoch. A list of the mollusca referred to in the paper was given, with critical remarks, as well as a list of twenty-two species of fish which Dr. Günther communicated as common to the Japanese Seas and the North Atlantic or Mediterranean.—Dr. Carpenter, F.R.S., made some general remarks on Ocean-currents, especially with reference to the zones of temperature in the North and South Atlantic. He stated that it has been ascertained that water of 40° F. comes nearer to the surface in the equatorial regions than in the north and south temperate zones. There are, he believes, zones of all temperatures in all deep seas, such as that of 33° F. observed by Capt. St. John between Socotra and the Seychelles. He hoped that Capt. St. John would, in his future expeditions, be able to obtain a very valuable series of observations of deep-sea temperatures. Dr. G. J. Allman, F.R.S., said the specimens all belonged to types hitherto considered extinct; and he entered into some description of one of the most remarkable forms.—Note on Japanese Brachiopoda, by Thomas Davidson, F.R.S., communicated by J. Gwyn Jeffreys, F.R.S.

Chemical Society, Jan. 15.—Prof. Odling, F.R.S., president, in the chair. Mr. W. C. Roberts handed in a table supplementary to his paper read at the last meeting, and containing complete analyses of all the standard trial plates still extant, dating from A.D. 1477, namely, 17 gold plates and 14 silver ones.—The first paper was "On the action of trichloracetyl chloride on Amines: I. Action on aniline," by Dr. D. Tommasi and Mr. R. Meldola. This reaction gives rise to a substance callen *phenyl-triacetamide*, which crystallises in lustrous plates. It is acted on by nitric acid with production of *dinitrophenyl-triacetamide* crystallising in yellow needles.—Dr. H. E. Armstrong read a note "On the action of sodic ethylate on ethylic oxalate and other ethereal salts."—"On the products of decomposition of castor oil: I. Sebacid acid," by Mr. E. Neison. An account of the preparation and properties of pure sebacic acid, and of many of its salts.

Geologists' Association, Jan. 2.—Henry Woodward, F.R.S., president, in the chair.—On the nature and formation of Flint and allied bodies, by Mr. M Hawkins Johnson. The object of the paper was to show the nature of several members of a large group of bodies occurring in sedimentary deposits of different ages, and which are generally known as nodules, and described as concretionary. Those specially alluded to were the septaria from the London and Kimmeridge clays, the flints from the chalk, the iron pyrites from the chalk, the phosphatic nodules from the gault, the clay ironstone nodules from the carboniferous series, and the ironstone from the Woolwich beds. By the gentle action of solvents the structure of these bodies is revealed so as to be easily examined by the microscope. They are thus found all to agree in possessing a silicified organic structure, which may be described as a net-work of fibres or a mass permeated in every direction by anastomosing canals. This structure was subsequently filled in with other material, such as carbonate of lime, silica, bisulphide of iron, phosphate of lime, carbonate of iron, &c., the particular substance thus filled in depending upon the relative abundance of the substance dissolved in the interstitial water of the surrounding matrix. The singular group of concentric siliceous circular bands seen upon many fossils, and known as orbicular silica, or Beekite markings, were also explained. The fossils on which they occur are imbedded in a matrix more porous than themselves and of irregular constitution, so that the evaporation, to which the consolidation of the dissolved silica in their pores was mainly due, occurred at a number of points on the surface of the fossil, at which points a deposit of silica took place forming the central tubercles. The cessation of evaporation was followed by a fresh saturation, with the solution to be again evaporated. But as the evaporating points were now plugged up by the previous deposits, the silica last consolidated was deposited around their margin and upon them internally appearing outwardly as a ring round the tubercles. Alternations of these conditions account for the numerous bands seen in some of the groups.

Anthropological Institute, January 13.—Prof. Busk, F.R.S., president, in the chair.—A paper, by Mr. S. E Peal, was read, on the "Nagas and neighbouring tribes." The tract of country occupied by the Nagas lies mainly between lat. 25° N. to 27° 30′ N., and long. 93° 30′ E. to 96° E. It is bounded on the east by the country of the Singphus or Tsingpos, a distinct race showing strongly-marked differences in language, physique, and customs; on the north by Assam; and on the west are various other tribes, while to the south the boundary is undefined. The inhabitants of the tract, although all termed Nagas, are divided and sub-divided to so great an extent that few parts of the world can present such a minute segregation of innumerable and independent tribes. A common and conspicuous feature of the Nagas, Garos, Kukis, Lushais, and other hill-races of that district, is their custom of taking human heads either by regular warfare, raids, or casual surprises. Not only is the custom general among them, but it has obviously existed for a long period of time, and, in its present phase, is the true cause of the strongly-marked variations both in language and physique that exist among the Naga tribes, no two of whom are really alike. An almost necessary consequence of this mode of life is that they are a fine, hardy, active race, excelling in all that relates to forest lore and labour, while, on the other hand, they are conspicuously deficient in the arts of pottery, working in metals, and writing. The most singular feature is, perhaps, the almost total absence of agricultural implements; everything is done with the Daú, or P-shaped axe. The mental capacity of the Nagas is low, although they exhibit smartness or cunning in matters relating to ordinary life; no individual known to the author was able to count beyond ten.—Mr. C. B. Clarke contributed a paper on the "Stone Monuments of the Khasi Hills." The Khasi Hills form a plateau, at a mean elevation of 4,500 feet above the sea, between the plains of Assam on the north, and Sylhet on the south, and are inhabited by a people quite distinct from the neighbouring Hindus. The stones, which are profusely scattered over the range of hills are of three kinds: the funeral pyres, the kists containing the jars of ashes, and the monumental groups. One great feature of the Khasi sepulture is, that the ashes of the family are collected from time to time. At first the ashes of a man are kept in a small kist, then, after a few years, a great funeral ceremony is held, and the ashes of the various individuals of the family are collected from the smaller kists. The ashes of all the men are collected into one earthen jar, those of the women into another, and these two jars are placed in one large kist; the jar of the women's ashes is placed next the last stone closed, for the reason that among the Khasi the woman is always mistress of the house.

Riga

Society of Naturalists, Aug. 27—Dr. Buhse presented some growing specimens of *Elodea Canadensis*, the American aquatic weed which, since 1836, has appeared and spread over Middle and Northern Europe; and gave some account of it. Two different analyses of the weed, by Fischer and Liebig, show a large proportion of salts in its ashes, and also how widely the proportion of its constituents varies with the nature of the water in which the plant grows.

Sept. 17—M. Schweder directed attention to a fossil egg now in the St. Petersburg Museum. It was found in the Chersonese Government a few years ago, and has been secured for 1,000 roubles (say 166*l*.). It is 18 cm. length, and 15 cm. short diameter; its capacity is reckoned equal to that of 40 to 44 hen's

eggs. It is thus larger than an ostrich egg, but much smaller than the egg of the Epiornis, which is equal to 148 hen's eggs.—Various plants and other specimens were presented.

Vienna

Imperial Academy of Sciences, Nov. 6.—Prof. Mach presented a paper on physical experiments as to the sense of equilibrium in man. From experiments on himself, he is led to think that Flourens' turning phenomena, the orientation of equilibrium and of motion, the phenomena of giddiness, certain optical movements, &c., may be explained by supposing that the nerves of the ampullæ of the semicircular canals respond to every stimulus (which commonly involves a turning of the contents of the canal), with a sensation of turning.—Dr. Boué gave results of 33 years' observations on the circumstances attracting lightning strokes. He points out that the lightning often strikes low objects, though higher may be nearer; and he considers that constancy of course, in thunder clouds (from presence of mountain chains, &c.) and repeated discharges at particular points, may afford an explanation, in the superior attraction, viz. of subterranean masses of metal in certain regions.—Prof. Niemtschik made a communication on the construction of an ellipse inscribed in a circle, centre and tangent being given.

Nov. 13.—Prof. Pfaundler described three forms of apparatus he had devised for showing the composition of vibrations occurring at right angles to each other.—M. Stefan gave a paper on evaporation, examining theoretically the experiments lately described. From the formulæ of his dynamical theory of gases, he calculates the mean courses of the vapour-molecules of ether and sulphuretted hydrogen from one collision to the next; these are 23 and 32 respectively, the millionth part of a millimetre being taken as unit; also, from these, the diameter of the molecules; which are 0·9 and 0·7.

Nov. 20.—M. Puschl presented a paper on the co-motion (*Mitbewegung*) of light in moved media. He states the following conclusions: (1) Through participation of the ponderable atoms in propagation of light, the latter may, in various bodies, be more or less retarded, but in no case is it considerably accelerated. (2) The specific refractive power of a body is connected with the substance of its atoms, and independent of its density, so long as the internal nature of the atom substance remains the same. (3) The internal nature of atoms is modifiable through external pressure, crystallisation, solution, mixture, and especially chemical action. (4) The ether waves sent out from substances themselves are not produced immediately through the motions of the atoms as a whole, but mediately, through corresponding disturbances and concussions of the atom substance, which vibrates in the periods natural to it, according to the specific elasticity and the dimensions of the atoms.—Prof. Luess read a paper on the earthquakes of Southern Italy. He specified some points, in Sicily, and neighbouring islands, from which shocks spread radially in various directions (Etna, however, not being one of these centres); in other cases the earthquakes seemed to take a quite irregular course.—Dr. Weiss made some observations tending to identify the comet lately discovered by Coggia and Winnecke with Comet 1818 I.—M. Payer presented some fossils brought by the Weyprecht expedition from Spitzbergen.

Boston, U.S.

Natural History Society, Nov. 19, 1873.—Mr. F. W. Putman gave an account of the anatomy of *Bdellostoma*, and compared it with that of *Myxine* (known as hag-fish), illustrating his remarks with series of dissections, showing the brain, skeleton, intestine, ovary, liver, heart, branchial sacs, &c. These two genera of fishes form the family of *Myxinidæ*, and have similar habits and a very close external resemblance, although they can be readily distinguished by the number and position of the brandial outlets, and by the position of the œsophageal duct. Mr. Putnam said that his dissections, though in great part repetitions of those of Müller, made over thirty years ago, showed conclusively the natural separation of the genera by their internal structure.—Mr. L. S. Burbank read a paper on the "Surface Geology of North Carolina," with especial reference to some phenomena of Northern drift. From the facts noted the following inferences may be drawn:—(1) The time which has elapsed since the close of the drift period must be very short compared with the previous ages, during which the solid ledges were disintegrated by chemical and atmospheric agencies. (2) Boulders of the drift do not, in general, owe their rounded forms to attrition by glacial action, but, while still in place, assumed these forms by disintegration and exfoliation. (3) Whatever the force or agency of the drift may have been, it did not produce the great mass of the drift material by mechanical action in wearing and grinding down the solid rocks, but has merely carried forward and commingled the materials already disintegrated.—The secretary read an extract from a letter dated St. John's, Newfoundland, Nov. 10, 1873, from Mr. Alexander Murray, the geologist of Newfoundland, to Professor Jules Marcou, giving an account of a remarkable marine monster, which recently made its appearance off the shores of that island, and of a severed arm or tentacle of the same in his possession. The tentacle measured on October 31, having then been several days in strong brine and shrunk in consequence, seventeen feet, but was said to have measured nineteen feet previously.

Paris

Academy of Sciences, Jan. 12—M. Bertrand in the chair.—The following papers were read:—Tables of Jupiter, by M. U. J. Leverrier. The author finds that the influence of all the small planets on Jupiter is inappreciable.—Third memoir on chemical dynamics, by M. Becquerel. This paper dealt with the action of water in chemical combinations and with the effects of water and other liquids acting as electrodes.—On the distribution of magnetism in soft iron, by M. Jamin.—On the heat set free by the combination of nitrogen with oxygen, by M. Berthelot.—On the osteology of the anterior limbs of the *Ornithorhyncus*, &c., as compared with that of the corresponding members of reptiles, birds, and mammalia, by M. Ch. Martins.—On the problem of three bodies, by M. F. Siacci.—Studies on diffraction, by M. A. Cornu. The author gave a method for the geometrical discussion of diffraction problems.—On the physiology of the flight of birds in relation to the action of the wing on the air, by M. Marey.—Organogenesis compared with androgenesis (*l'androcée*) in its relation with natural affinities (class of *Cruciferæ*), by M. Ad. Chatin.—On the transformation of the vibroscope into a tonometer, and on its use for determining the absolute number of vibrations, by M. A. Terquem.—On chloral and its combinations with albuminous substances, by M. J. Personne.—On an acoustic pyrometer, by M. J. Chautard. This instrument depends on the variation of wave-length of a sonorous wave when the vibrating air is heated.—On a re-agent paper for detecting urea, by M. Musculus.—On the formation of gum in fruit trees, by M. Ed. Prillieux.—Researches on the glands of *Rosa rubiginosa* and on their contents, by M. R. Guérin.—On the geometrical properties of rational fractions, by M. F. Lucas.—On theorems of indeterminate analysis, by Father Pepin.—On the action of definite ternary systems compounded of mannite, borax, and water on polarised light, by M. L. Vignon.—On the artificial production of crystals of calcic oxalate resembling those produced by plants, by M. Vesque. The method consisted in causing solutions of potassic oxalate and calcic chloride to mingle very slowly in a third neutral liquid by causing them to flow through strips of blotting paper, or one solution and the neutral liquid were mixed and the other introduced in the same way, or the solutions were diffused into each other through a dialyser.—Notes on the storms of the year 1869, by M. Fron.

CONTENTS

Erratum. Vol ix. p. 128, 1st col. line 35, for "18 degrees" read "180 degrees."

THURSDAY, JANUARY 29, 1874

THE DUTY OF ELECTORS

IN his address to his Greenwich constituents Mr. Gladstone has undoubtedly attacked a weak point of human nature, by his announcement of a large balance, the promise of the removal of the income-tax, and other reductions in taxation; but those who really have the welfare of their country at heart cannot help feeling that, by making one doubtful good all-prominent, he has placed too far in the background many of those points which are daily becoming of more and more importance to the national welfare. Our country depends for its high position among nations, not only on its resources in coal and iron, but also, and more securely, on the mental capacity of its people, whose peculiarity is that they have the power of always using the resources at their disposal to better advantage than any others. We in nearly all cases have taken the lead in invention. A discovery, for instance, is made by which the amount of coal required to produce a certain amount of useful work is diminished greatly; this is adopted by others of ourselves, and is gradually spread to other countries, not however before sufficient time has elapsed to place us on the way to another method, which will have as great advantages over the new one as that had over the one which preceded it. There are those amongst us who, with our national tendency to depreciate our own abilities and resources, carefully compile statistics show that our gradual decline and destruction are inevitable in a certain definite number of years. They, however, inevitably leave out of the question the potentiality, as it may be termed, of the British brain.

But how is it that we are able to maintain this high position of progressive discovery? is a question which may be well asked. The answer is not difficult to find. It is on account of the thoroughness of the work done by some of the scientific members of the community, who but too often use their best efforts, involuntarily though it may be, to the working out of those inductions which lead to the discovery of new methods that prove so invaluable to their fellow-creatures, and so often unremunerative to themselves. There are many who must feel that it is not too early to make it a part of all Government legislation, that more stress be laid on and more direct pecuniary assistance given to such unremunerative scientific work, and encouragement offered for the production of it in greater quantity, so as to secure more of its invaluable results.

It may be said, and it is said by some, that we have gone on very well as yet without any great encouragement in this direction; but this is the old argument over again; we are now in a very different position to what we were formerly. When Science was in its infancy, it was not so essential to the production of good work that those who made the greatest strides should know much of the investigations of those who preceded them, nor of the principles of the sciences, by the employment of which alone they can expect to advance. But the last half century has been so prolific in scientific method and detail, that any one ignorant of all its branches, however great his ability, can have little or no chance of making fresh improvements or discoveries. What was not essential formerly is essential now; and just as the standard of general education is much higher at the present time than it was some years ago, so must the scientific education be.

But there is only one method of improving scientific education satisfactorily, and that is by making scientific work more possible and lucrative. A young man does not commence physics or chemistry or biology until he has really begun the battle of life; his mind is scarcely fit for it before; he must therefore, when he takes them up, see clearly a livelihood ahead. Such a livelihood at present is little more than a phantom. The prospect of a post in any Government institution, such as the British Museum, for example, is, to say the most, to scarcely a pittance, and there are many of the best workers who would undergo many privations rather than have to devote the greater part of their lives to the drudgery of an educational appointment. Most scientific men do not expect to become rich on their avocation; the inherent pleasure of their subject compensates to a certain extent for the diminished income; but they must live, and living means more than obtaining an income which is insufficient to allow of their maintaining the social position to which they are born, or to which their education has brought them.

Such being the case, ought not the nation in a fresh Parliamentary election to lay some stress on the improvements that are indispensable for the healthy progress of scientific thought? Why does Mr. Gladstone's interest in the higher Education begin and end with Ireland—can it have any reference to party questions? Why is there all too slight a reference to the University question and no reference at all to the Report of the Royal Commission which has recently been issued—is it because Mr. Gladstone knows that there are many Conservatives much more liberal and large-minded than the Liberals themselves on this subject?

Is there no feeling throughout the country on the subject of Museums, or the ever-growing necessity for a Minister of Education? Mr. Gladstone may well be excused from referring to these topics in his "prolix" manifesto, but are all the Constituencies to neglect them? Is the Sectarian or the Licensed Victualler to be the only man who shall require his candidate to render a reason—to state his views? Our point is, that every voter in the kingdom has now an opportunity of helping on the cause of Science and Education by insisting upon his representative having ideas—and right ideas—on these questions.

Why should there not, among the numerous influential scientific societies which are spread through the country, be formed organised committees whose duty shall be to use their influence in representing their requirements to the candidates for parliamentary election, and doing all in their power to get their wants respected and complied with? Again, why should not those bodies, like the University of London, with a large number of scientific voters, and a representative, do all in their power to return for their member one who has the interests of Science and the higher education at heart, and who will do all he can to put these interests in the best light? That such will not be done by the University of London at least, will be evident if Mr. Lowe is again returned as their member at the

coming election; for his principles of action are understood; his views with regard to the Universities and the higher teaching generally are known; and his unwillingness, even to consider the desirability of raising the salaries of the scientific officers of the Biological Department of the British Museum to the level of those of ordinary Government officials is before the world. There is no doubt that he has forfeited all claim, either to the support of the Scientific or the Medical Graduates of the important Corporation which he represents.

PHYSICAL GEOGRAPHY

Physical Geography, in its Relation to the Prevailing Winds and Currents. By John Knox Laughton, M.A., F.R.A.S., Mathematical and Naval Instructor at the Royal Naval College. Second Ed. (J. D. Potter, 1873.)

The Ocean: its Tides and Currents, and their Causes. By William Leighton Jordan. (Longmans, 1873.)

THE first part of Mr. Laughton's work consists of a comprehensive and valuable summary of the present state of our knowledge of the prevailing Winds in different parts of the globe; on the basis of which he proceeds to examine into the commonly-received theory of Atmospheric Circulation, and pronounces that "it describes the phenomena which do not exist, and misrepresents, or does not account for, phenomena which do." The second part treats of the Currents of the Ocean; and these (following Major Rennell) he attributes for the most part to the winds prevailing in the localities in which they originate, their effects being variously modified by coast-lines, the meeting of other currents, &c. We believe that he is quite justified in upholding this general doctrine, and in repudiating the notion of Captain Maury that differences of temperature, excess of evaporation, &c., can sustain the Gulf Stream or any great oceanic current. But he rides his hobby a great deal too hard, when he affirms that under no circumstances can these agencies produce currents; going so far as to attribute the in-current of the Strait of Gibraltar to the *vis-à-tergo* of the Gulf Stream. As well might he attribute to it the constant current which sets over the bar of the Karaboghaz or Black Gulf on the eastern side of the Caspian, and carries (according to the computation of Von Bär) 350,000 tons of salt a day into this great natural salt-pan, the water (which the natives fancy must have some subterranean outlet) being all got rid of by evaporation. According to Sir John Herschel's computations, the excess of evaporation from the Mediterranean area, over the return of water by rain, would require *twelve Niles* to supply it; and as there is only *one* Nile, and as Captain Wharton's recent researches in the Dardanelles show that the Black Sea sends very little of its river-water into the Mediterranean (the supply poured in by the Danube, the Don, the Dnieper, and the Dniester, being very little more than sufficient to make up for the evaporation of the Black Sea itself), it is obvious that an enormous deficiency must exist, after every allowance has been made for the Rhone, the Ebro, and the Po, which are the only considerable rivers, beside the Nile, that pour their waters direct into the Mediterranean basin.

Mr. Laughton does not seem to have made himself as well acquainted as a Government naval instructor might have been expected to be, with recent contributions to Oceanic Hydrography. Thus he repeats the statement of his first edition, that the Gulf Stream rushes through the Florida Channel at a rate varying from 80 to 120 miles a day; whereas the Admiralty Pilot Chart, based on the most trustworthy information, makes the annual average only 48 miles per day. He does not deign to notice the arguments adduced by Dr. Carpenter in his last report to the Royal Society, which have satisfied many eminent authorities that the amelioration of the climate of North Western Europe is due, not to the *true* Gulf Stream or Florida Current, but to a slow north-easterly movement of warm water sustained by thermal influences alone. He repeats (p. 200) the old fallacy that the cold of the ocean-bottom is "due to the great depth, to the impermeability of water by the sun's rays;" as if this had not been disproved by the fact, that the bottom-temperature of the Mediterranean, at depths ranging to 2,000 fathoms, is from 54° to 56°, whilst that of the Atlantic at similar depths and under the same parallel is *twenty degrees lower*. And in p. 250 he makes the astounding statement that "the gradual closing up of the channels [through which the Gulf Stream flows], by the ceaseless work of the polypes, has, *by diminishing the outlet, increased the force of the stream;*" which is tantamount to saying that the stream of water which issues from a fire-engine has a greater force than that which works its pumps! If we had only to narrow an outlet to create force, we need not be afraid of the exhaustion of our coal.

We recommend Mr. Laughton, before he issues another edition of his book, to dismiss from his mind, if he can, all prejudice in favour of his particular theory, and to open his mind more fully to the evidence of a *vertical* Oceanic circulation, which he already partly admits, and which is not in the least inconsistent with his fundamental principle (in which we entirely accord) of the maintenance of the *horizontal* circulation of the great Ocean-basins by the movements of the atmosphere.

The title of Mr. Jordan's book is very misleading; for, although professing to treat of the tides and currents of the Ocean, he devotes the greater part of his 344 octavo pages to an exposition of what may be called the Jordanian (in opposition to the Newtonian) system of Astronomy. This system is based on the doctrine of *inertion*, by which Mr. J. means the inherent tendency of all motion to come to an end. The only motor force he admits is that of gravitation; and he considers himself to have proved that the revolutions of the planets round the sun are due to the opposition between solar gravitation and astral gravitation, "so that, in their courses, they are borne smoothly along the lines of equilibrium lying between opposing forces of gravitation." He also maintains that "the rotation of a sphere tends to cause surrounding bodies to revolve around it;" and that, in this manner, the rotation of the earth from west to east tends to carry the moon in the same direction, its "lagging behind" beng due to "astral gravitation."

The application of Mr. Jordan's theory of inertion to the movements of the ocean is very obvious. Reasoning upon the fact that when a vessel containing water is made to rotate, "the water tends to maintain its position, and therefore has a relative motion over the surface of the vessel in the opposite direction to that in which

the vessel is moved," Mr. Jordan supposes that this will *always* be so; and that the tendency of ocean-water to be left behind is the great source of tides and currents. But if he will try the experiment of *continued* rotation, especially with a vessel havng not a smooth but an irregular interior, he will find that *after a time* the water rotates as fast as the vessel itself, and partakes of its momentum. Were it otherwise in the case of the Earth, no rock could withstand the abrading power of the mass of water which would be constantly impelled against its eastern face—not only on the surface, as in the case of the trade-wind current, but at its greatest depths. That Ocean-water not changing its place northwards or southwards, *does* fully partake of the Earth's motion, and *does not* tend to lag behind, is proved by the exceptional cases in which a flow of water moving towards either Pole tends *eastwards* in virtue of its *excess* of easterly momentum, and in which a flow moving towards the Equator tends *westwards* in virtue of its *deficiency* in easterly momentum. The *Challenger* temperature-sections of the Atlantic show this to be the case with the cold-stratum beneath the Gulf Stream, which comes to the surface along the Atlantic sea-board of the United States; a similar "cold wall" has been found by our Naval Surveyor, Capt. St. John, to intervene between the Kuro Siwo (which is the counterpart of the Gulf Stream in the Pacific) and the eastern coast of Japan; and the recent researches of Dr. Meyer have shown that even in the North Sea a like upward movement of the colder understratum is distinctly traceable along the eastern shores of Britain, and still more on the eastern slope of the Dogger Bank.

It would be quite useless to either follow Mr. Jordan through his detailed application of a theory which is so completely baseless, or to examine into the validity of his criticisms of the views of others. He is obviously a man possessed, like the notorious upholder of the earth's flatness, by a "dominant idea" which nothing will dispel; and all we can do is to warn our readers that his book is good for nothing, except as a warning example of misdirected ingenuity.

ANIMAL MECHANICS

Principles of Animal Mechanics. By the Rev. S. Haughton, F.R.S. (Longmans, Green and Co.)

THIS formidable volume has four languages on the very title-page, and bristles throughout with numerical calculations, analytical formulæ, and geometrical constructions. When, in addition, we record that it contains anatomical details, teleological postulates, hints on the best mode of hanging, &c., it will be obvious that no one man can be expected to be able to pronounce upon its value from more than a few of the possible points of view.

We are told in the Preface that the object of the work is to show "the mutual advantages obtainable by anatomists and geometers from a combination of the sciences which they cultivate. Anatomists will gain by the increased precision which numerical statements must give to their observations, and geometers will find in anatomy a new field of problems opened out to their investigation." Surely there is nothing new in this statement! Every anatomist worthy of the name strives after the greatest attainable precision in those observations in which it is requisite, and many able mathematicians have treated of anatomical problems. But passing this over, we are obliged to say that Dr. Haughton's mathematics are barely such as are calculated to attract the anatomist. When writing for a class of persons who, at the best, rarely know more than the merest elements of mathematics—surely it would be well to use the simplest processes which will suffice. This is not Dr. Haughton's method; he rather acts on the principle of making an investigation as showy as possible by the introduction of an immense quantity of quite superfluous analysis. This is, no doubt, calculated to impress the majority of readers with an idea of the author's profundity; and, though even very ordinary mathematicians will find no reason to share this impression, we cannot understand the necessity for putting such a threatening barrier in the way of the poor anatomist who wishes to understand the reasons here assigned why muscles have the particular forms which it is part of his business to examine, describe, and classify.

Excellent instances of this peculiarity of the work may be given in great numbers, but one must suffice. Take the investigation in p. 239, which is given to prove that no work is done by a quadrilateral muscle when one of the bones acted on revolves about a certain given point. The result given in the text follows instantly from the most elementary geometry, if a single additional line be inserted in the woodcut; always, however, providing that the reader is prepared to allow the following postulates, which may, perhaps, not be very readily assented to, but which are as necessary for the elementary geometry as for the pompous analysis. The first is, that when muscular fibres are extended, as much *negative* work is done by them as there is done of positive work when they contract by the same amount! The second is, that in a plane quadrilateral muscle the fibres run in lines which, if produced, would all meet in the intersection of the lines joining the ends of their places of attachment to the bones, and that they are *uniformly* distributed radially from this point. Postulates of this kind are, indeed, very common throughout the work.

The three great features of novelty in the work, so far as we can perceive—in addition to the very numerous, and obviously careful, determinations of the weights, &c., of corresponding muscles in various beasts, birds, and fishes—are the *Law of Fatigue*, a grand teleological *Postulate*, and the *Principle of Least Action.*

These are enunciated as follows, the third as applied to the heart:—

"When the same muscle (or group of muscles) is kept in constant action until fatigue sets in, the total work done, multiplied by the rate of work, is constant."

"The Framer of the Universe (Δημιουργός τοῦ κοσμοῦ) has constructed all muscles upon the principle that each shall perform the maximum of Work possible for it under the given external conditions."

"The arrangement of the fibres of the heart must be such as to allow each fibre to contract to the fullest extent required by the law of muscular contraction."

As a simple comment on the first of these, rendered very instructive by the insight it affords us into the general cogency of the author's reasoning, take the following:—

"If any man wishes for a simple proof of the inferiority of the endurance of his muscles as compared with those of a woman, let him carry a child on his arm for the same time that his wife or nurse can do (*sic*) with ease, and he will find himself much fatigued."

In this striking passage, for "a woman" read "another man;" for "wife or nurse" read "coalheaver;" for "child" read "sack of coals;" and for "arm" "back." It is still obviously true! Many other, perhaps even more remarkable, forms of this statement will present themselves to the intelligent reader.

We had marked for comment or quotation a great number of passages, but considering the characteristic qualities of the specimens we have given, we think the reader who wishes more may safely be left to seek them in the work itself. Perhaps the most curious point we have not yet alluded to is the author's calculation of the force which can be exerted by the abdominal muscles. In his first publication of this astonishing result he adopted *seriously* a quotation from Sterne which Duncan, writing on the forces employed in parturition, had used (in its original intention) as a mere joke; and in the work before us, in spite of all that has been done, especially by Duncan and Schatz, since that first publication of his, Dr. Haughton still gravely writes:—

"Thus, we see that, on an emergency, somewhat more than a quarter of a ton pressure can be brought to bear upon a refractory child that refuses to come into the world in the usual manner."

It is only necessary to explain that this is assigned not as the whole pressure on the *surface* of the child, but merely as the component in the direction of its motion!

POLAR EXPLORATION

The Gateway to the Polynia: A Voyage to Spitzbergen. From the Journal of John C. Wells, R.N. With numerous Illustrations. (London, 1873. 8vo, pp. 355.)

EVERY fresh book on the Arctic Regions helps to awaken the dormant interest of the public in the question of Polar Exploration, and from that point of view this volume commands our attention. From no other, however, can we recommend it. The "rapid sketch of Arctic voyages" contained in the introductory chapter is rapid indeed—we might also add vapid—and it is followed by a disquisition on things in general in which some of the statements are true and a few of them new, though the new and the true do not seem to be always successfully combined. Of course it was not to be expected that the masterly summary of the progress of northern discovery given by Richardson in his well-known "Polar Regions" should be excelled or equalled, but we had a right, we conceive, to look for a few more details than we get of the American, German, and especially of the Swedish expeditions executed since Sir John's work appeared. But even letting that pass, we should have been contented with a plain narrative of Capt. Wells's own "Voyage," whereas we have nothing of the sort. We are told, it is true, that he sailed in the yacht *Sampson*, that he left this country in May 1872, and, after reaching lat. 80½°, returned in the following September—facts which any of our readers may find if they take the trouble of looking back into our columns; but of the incidents and results of the voyage we are afforded only the most vague outline, drawn in a confused and book-making way. One remarkable and suggestive fact is to be noticed. The name of the owner of the yacht never appears in regard to this voyage! Little bits of what may once have been written in a journal pieced together with stories more or less (and rather less than more) connected with the subject, such as that of the building of Scalloway Castle (imperfectly told by the way)—yarns spun by old whalers and sailors—scraps of zoology, botany, geography, and meteorology (some of them incorrect)—long extracts from Parry's well-known "Voyage"—the whole jumbled into one chaotic mass, from which it is difficult to derive any clear knowledge of what belongs to the writer of the "Journal," and what has been drawn from other authors. We are treated to certain woodcuts, the like of which were the wonder of our childhood, such as that of the Right Whale (p. 64); but whether Captain Wells saw a Right Whale, or knows one when he sees it, we don't profess to say, and this particular portrait is simply named "Whale." The cut representing "Whales' Food" (p. 82) is altogether wrong; whales would fare badly if they only swallowed such nourishment as the *Hydrozoa* there figured, and the author might have learnt better from old Friderich Martens, two hundred years ago. Shetlanders are said (p. 71) to be a "branch of the Celtic family." The Reindeer figured (to face p. 223) were certainly not drawn from Spitzbergen examples, and most parts of the book indeed might almost just as well have been written by a man who had never been to that country.

But perhaps all this may be looked upon as trifling. Capt. Wells's great object is to urge the claims of the Spitzbergen over the Smith's Sound route for future Arctic discovery. On this question much has been written and spoken; and though the opinion of experts is overwhelmingly strong in favour of the latter, the former is not to be dismissed in the off-hand way in which it frequently is. Impossible as it may seem, we wish to reconcile the adherents of either creed. Capt. Wells, we think, is not the ablest of advocates. He omits putting the point as strongly as it ought to be put, indeed his theory is utterly opposed to it. In his map all the space encircled by the 85th parallel is marked "Polynia," and an arrow-head obligingly informs us that "the gateway to the Pole" lies in long. 10° E. To force this gateway by steamer would seem to be his advice. Now we cannot agree with him here, for the idea of a great extent of perpetually open water, which is the essence of the notion of a *Polynia*, is a mere assumption, against which much seems to militate. Now there are two entirely different things for the Arctic discoverer to do. If his object be merely to reach the Pole by the cheapest and easiest means, our belief is that there is no way better than the Spitzbergen route, but one cannot expect to do it by water. The expedition should winter in the north of Spitzbergen, or on one of the outlying islets, and sledge-parties should be sent in early spring over the ice to reach the goal, and return with all possible speed. But if the object be to make a really satisfactory exploration, then the almost perfect agreement of Arctic authorities declares for Smith's Sound. It is possible that the Spitzbergen route might be accomplished by private enterprise, but for the other a Government expedition is essential. On parting with Captain Wells, we are

glad to find we agree with him on one point :—"We want a new motive to rouse up the spirit of the nation and Government ; and what higher and nobler one can be found than the search for truth and the advancement of Science? This is the duty of a Government, to promote the national welfare ; and one of the surest ways in which this can be done is by encouraging scientific efforts. . . . There are few ways in which this spirit can be better fostered than by Polar exploration ; and so popular is such service amongst our sailors, more especially Arctic sailors, that hundreds of them volunteer to go when any project of this kind is afloat. From this point of view, the exploration of the higher latitudes is a matter for Government, and not for private enterprise" (pp. 2, 3).

OUR BOOK SHELF

Perils in the Polar Seas. True Stories of Arctic Adventure and Discovery : A Book for the Young. By Mrs. Chisholm, authoress of "Rana ; or, the Story of a Frog," &c. (London : John Murray, 1874.)

THIS is one of the best books of the kind we have met with. It is written for the young, but Mrs. Chisholm has wisely made no attempt to "write down" to the supposed mean capacity of the little folks ; she tells her intensely interesting story in simple, unaffected, clear, forcible English. Indeed, were it not for the occasional interruptive questions and remarks of the group of youngsters to whom the authoress is supposed to be telling her story, one would naturally fancy that the book, like "Gulliver's Travels" and "Robinson Crusoe" had been written for all who can understand plain English. Mrs. Chisholm, in her opening chapter, "Life with the Esquimaux," gives many details concerning the habits of that people, taken mainly from the late unfortunate Captain Hall's account of his residence among them. After another brief chapter on "North-East Voyages," she enters upon the history of Arctic discovery on the American side, and with the greatest care and clearness, tells what the principal explorers, from Frobisher down to Hall, have done to make known to us the outline of the lands and seas of these mysterious northern regions. In doing so the authoress's object is something more than merely to fascinate and thrill her readers by a narrative of strange adventures by flood and field ; while there is no apparent attempt at making the story a vehicle for conveying useful information, yet Mrs. Chisholm manages to convey, in an impressive manner, a great amount of knowledge of the geography, natural history, and meteorology of the Polar Regions. Indeed it would be difficult to devise a better method than is here followed, with the assistance of two excellent maps, of teaching the geography of Arctic America. As might be expected, the greater part of the book is occupied with modern voyages, mainly those of Parry, the Rosses, Franklin, and the Franklin Search parties. "Uncle George" gives a good deal of information concerning the whale fishery, and also an account of Parry's boat voyage to the north of Spitzbergen. Besides the two maps already referred to, the volume contains many beautiful illustrations. Perhaps it was scarcely necessary to make the children interrupt the story-teller so frequently with their questions ; indeed the story is so attractively told that such diversions are sometimes irritating. But this is a small matter ; the work as a whole is capitally done, thoroughly interesting, healthy, and full of information.

Historische Fragen mit Hülfe der Naturwissenschaften beantwortet, von Dr. Karl Ernst v. Baer.

Studien aus dem Gebiete der Naturwissenschaften, von Dr. K. E. v. Baer, Part II., Sec. I. (St. Petersburg, 1873.)

THE "Historic Questions," just published by this eminent naturalist, aim at solving by evidence from natural history certain disputed traditions which have puzzled historical critics. The first subject remarked on is the "swan's song," which seems so fanciful a myth to western nations accustomed only to the songless swan, which the Russians call *shipûn*, the "hisser," but not to the other swan, which they name *klikûn*, the "caller," whose melancholy notes are so often heard by travellers in North-East Europe and North Asia ; it is stated on no less authority than that of Pallas, that the swans utter these tones when mortally wounded. Next follows an examination of the voyages of Odysseus, made with the view of ascertaining how much of ancient geography is embodied in the Homeric narrative. According to Dr. v. Baer's map, several localities of the ideal voyage are to be traced in the Black Sea, at whose entrance are Skylla and Charybdis and the Symplegades, while the Læstrygonians dwelt in the Krimea, and Kimmerian darkness began at the opening into the Sea of Azof. Lastly, the locality of the Biblical Ophir is discussed ; Dr. v. Baer finds it in the Peninsula of Malacca.

In the collected "Studies" we find a German version of a paper dating from 1848, on the Influence of External Nature on the Social Relations of Races. The next is dated Berlin, 1866, on Purpose in the Processes of Nature, in which he gives the name of *teleophoby* to the fear he observes among some naturalists of recognising an object or purpose in Nature. Dr. v. Baer's doctrine is summed up in a passage reproduced, with slight alteration, from his own writings 33 years ago : "Thus the earth is but the seed-bed in which the spiritual inheritance of man increases, and the history of Nature is but the history of continuous victory of Spirit over Matter. This is the fundamental idea of Creation, for the satisfaction or rather for the attainment of which individuals and series of generations must disappear, that the future may be built on the framework of an immeasurable past." The concluding paper is on Rivers and their Action, a contribution to physical geography in which arguments as to the antiquity of man founded on the presence of human relics in river-beds or deltas are treated as of little account.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Prof. Barrett and Sensitive Flames

THOUGH my memory fails to recall the fact, I cannot, with Prof. Barrett's letter before me, refuse to believe that he sent me the paper to which he refers.

Perhaps I ought to have known what Mr. Barrett had been doing before large audiences, but I regret to say that I did not. My excellent assistant, Mr. Cottrell, first heard of Mr. Barrett's experiments from one of my own audience, and steps had been taken to do Mr. Barrett justice before his letter appeared. That act he has anticipated by very ably and very modestly doing justice to himself.

J. TYNDALL

Remarkable Fossils

ONE of the most remarkable collections of Wealden fossils ever seen, was lately on loan for a few days to the exhibition then open at Horsham, and is one that is not to be equalled by any at our public museums in the country. So remarkable is it that I am induced to give you a short description. As you enter the room to the left, the first thing to attract the attention of the palæontologist was the collection contained in a case of about 12 ft. long by 3 ft. wide, filled to repletion with the fossil bones of the "Great Horsham Iguanodon" and the "Tower Hill Iguanodon," and various other bones. There were the fibula, scapula, and caracoid of Iguanodon in juxtaposition with the humerus belonging to the same specimen, the jaw of the young Iguanodon and the caudal vertebræ, all figured and described in the monographs of the Palæontographical Society. Also the

Hawksbourne, femur, and tibia with metatarsals and a distal phalanx, and various other vertebræ, teeth and phalanges. The jaw of a very young Megalosaurus which evidently perished very shortly after its escape from the egg. The tibia, supposed scapula, and various other bones and teeth of Megalosaurus, the ribs, vertebræ, and teeth of Hylæosaurus. The jaw and other remains of a young *Suchosaurus cultridens* not long escaped from the shell, and teeth of *Suchosaurus*, a fine vertebræ of Streptospondylian type found with the "Great Horsham Iguanodon," and a femur of a young crocodile. The muzzle and portions of jaws, teeth, vertebræ, scutes, and various other bones of *Goniopholis crassidens*. This specimen shows the succession of three teeth. This specimen was borrowed in 1842 by a well-known palæontologist for the purpose of illustration and description. Three artists were employed, who executed five quarto plates of the various portions, but they have never yet been published. Seventeen specimens have not been returned. A younger and very beautiful specimen of *Goniopholis crassidens* in its matrix of stone is missing from this collection. It was borrowed shortly after the above specimen and lithographed at once. It has unfortunately made its escape from custody. It is clear from the specimens shown that the armour of Goniopholis was far more perfect than that of any other living or extinct crocodilian. The toothed and imbricated scutes were in connection with others of a hexagonal or pentagonal shape, which were suturally united. The abdominal scutes overlapped each other on one side. Besides these there are several bones of Pterodactyl, the vertebræ, ribs and teeth of Plesiosaurus, a fine jaw of a beaver, various pubic and tympanic bones, and the pubic bone of a saurian described by Dr. Mantell, bones of turtles and many other bones, too numerous to mention, and some of most gigantic size, and in a wonderful state of preservation. This collection is the property of Mr. Holmes, who is also the discoverer of them.

Many of the bones are altogether unknown, and their inspection may throw some light on the kind of animals to which they belong. THOMAS WM. COWAN

Horsham, Jan. 5

Earthquake in Argyllshire

I BEG to forward to you a letter from the principal light-keeper at Dhu Heartach Lighthouse, addressed to Mr. Cuningham, Secretary to the Board of Northern Lighthouses.

The Dhu Heartach is a trap rock about fifteen miles to the W.S.W. of Iona, in Argyllshire, which is the nearest land. It is 220 feet long and about 30 feet high, the tower, which is of granite, being raised to the height of 130 feet above the sea. The rock is everywhere surrounded by deep water, and is of an elliptical form. During the erection of the tower fourteen stones, each of two tons, which had been fixed in the tower by joggles and Portland cement at the level of 37 feet above high water, were torn out and swept off the rock into deep water.

Although the tower is much subject to impact from the waves, in spite of its height above the sea, yet neither my brother nor I have any doubt that the light-keepers are right in tracing the shock to an earthquake. Perhaps some of your readers may have experienced the shock in other places.

Edinburgh, Jan. 16 THOMAS STEVENSON

"Dhu Heartach Lighthouse, Jan. 7, 1874

"Sir,—I beg leave to inform you of the following rare occurrence :—On the evening of the 6th inst. at 8.13 p.m. (local time), Mr. Leith and I were sitting in the kitchen, when we heard a rumbling noise, followed by a tremulous motion, which lasted about two seconds. On going to the light-room, Mr. McAllister (who was on watch at the time) states that the noise resembled the booming of a cannon, and the tremulous motion was very apparent. A fresh gale from W.S.W. was blowing at the time, but there was no sea striking the rock to cause the concussion ; in fact there was less sea than had been for some days previous. When a heavy sea strikes the tower, it has quite a different effect, and cannot be mistaken for anything else. There was neither thunder nor lightning at the time ; barometer steady at 29°·96 ; thermometer 46° ; weather hazy.

"I can offer no suggestion as to the cause, unless it proceeded from a slight shock of earthquake : the rumbling noise and tremulous motion indicated such. One thing we are all confident of, it was not from a sea striking the rock. I have no wish to be at all sensational, but I have thought it right to send you the above details, as the same may have been felt in other parts of the country, and this may tend to corroborate it

(Signed) "JAMES EWING

"To the Secretary, Northern Lighthouse Office, Edinburgh."

Telegraphing Extraordinary

THERE appears to have been a misprint in your article "Telegraphing Extraordinary (Jan. 15).

It is there stated that the speed of the automatic instrument is but 200 letters a minute. This speed can be reached by *hand-signalling*, a very usual speed being 170 letters ; and perhaps the writer intended to say that 200 letters, or 40 words, was the utmost limit of *un*-automatic service, which would be correct.

Post Office, Jan. 10 R. S. CULLEY

[In contrasting the work obtained out of the Wheatstone "high speed" automatic service in use by the General Post Office in this country with that of the new American instrument, by a slip of the pen the word "letters" was substituted for "words ;" but in giving 200 words as the speed over a circuit of similar length to that between Washington and New York, a maximum under most favourable circumstances of insulation of the wires was recorded.

Practically the average working speed obtained on a circuit of from 300 to 400 miles in length, by the Wheatstone, does not exceed 90 words or about 450 letters per minute, and with the Morse about 25 words, or 130 letters. On circuits between 200 and 300 miles the Wheatstone Automatic Service may be considered practically to average 120 words, or about 600 letters per minute. The American instrument transmits from 1,200 to 2,500 words a minute over a 300 mile circuit.—ED.]

Echo at Maidenhead

THERE is a railway-bridge over the Thames at Maidenhead which is said to be of a wider span than any other in England. While standing beneath this arch, we hear the echo of a sound repeated fourteen or fifteen times with tolerable distinctness. From the first to the fourteenth echo occupies about five seconds. The sounds become, of course, less and less loud, but, at the same time, the *pitch* of the note is raised, and has at last risen three quarters of a tone as indicated by a delicate instrument which gives quarter-tones. As I have not seen a similar fact noticed in any work on Sound, I shall be glad if any of your readers can give an explanation.

I may add, that this echo repeats distinctly the sound of the letter *s*, which is not usually the case. J. P.

Belmont, Dartmouth

Flight of Birds

DURING the hurricane of October 6, 1873, I was residing on the west shore of Biscayne Bay, South Florida. In the early part of the gale, and while it was approaching its height, I noticed overhead innumerable "man-of-war hawks." They seemed to be "laying-to" (to use a nautical phrase), with but little motion of their wings ; their heads were towards the wind, but instead of moving backwards they seemed to drift off in a line calculated to take them directly away from the storm-centre.

A short time ago I communicated these facts to the secretary of the Smithsonian Institution, who immediately informed me that what I had observed was new to him, and probably to the scientific world, and he advised me to send a copy of my letter to you. The learned secretary also wrote a flattering approval of my suggestion that the behaviour of the birds under consideration might be explained on the theory of "natural selection." I have forgotten the exact wording of my letter, but the idea embodied in it was that during a cyclone the "man-of-war hawk" profits by the experience of its ancestors, an experience which has become organised in the race, and which enables them to make the best possible adjustment to the circumstances which surround them.

Kasson, Minn., Dec. 28, 1873 HORACE B. PORTER

Vivisection

ASSUREDLY "the worthy and humane Huxley" stands in no pressing need of the testimonial of Mr. G. W. Cooke (NATURE, vol. ix. p. 202) to his worth and humanity. (By the way, I thought at first that the gratuity came from the generosity of Mr. E. W. Cooke, whose amusing vivisections, in his "Grotesque Animals," could offend nobody.) Still less does the practice of vivisection stand in need of such encouragement as is given to it in the leading article in NATURE, vol. ix. p. 177. With such a champion as Mr. Ray Lankester, there is n

fear of physiologists losing sight of the duty of vivisection, not merely for the discovery of truth, but for its demonstration to students of physiology.

Meanwhile I (for one) who, not being an expert in any branch of physiological science, have been educated to set the highest value on its conquests, cannot concede to the physiologists the principle which has been somewhat arrogantly put forth in recent discussions, that research for the purpose of acquiring new facts in physiology necessitates and justifies vivisection. On the contrary, I cannot admit that to ascertain the order of Nature is so high an end in itself as to render superfluous or irrelevant the preliminary question, Whether the means to be employed for that object are right or wrong? We have no need to discuss the rights of the lower orders of sentient beings; it is sufficient that we should recognise the fact that they have been endowed with organisms of exquisite sensibility, not for the purpose of affording man a ready means of experiment, but for the fulfilment of their own functions. To overlook this, to exercise the law of the strong over the weak, and to accustom ourselves to the conscious and deliberate infliction of pain on those beings, with no other object than to satisfy a rational curiosity, must recoil on the operator, and do violence to his moral nature.

When I see acts of wanton cruelty I am revolted, but I have hope; for I trust to the ameliorating effect of education to eradicate the propensity to cruelty. But when I learn that acts of deliberate cruelty are done by "worthy and humane" men, I am revolted without hope. Convince me that the cultivation of physical science culminates in making men so "worthy and humane" that they can practise the vivisection of an animal (to quote Isaac Walton's words) "as if he loved him," and you convince me of the mischievous tendency of such an education.

One word more: if there were a race of intelligents as much superior to man as man is to the dog, and certain investigators of that race were to capture men and women, and subject them to vivisection, in order to advance a knowledge which is beyond the faculties of man, what should we do? Submit, of course; but should we bow with resignation to our lot, and think our pains well spent, if our wretched tortured bodies did thereby add one jot to the scientific capital of our captors? Or, should we not protest to the God of Heaven (if we happened to believe in Him) against the monstrous and enormous injustice of which we should be the victims? Surely there is the same injustice in the abuse of animal organisms (*i.e.*, the use of them against their nature) for the purpose of scientific exploration.

Valentine House, Ilford, Jan. 18 C. M. INGLEBY

Instinct of Monkeys

HAVING read the letters of Dr. Gulliver and G. J. R. in NATURE, vol. viii. pp. 103 and 163, in which the affection of monkeys for their dead is discussed, I think that I may perhaps be permitted to record my experience in regard to a certain class of monkeys that I have peculiar facilities for observing, which is not in accordance with the observation of Mr. Forbes or G. J. R.

I keep, in my garden, a number of Gibbon apes (*Hylobates agilis*); they live quite free from all restraint in the trees, merely coming when called to be fed. One of these, a young male, on one occasion fell from a tree and dislocated its wrist; it received the greatest attention from the others, especially from an old female, who, however, was no relation; she used, before eating her own plaintains, to take up the first that were offered to her every day and give them to the cripple, who was living in the eaves of a wooden house; and I have frequently noticed that a cry of fright, pain, or distress from one would bring all the others at once to the complainer, and they would then condole with him and fold him in their arms.

But one morning one of the flock was found hanging dead in the fork of a tree, his comrades took no notice whatever of him, and were playing and singing their peculiar song as usual close to him; on the body being removed they took no notice whatever.

A neighbour of mine who keeps a pair of these apes, informs me that the male lately came home after an absence of two days very sick; the female, who had theretofore been very affectionate, carefully avoided him, and on his death a few days after showed the most thorough indifference. Very possibly the alleged affection for their dead may exist among some families of monkeys, and not among others. Though my apes live in complete freedom, they have never shown any disposition to breed, though I have had some of them over two and a half years.

A E

VIVISECTION

AS public attention has again been directed to this question, we think it convenient to reproduce the report of a Committee of the British Association on the subject.

The committee consisted of ten individuals, appointed at the meeting of the British Association, held at Liverpool in the year 1870, to consider the subject of Physiological Experimentation, in accordance with a resolution of the General Committee hereto annexed. The following report was drawn up and signed by seven members of the Committee:—

i. No experiment which can be performed under the influence of an anæsthetic ought to be done without it.

ii. No painful experiment is justifiable for the mere purpose of illustrating a law or fact already demonstrated; in other words, experimentation without the employment of anæsthetics is not a fitting exhibition for teaching purposes.

iii. Whenever, for the investigation of new truth, it is necessary to make a painful experiment, every effort should be made to ensure success, in order that the suffering inflicted may not be wasted. For this reason, no painful experiment ought to be performed by an unskilled person with insufficient instruments and assistance, or in places not suitable to the purpose, that is to say, anywhere except in physiological and pathological laboratories, under proper regulations.

iv. In the scientific preparation for veterinary practice, operations ought not to be performed upon living animals for the mere purpose of obtaining greater operative dexterity.

Signed by:—M. A. LAWSON, Oxford. G. M. HUMPHRY, Cambridge. JOHN H. BALFOUR, ARTHUR GAMGEE, Edinburgh. WILLIAM FLOWER, Royal College of Surgeons, London. J. BURDON SANDERSON, London. GEORGE ROLLESTON, *Secretary*, Oxford.

Resolutions referred to in the Report.

That the Committee of Section D (Biology) be requested to draw up a statement of their views upon Physiological Experiments in their various bearings, and that this document be circulated among the Members of the Association.

That the said Committee be further requested to consider from time to time whether any steps can be taken by them, or by the Association, which will tend to reduce to its minimum the suffering entailed by legitimate physiological inquiries; or any which will have the effect of employing the influence of this Association in the discouragement of experiments which are not clearly legitimate on live animals.

The following resolution, subsequently passed by the Committee of Section D (Biology), was adopted by the General Committee:—

"That the following gentlemen be appointed a Committee for the purpose of carrying out the suggestion on the question of Physiological Experiments made by the General Committee:—Prof. Rolleston, Prof. Lawson, Prof. Balfour, Dr. Gamgee, Prof. M. Foster, Prof. Humphry, Prof. W. H. Flower, Prof Sanderson, Prof. Macalister, and Prof. Redfern; that Prof. Rolleston be the Secretary, and that they be requested to report to the General Committee."

AMERICAN SCIENTIFIC ENTERPRISE

THE magnificent Free Museum and Menagerie already established in the Central Park, New York, will ever stand as noble monuments of their founder's munificence, and it is now proposed to add to these a third source of benefit to science, and of recreation and instruction to the commonwealth at large. The scheme now in contemplation is the erection in the same Park of a Marine and Fresh-water Aquarium on the most approved system, and of greater magnitude than anything of the kind hitherto attempted. Following a similar principle, it is likewise intended to raise the funds requisite for establishing this aquarium through appeals to the public spirit, and proverbial liberality of New York's more wealthy citizens, as also hereafter to endow the institution, and throw the same freely open to all comers.

The credit of starting this praiseworthy enterprise is due to the Messrs. Appleton, the proprietors of *Appleton's Journal*, a house well-known for their zeal and energy in

the promotion of the interests of science, and for the educational benefits that have been conferred through their agency on all branches of the American community. Learning some time since from a notice in NATURE that Mr. Saville-Kent was about to resign his late curatorship of the Brighton Aquarium, Messrs. Appleton at once placed themselves in communication with that gentleman with the view of securing his aid in their scheme. As a site, New York offers remarkable inducements for the establishment of a marine and fresh-water aquarium on the magnificent proportions intended, the sea and the Croton river being equally available for the supply of the two descriptions of water required, while as a position for the acquisition of specimens to stock its tanks its advantages cannot be over-estimated. The art of transporting fish from one distant locality to another has been already practised under the auspices of the "American Fisheries Commission," on a larger scale and with more momentous results than have been obtained on this side of the Atlantic, through means of special cars fitted up with tanks. These last appliances will prove of eminent service and importance for the ordinary transfer of aquarium specimens, while a slight modification of the same might be adapted for accommodation on ship-board, and for the conveyance of fish from distant seas. In fact, starting with this proposed aquarium in the Central Park, the future aim of high-class aquaria should and will doubtless be, to as perfectly represent in its tanks the marine fauna of every quarter of the globe as Menageries and Zoological Gardens do at present the terrestrial inhabitants. The most solid and important advantages, however, likely to arise from an institution founded on the basis of the New York scheme, are associated with the pre-endowed system on which it is to be established; this of itself constitutes a guarantee for the attention to, and accomplishment of, scientific results unattainable in connection with any similar undertaking set up as a mere commercial speculation, and necessarily weighted with the many antagonistic interests upon which its financial profits are dependent. The time again could not be more ripe than the present for projecting the proposed scheme, a sufficient number of aquaria having been established in this country and on the Continent to illustrate the advantages or defects attendant upon the several principles of construction which have been hitherto attempted, as also to indicate the special modifications yet required to make them thoroughly efficient for biological research.

It is to be hoped that the meritorious example set by America will not be lost on this country. England, with her great resources, richly indented coast-line, and innumerable populous centres scattered along the latter, offers remarkable facilities for the establishment of a large zoological station and aquarium, and which, conducted under the auspices of a body of scientific men, with a trained naturalist to superintend it, could not fail to yield the most valuable results. In the absence of sufficient funds forthcoming from private sources for free endowment, the self-supporting system initiated by Dr. Anton Dohrn at Naples offers singular advantages. His scheme of letting out laboratory tables to various universities, governments, and scientific bodies is particularly worthy of notice. The fact that Cambridge has consented to take a share in one of these tables, while testifying to the praiseworthy spirit of that University, carries with it at the same time a severe censure upon the insufficiency of the means provided for scientific investigation nearer home. A well-appointed marine aquarium with suitable laboratories established at Torquay, Plymouth, or such other desirable locality, could not fail to command the support of our leading English universities, and it might be anticipated that also of many others in France, Belgium, Denmark, and other countries of Northern Europe, too far removed to profit fully by the advantages of the Naples station. Through the supply of specimens for class demonstration, such an institution might also derive a considerable income. One of the great disadvantages under which science courses are at present conducted throughout this country arises from the difficulty of obtaining for dissection typical examples of the commonest representatives of our marine fauna and flora, all of which might be furnished regularly and at a low rate through the medium of a large seaside aquarium, towards which is constantly flowing from every side an amount and variety of material more than sufficient for its own requirements.

TUBES FOR SILENT ELECTRICAL DISCHARGES *

RUHMKORFF'S induction coil is now a classical instrument found in every laboratory. It is constantly employed to obtain the sparks intended to combine gases in eudiometric analyses, but its use is not limited merely to effecting combinations, it effects also decompositions, another property utilised in chemistry, particularly to show that at the moment of its decomposition into nitrogen and hydrogen, ammonia gas doubles its original volume. We never obtain, however, in this experiment, a perfectly accurate result, for the induction spark which separates the ammonia gas into its elements is also capable of determining anew their combination to reform the original gas. It exercises thus two actions of a perfectly opposite kind, one of which seems due to true electric action, and the other to the heat which accompanies the passage of the spark.

It would certainly be advantageous to separate these two actions, since they are capable of acting in opposite directions, and it is especially in the preparation of ozone that this separation would be valuable, since ozone, which is easily formed under the influence of the spark, is destroyed by the action of heat. For the purpose of more easily obtaining ozone M. Houzeau has recently constructed an apparatus worked by a Ruhmkorff coil, in which there are no longer sparks, but only dark discharges—*effluvia*—far more efficacious in the production of modified oxygen.

It is known that at the end of last century, Van Marum noticed a peculiar odour in the vicinity of an electric machine giving large sparks, and that he attributed this odour to electricity. In 1840 Schœnbein showed that oxygen disengaged by electrolysis from water has this same odour, and preserves it after being kept in well-stoppered phials; he gave to the substance characterised by this odour the name of ozone.

There remained, however, some doubts as to the real nature of this substance, until the investigations of M. Marignac and of De la Rive in Switzerland, and MM. Fremy and E. Becquerel in France. They succeeded in demonstrating with precision that it was merely pure oxygen which assumed, under the electric influence, a new form. Researches on this modified oxygen soon accumulated, and chemists investigated it with the greater ardour, thinking that in studying this particular form of oxygen, they were touching that important question of simple bodies which at present remains the "great unknown" of chemistry.

So far as research has gone, ozone appears to be a strongly oxidising gaseous body, of one and a half times the density of oxygen, and possessing affinities infinitely more energetic than the latter. Thus it can oxidise cold silver, which so strongly resists the action of ordinary oxygen, it can inflame pure phosphuretted hydrogen, can burn ammonia, transforming it into nitric acid, and can displace the iodine of iodide of potassium. All these properties have been observed in the traces of ozone contained in oxygen submitted to suitable treatment, and the difficulty of obtaining appreciable quantities of ozone

* Translated from an article in *La Nature*, No. 29.

was not one of the least obstacles which stood in the way of continuous researches. Thus chemists and physicists have eagerly sought to discover a regular process of preparation, or at least a method of obtaining appreciable quantities of ozone. M. Houzeau, who has devoted much of his time and talents to the study of ozone, has recently devised an apparatus which is spreading rapidly among the laboratories, and which has already yielded very remarkable results, of which the following is a brief *résumé*.

The apparatus of M. Houzeau consists of two concentric tubes, the middle one enclosing a metallic wire, fixed to one extremity of a Ruhmkorff coil; the other wire, attached to the second pole of the coil, is rolled spirally round the exterior tube; finally, the gas circulates in the annular space comprised between the interior and exterior tubes, and, consequently, is not directly in contact with either of the two wires. The two metallic wires, along which the electricity flows, play the part of a Leyden jar, and the gas which circulates in the space traversed by the dark effluvia, by means of which the two different electricities shot along the wires are re-united, is essentially modified. If it be oxygen, it is charged with a notable quantity of ozone, whose odour rapidly spreads around the apparatus.

M. Houzeau's method produces oxygen much more charged with ozone than any other process; thus it has enabled some new properties of the gas to be discovered. Let the gas issuing from the effluvia-tubes come into contact with olefiant gas and the latter will be immediately set on fire with a loud explosion. M. Houzeau has devised a beautiful experiment, by introducing gradually into a somewhat large tube, a current of bicarburetted hydrogen, obtained by the reaction of sulphuric acid on alcohol; then by means of another narrower tube, penetrating about a centimetre into the tube filled with ethylene, he directs very gently a current of ozone, condensed as much as possible; the ozone which is introduced causes detonation.

When ozone is made to act on benzine a product is obtained, which, according to M. Houzeau, is essentially detonating; this ozo-benzine under concussion or pressure disengages suddenly a considerable quantity of gas, as do nitro-glycerine or the picrates, whose fulminating properties are well known. A few decigrammes of ozo-benzine produce a detonation so violent that the windows of the laboratory are invariably broken, and thus only the very smallest quantities should be used in experiments; 3 to 5 milligrammes suffice to establish the eminently explosive properties of this dangerous substance.

M. Houzeau has also been able to show by means of his apparatus, the remarkable decolourising properties of ozone. If a solution of indigo is thrown into a bottle containing oxygen mixed with ozone, it is as easily deprived of its colour as if it were in contact with chlorine. It is known, moreover, that dyed stuffs are bleached by being simply exposed to the air, and as it is now proved that our atmosphere contains ozone, it appears very probable that it is this gas which is the active agent in the old process of bleaching on the grass.

Such are the new properties which M. Houzeau has been able to establish by employing ozone in a state of condensation infinitely greater than that which is presented when it was prepared by the old methods; and these results are certainly not the only ones which may be looked for.

M. Houzeau is not the only one who has made use of the tubes whose structure he has made known, and soon we may expect to see them modified so as to make them much more durable. M. Boillot, a writer well known to the readers of the *Moniteur*, proposes to substitute for the wire of M. Houzeau's tube, whalebone charcoal contained in the interior tube and in the space comprised between the gas-holding tube and a thin tube concentric with the first two; and M. A. Thénard has brought to bear on the construction of the tubes a further modification which makes them still more efficacious.

As is shown in Fig. 1. M. A. Thénard's apparatus is composed of three tubes of unequal length, welded together. The central tube *aa'* is filled with chloride of antimony in solution with hydrochloric acid; the negative pole B of the coil dips in the liquid which descends to the bottom of the tube at *a'*; the same solution of chloride of antimony is placed in the exterior tube E; it receives the positive wire of the coil at A. The liquid E E is then positively electrified, the liquid *aa'* negatively, and the gas which enters at C and issues at D, after having passed across the annular space between the two tubes, is submitted to the electric effluvia determined by the two opposite electricities of the two liquids.

Into the tubes thus arranged M. A. Thénard directs the gases on which he wishes the electric effluvia to act. One of those which he first submitted to this treatment was carbonic acid, which is decomposed in oxygen and carbonic oxide, with increase of volume. The experiment is perfectly clear, and such as to show the complete difference between the action of the effluvia and that of the spark. While carbonic acid submitted to the decomposing power of dark discharges contains about one-fourth of its volume of the mixture of oxygen and oxide of carbon, which proceeds from its decomposition, carbonic acid decomposed by the luminous sparks of a coil never yields more than 7·5 per cent.; for the latter act not only by their decomposing power, but also by their heat, which determines the combination of the gases as first separated, up to the moment when carbonic acid, oxygen, and carbonic oxide, are formed in such a state of equilibrium, the spark produces no further effect, the decomposition being equal to the combination. This equilibrium is reached when the mixture contains precisely 7·5 per cent. of carbonic oxide.

This experiment is not, however, the most curious of those which have been published during the course of last year by MM. Paul and A. Thénard working together in that laboratory in the place Saint-Sulpice, which is so liberally opened to all who wish to study.

M. Paul Thénard has noticed that marsh-gas sometimes contains equal volumes of carbonic acid and protocarburetted hydrogen, *i.e.*, it constitutes a mixture in which the carbon, the hydrogen, and the oxygen are found in equal quantities, as when they are combined in a very largely diffused organic matter—glucose. Has the effluvium the power of determining the union of these different elements, so as to reconstitute an organic substance? Such was the idea which MM. P. and A. Thénard wished to verify by making a mixture in equal quantities of formic acid and carbonic acid in one of their effluvia tubes, so arranged that the changes of volume which the gases may undergo are easily determined.

After ten minutes, the condensation of the gases was already sensible; it increased in time, and soon there was seen to appear upon the sides of the tubes a liquid possessing a strong refracting power, viscous, yellowish, which was found to be an organic substance of a somewhat high order, burning readily. Its nature has not been determined, but it is sufficient to prove the importance of MM. Thénard's experiment, that its formation has been established.

The synthesis of organic matters from the elements has always been one of the problems which profitably engage the attention of chemists; and vegetation, indeed, enables us to witness their formation by a series of reactions which we cannot reproduce in the laboratory. Is it not surprising, for example, that under the influence of light a leaf can decompose carbonic acid and water, both extremely stable substances, and which we can only reduce to their elements by means of the most elevated temperatures which we can produce? But this work which is accomplished in the leaf of a plant, the effluvium performs equally well; it decomposes water into oxygen

and hydrogen. It can reduce carbonic acid to oxygen and oxide of carbon, just as happens in the green parts of plants under the rays of the sun.

As we learn by experiment that for one volume of carbonic acid decomposed by the green parts of plants, one volume of oxygen is given off, *i.e.* one volume of oxygen exactly equal to that of the carbonic acid, the decomposition of the latter being only partial, it is necessary that the water be forcibly decomposed in the same time as the carbonic acid, and that it yield us the half volume of oxygen necessary to complete that which appears at the moment of insulation, so that the decomposition is represented as follows :—

1 vol. carbonic acid = 1 vol. carbonic oxide + $\frac{1}{2}$ vol. oxygen.
1 vol. vapour of water = 1 vol. hydrogen + $\frac{1}{2}$ vol. oxygen.

The disengaged oxygen presents then a volume equal

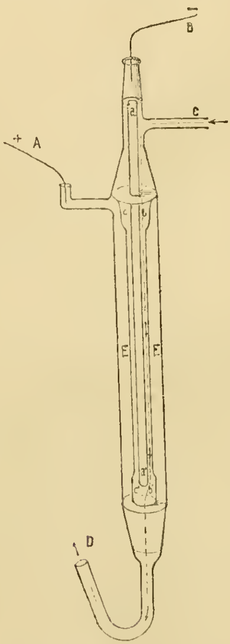


FIG. 1.—Effluvia Tubes of M. A. Thénard.

to that of the decomposed carbonic acid, and leaves instead carbonic oxide and hydrogen in equal volumes, which, on uniting, furnish in vegetables one of the products that are met with in young plants, glucose, which exactly represent the carbonic oxide and hydrogen, or, again, the carbon and the water. But this product has never been directly prepared ; it has been impossible, so far, to obtain it by synthesis, and all the attempts to unite the carbonic oxide to the hydrogen have been futile. There is, however, a problem of the same order which has been solved by MM. Thénard, and, in our opinion, is one of the most important points of their recent labours. They have not obtained, it is true, the organic matter, yet without a name, which was condensed upon their tube by directly combining hydrogen and the carbonic oxide, but by employing carbonic acid and formic acid, in which the elements are met with in the same proportions, in fact, instead of having

2 vols. carbonic oxide containing	1 vol. oxygen, 1 vol. carbon vapour.
2 vols. hydrogen.	

they have employed

4 vol. carbonic acid, containing	4 vols. oxygen, 2 vols. carbon vapour.
4 vol. carburetted hydrogen containing	2 vols. carbon vapour, 8 vols. hydrogen.

in which the oxygen and carbon, as in the first case, are in equal volumes, and the hydrogen in double volume. We may then regard the experiment of M. Thénard as opening a new way to the synthesis of organic substances, already so brilliantly studied by M. Berthelot.

The first apparatus employed by MM. Thénard presented a drawback ; the gases circulated with considerable difficulty, and their union was not so complete as could be desired ; they could not easily be renewed. MM. Thénard have got rid of this difficulty by means of the apparatus represented in Fig. 2. It will be seen that the electricity

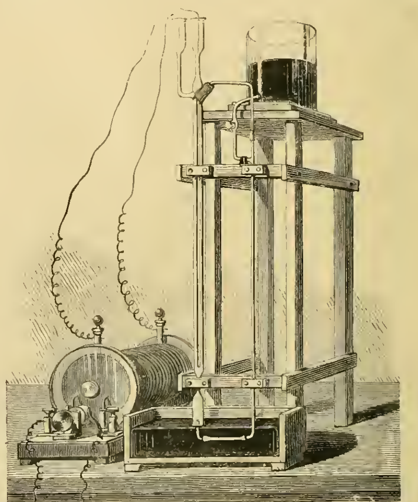


FIG. 2.—Apparatus employed by MM. Thénard to make gases circulate in effluvia tubes.

from the coil is distributed in the two tubes by cups filled with chloride of antimony, one forming the external tube, the other the interior, between which circulate the gases. These are kept in continuous motion by means of a very ingenious employment of mercury. By examining the figure it will be seen that the mercury placed in the large vessel, firmly fixed above the apparatus, can be let out drop by drop into the vertical tube on the right and carry along a certain quantity of gas imprisoned between two consecutive drops. The excess of mercury falls back into the vat into which the horizontal tube goes, while the moving gas received into a funnel which dips into the mercury, is brought into the annular space where it is subjected to the effluvia.

It is thought that if the gases in coalescing yield a liquid or solid substance, which can only happen by a great diminution of volume, it may be possible to introduce through the funnel placed under the mercury, a new proportion of the gases which, under the influence of the effluvium, will react upon each other.

HAECKEL ON INFUSORIA

IN this communication* Prof. Haeckel discusses the different views which have been entertained as to the structure of the Infusoria, and adopts that of Prof. Siebold, that they are unicellular. This constitutes in his opinion a fundamental distinction betweent hem and the rest of the animal kingdom, although, strictly speaking, some species, as for instance, *Loxodes rostrum*, and *Enchelys gigas*, have more than one nucleus, and must, therefore, be regarded as physiologically consisting of more than one cell. Prof. Haeckel, however, does not attach much importance to these exceptional cases, because the multiplication of the nuclei involves little change of organisation in other respects.

The difficulty of conceiving a single cell with such complex properties becomes lessened, if we remember the nerve-cells of the higher animals, the thread-cells of many Acalephæ.

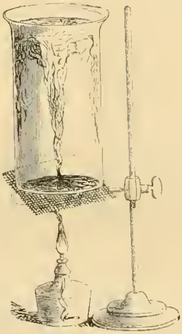
Considering, then, that the true Infusoria are unicellular, as first maintained by Prof. Siebold in 1845, Prof. Haeckel denies that they have any near connection with either Cœlenterata or the worms. In all the higher groups of the animal kingdom the organism is multicellular, and develops itself from the original egg-cell by the characteristic process of segmentation, and the cellular mass thus formed differentiates itself into two epithelial layers, from the inner one of which the digestive canal, with all its appendages, develops itself; while from the outer layer are formed the skin, nervous system, &c. In his monograph of the Calcareous Sponges, Prof. Haeckel has developed his views of the relations of these two primary layers in the principal groups of animals, and from this fundamental homology has enunciated the theory of a common original form, which he proposed to call "Gastraea," and from which all the higher forms of animals are derived. This theory, which he calls the Gastræa theory, is based upon the consideration that all the six higher animal classes, from the sponges to the lowest vertebrates, pass through a similar stage of development, which he proposes to call the Gastrula stage, and which he considers to be the most important and instructive embryonal form of the animal kingdom. In the calcareous sponges, for instance, this Gastrula law forms a simple generally egg-shaped body, surrounding an ample hollow, the primitive stomach, or digestive cavity, and with an orifice at one end, the primitive mouth. The wall of the digestive cavity consists of two layers, the entoderm, and the ectoderm, which, as Prof. Huxley was the first to point out, are homologous with the outer and inner layers of the vertebrate embryo. Similar larvæ occur in other sponges, and in many zoophytes, while as examples of embryonal forms in other groups he refers to the researches of Kowalevsky in Phoronis, Sagitta, Euaxes, Ascidia, &c.; and of Ray Lankester in Mollusca. He considers that the larval forms of Arthropods can be reduced to the same type; and finally that the researches of Kowalevsky have shown that the same is the case with the lowest vertebrata (Amphioxus). The Infusoria, on the contrary, have no yolk-segmentation, no blastoderm, and consequently nothing which corresponds to the Gastrula stage, nor any homologue of the digestive cavity of other animals. The resemblance of many ciliated larvæ to the Infusoria is therefore merely superficial, the latter being unicellular, the latter multicellular. He regards this difference as so fundamental that he proposes to divide the animal kingdom into two great groups, the Protozoa, and the Metazoa, Blastozoa, or Gastrozoa. The Metazoa, to use his first name, he again divides into two; the Zoophytes, or Cœlenterata on one side, and the Worms, from which again the Molluscs, Echinoderms, Arthropods, and Vertebrates have sprung, on the other.

* Zur morphologie der Infusorien. Sep. Abdruck aus der Jenaischen Zeitscrift. Bd. vii.

LECTURE EXPERIMENT

THE ordinary experiment described in books for demonstrating the heating of a body of fluid by convection currents consists in throwing bran into a vessel of water, to the bottom of which a source of heat is afterwards applied. Mr. Clowes's experiment, given in NATURE, vol. ix. p. 162, is no doubt more effective. I have, however, found that the ordinary experiment admits of being made quite satisfactory for the purpose of clear demonstration, and the hint may be useful to those to whom it has not already occurred.

Take a large beaker filled with water, and introduce down to the bottom the end of a burette filled with a strong indigo solution and closed at the top by the finger. If necessary, the solution may be driven out by the application of the mouth to the other end, and gently blowing. The burette must be carefully withdrawn without producing upward currents; this can be easily managed with a little care. The dark fluid now lies at the bottom of the clear water, with which, during a time sufficient



for the experiment, it does not appreciably mix. But when a spirit lamp is applied it rises in slender streams, which can be rendered very visible by placing a sheet of white paper behind the beaker. W. T. T. D.

A SCIENCE LECTURE AT THE CHARTERHOUSE

A LECTURE on one who was once a Brother of the Charterhouse, and who laid the foundations of scientific electricity, could not fail to be of interest when delivered within the walls of that building, where indeed many of the experiments of the original investigator in question were conducted. This pleasant duty devolved on Dr. Richardson on Thursday, January 22, when he gave to the brethren of the Charterhouse, and to many eminent friends, an experimental demonstration of the work of the early electrician, Stephen Gray.

The lecturer opened his discourse with an exposition of the personal history of Mr. Gray; of this, he said, he could gather little. He discovered Gray first at Canterbury, in 1692, making an observation of a mock sun, in the afternoon of February 6. At this time Gray was evidently engaged on physical and astronomical research. In 1696 he was busy constructing a water microscope; in 1698 he was engaged making a microscope with a micrometer for measuring the height of mercury in the barometer more exactly; in 1699, on April 7, between 4 P.M. and 5 P.M., he was observing an unusual parhelion and a halo; in 1701 he was studying the fossils of Reculver

Cliff and inventing a method for drawing the meridian line by the Pole star and finding the hour by the same; in 1703, on June 15, 16, and 18, he was making some observations on spots on the sun; and in 1706, on May 12, in conjunction with Flamstead at Greenwich, Captain Stannyan at Berne, and Mr. Sharp at Bradford, he was taking observations of the great solar eclipse of that day.

From his various reports on these subjects it is clear that Mr. Gray, while at Canterbury, had a good observatory; he had three telescopes, one of which was of 16 ft., an astronomical table, a theodolite, a pendulum clock, and various other instruments, with the use of which he was quite familiar; but what his occupation was, otherwise, there is no record.

We now lose all sight of Gray until 1717, when we find him being recommended to the Charterhouse by Prince George to become a pensioner there. The letter of recommendation is signed by the Prince, but says no more than that the applicant is a proper person to receive the advantage of residence. In 1719 he entered the building as a pensioner and remained there until his death, seventeen years later.

With his entrance into the Charterhouse a new career of scientific research seemed to have opened itself to Mr. Gray. He became an electrician, and, said Dr. Richardson, his experiments led to such extraordinary results that, but for them, electrical science might have waited for centuries, or for ever, in the state in which he found it. That the audience might know upon what pre-existing data Gray proceeded, Dr. Richardson traced back the origin of experimental electricity to the reign of Queen Elizabeth and to her physician, William Gilbert. He reviewed from this source, briefly and succinctly, the labours of Boyle, Otto de Guericke, Wall, Newton, and Hawksbee, introducing a model of Hawksbee's revolving cylinder, and Sir Isaac's simple experiment of making light bodies move between an excited plate of glass and a table.

In 1720 the first electrical work of Mr. Gray saw the light in a paper entitled "An account of some new electrical experiments," which appeared in that year in the Philosophical Transactions. In this paper the communicability from one electrified substance to other substances not previously electrified is described.

From this point in Mr. Gray's career Dr. Richardson traced him step by step through his experimental researches, making each of his (Gray's) experiments a matter of direct demonstration to the audience, and using only the simple kind of instruments the original investigator himself had at command. Thus were demonstrated the experiments of the cork and the excited tube, the ivory ball on the wooden rod, and the pack-thread experiments, by which Gray discovered that electricity could be conducted long distances. Next were demonstrate the famous loop experiments and those with bridges of pack-thread, silk, and wire, by which silk was discovered to be an insulator, and the new fact of insulation was recorded. The audience, at this point, were carried, by description, to the Mansion of Mr. Granville Wheeler, Otterden House, near Faversham, and were shown by a beautifully simple diagram, drawn for the occasion by the distinguished George Cruikshank—how Mr. Gray, putting up poles in Mr. Wheeler's grounds, insulated a pack-thread line on silk supports, and on July 14, 1729, sent by the line a communication through a distance of 650 ft.

Another series of experiments showed how Mr. Gray discovered induction, the conducting power of water and of metals; the fact that electricity arranges itself upon the surfaces of bodies; that attraction will take place *in vacuo*; and that an insulated, pointed iron rod, when electrified by induction, will yield a brush at its extreme point, will charge another insulated conductor, will give a spark to the knuckle when tha is brought near, and will pass through a chain of animal bodies, if they be insulated.

A beautiful experiment with a soap-bubble, showing how, when insulated and charged, it will attract, closed the experimental part of the lecture. The experiments throughout were highly successful, and were so rendered as to be distinctly visible to all the observers.

A few more points in the personal history of Gray were introduced. It was told that he gained the first Copley Medal of the Royal Society in 1731, and the second in 1732, and that he was admitted a Fellow of the Society on March 15 of the latter year. A graphic description was given of a meeting of the Royal Society on November 25, 1731. At this meeting Prince George was present with the Duke of Lorraine, and the Duke was admitted a Fellow. Afterwards a model of a fire-engine, used at York, was exhibited; then Dr. Frobenius lectured on phlogiston, and on the transmutation of phosphorus, using several pounds' worth of that now common element. Finally, the company ascended to the library, where Mr. Gray showed some experiments, proving how electricity travels along conductors, and succeeded well, notwithstanding the largeness of the company.

Two remaining subjects relating to Gray were briefly touched upon. One was his prediction that what he was doing *in minimis* would some day be so extended, that electrical phenomena would be made to resemble those of thunder and lightning; and the other, his belief that he had invented what he called a Planetarium, that is, a method of making a pith-ball suspended by silk move in circles or ellipses round a metallic centre set in a cake of resin, while the resin was excited by friction of the hand. The first of these observations of Gray had been fulfilled; the latter had appeared as an error of the last days of this wonderful man, and might well be forgiven.

The death of Stephen Gray afforded the lecturer an opportunity for a touching description of a man of science struggling to the last with his labours. On February 14, 1735-36, he was visited by Dr. Cromwell Mortimer, the secretary of the Royal Society, who took from his lips the account of the Planetarium by which, "if God spared his life," the electrical philosopher would create, he thought, much astonishment: but the following day, experiment, speculation, and hope, lay alike low in death.

NOTES

THE report which reached England a few days ago of the death of Livingstone, and which Dr. Kirk was able to characterise as possibly unfounded, as it closely resembled a discredited one current in Zanzibar before he left, received important confirmation yesterday morning. We are enabled, however, to state that a letter seems to have come from Lieut. Cameron at Unyanyembe, reporting that a man named Chumas, who was with Livingstone, had arrived there with a circumstantial story of his death, which Lieut. Cameron, with his slight knowledge of Suabili, had to turn into English. It now depends upon the veracity of Chumas, of which at present there is no means of judging. The circumstantiality is nothing, for the tale of the lying Johanna man was quite as detailed. There is, however, we are bound to confess, much reason to fear that we have lost one of the most unselfish, noble, and devoted investigators the century has produced.

THE Council of the Geological Society has awarded the Wollaston Medal for the present year to Prof. Oswald Heer of Zurich, and the balance of the Proceeds of the Wollaston Donation Fund to M. Henri Ngst of Brussels. The Murchison Geological Medal was awarded by the Council to Dr. Bigsby, F.G.S., and the balance of the Proceeds of the Murchison

Geological Fund to Mr. Alfred Bell and Mr. Ralph Tate, F.G.S., between whom it will be divided.

WE are glad to note that the Emperor of Brazil has conferred upon Dr. Huggins, F.R.S., the honourable distinction of Commander of the Order of the Rose.

WE are informed there is a scheme in contemplation for the erection of an aquarium at Margate. The building will commence at Cold Harbour and pass round Fort Point to the flagstaff point on the Fort Promenade, and will be carried out by a limited liability company, with a capital of 15,000*l.* In all likelihood the work will be commenced early in the spring and will take about nine months to complete. According to present plans the aquarium will be 250 ft. long by 100 ft. broad, and will be connected with a large hall suitable for concerts and balls.

THE Royal Irish Academy have granted to Messrs. Draper and Moss the sum of 30*l.* towards their researches on Selenium, and 35*l.* to G. J. Stoney, F.R.S., towards the construction of the Academy's spectroscope.

ON the 19th inst. Prof. Corfield delivered a lecture on Smallpox and Vaccination, in connection with the Laws of Health Class of the Birmingham and Midland Institute.

A COURSE of "Science Lectures for the People" has been arranged by the Council of the Crewe Mechanics' Institution, to be delivered in their hall. The following is the programme for the next two months:—February 5th and 12th, two lectures on "Mechanics," by Sedley Taylor, M.A., late Fellow of Trinity College, Cambridge; February 19th and 26th, two lectures on "Waves," by G. W. Hicks, B.A., scholar of St. John's College, Cambridge; March 5th and 12th, two lectures on "Light," by William Garnett, B.A., scholar of St. John's College, Cambridge. These two last will treat of spectrum analysis, and its application to the Bessemer flame. H. N. Read, B.A., of St. John's College, Cambridge, will give the two concluding lectures on "Chemistry," on March 19th and 26th. Each lecture will be illustrated by experiments.

WE have received two more of the penny reprints of the Science Lectures for the people delivered at Manchester, namely:—"Muscle and Nerve," by Prof. Gamgee, M.D., F.R.S., and "The Time that has elapsed since the Era of the Cave Men of Devonshire," by William Pengelly, F.R.S. They both seem admirably adapted for the purpose for which they were given, the subjects being treated clearly and familiarly without that sacrifice of scientific accuracy which is often the bane of popular lectures delivered before mixed audiences.

WE have received the thirteenth annual report of the Manchester Scientific Students' Association, containing an account of the various soirées, excursions, and papers for the past year. We are pleased to see that the Committee speak very favourably of the position and prospects of the Society. The total number of members is 177. During 1873 two soirées were held, seventeen lectures delivered on various branches of science, and eleven excursions made to places of scientific and antiquarian interest in the locality.

A NEW society has been formed at Londonderry under the name of the "Londonderry Scientific Association" to promote the study of physical, natural, and historical science. Courses of lectures will be delivered on scientific subjects, single lectures on special subjects by eminent Lecturers will also be provided as occasion may serve, and excursions made during the summer for the field-study of Geology, Zoology, and Botany. The first meeting was held on January 14, when Mr. W. E. Hart, M.A., President of the Society, occupied the chair and opened the proceedings by reading a paper on "Local Scientific Societies; their aims and objects;" in which he pointed out the importance of the study of natural science, both as in itself a valuable branch of education, and as a means of intellectual discipline. This was followed by a discussion on the "Relations of Physico-Geographical Conditions to Civilisation." The "Londonderry Scientific Society" is chiefly composed of ex-members of the "Londonderry Natural History and Philosophical Society," which ceased to exist some two years ago.

WE learn from Mr. Gerard Krefft, F.L.S., Curator of the Australian Museum at Sydney, that the museum, which is the oldest and richest in the Australian colonies, was visited last year by nearly 250,000 persons, who were admitted free. We understand that Mr. Krefft will be glad to receive specimens of all kinds from any individuals interested in the progress of science in New South Wales.

MR. HENRY SOLLY writes to the *Times* with reference to the address issued by the Trades Guild of Learning noticed in NATURE. He says that the Guild originated with himself, and was first proposed at a meeting he called last March to a number of leading working men, when Lord Lyttelton was in the chair, and when Mr. James Stuart, of Trinity College, Cambridge, the originator of the University Extension Scheme, was present at his invitation. A Provisional Committee was then formed, consisting of most of the working men present, with the addition of Mr. Stuart, Mr. Webster, Q.C., Mr. Hodgson Pratt, Mr. Edward Hall, himself, and a few other friends of the movement. That committee resigned its trust, after doing a good deal of work, to a conference held in June at the Hall of the Society of Arts, when the Guild was formally founded, and a Council was appointed on which nearly the whole of the Provisional Committee was placed.

DURING several days in December, says the *Levant Times*, consternation prevailed in the town of Adramytti, in Asia Minor, in consequence of certain ominous noises which seemed to proceed from a considerable depth below the earth's crust. The sound which was heard at intervals and resembled the report of distant cannon, was accompanied and followed by shocks of earthquake, which added to the terror of the inhabitants. At a short distance from the town and in the surrounding villages there was no such cause for alarm, the earth maintaining its normal condition of harmless repose. These details are, no doubt, trustworthy, as they are taken from the report sent in by the Governor of Adramytti to the Governor-General of the Vice-Royalty of Smyrna.

ON December 1, at 10.25 A.M., a violent shock of earthquake was felt at Sofia, in European Turkey. The shock was accompanied by a loud subterranean noise.

THERE were two shocks of earthquake at 8 P.M. on Dec. 26 at Salonika, in European Turkey.

AT the Berlin Medico-Psychological Society in November last, says the *Medical Times and Gazette*, Dr. Hitzig, the author of the method of examination of the brain by electricity, made some remarks on Dr. Ferrier's well-known experiments on the localised functions of the brain, especially with regard to the discrepancies between his own and the latter's results. He considers that the chief of these is that while he and Fritsch have found only one part of the convexity of the hemispheres capable of electrical excitation, Ferrier extends this property to nearly the whole of it. This Hitzig explains by saying that Ferrier has in his experiments used two strong currents (the secondary

coil of Stohrer's battery being pushed into eight and even four centimetres), and has thus excited the ganglia at the base of the brain, so that it is to them, and not to centres localised in the cortex, that the movements noted must be referred. Another reason why Hitzig doubts some of the effects of irritation in Dr. Ferrier's cases is because, although there is such a remarkable similarity between the brains of the dog and the cat, the latter found that electrisation of the spot on the cat's brain corresponding to the centre of movement for the tail in the dog gave no result. Hitzig has repeated several of the experiments in which Ferrier's results differed from his own, and declares that his own views are re-confirmed. He will shortly publish a detailed account of all his work in Du Bois-Reymond's *Archiv.*

DR. PETERS of Berlin, in the 1873 *Festschrift* of the *Gesellschaft Naturforschen der Freunde zu Berlin*, has described a very interesting new genus of Rodent animals, named by him *Dinomys branickii*. The specimen on which the memoir is based is a skin and skeleton, which were placed in his hands by Mr. L. Taczanowski, Conservator of the Zoological Museum at Warsaw, the latter naturalist having obtained it from Mr. Constantin Jelski, who found it in the high lands of Peru.

WE are glad to know that a Microscopical Society has been founded in Victoria quite recently, this being the first of such institutions established in Australia. The first meeting, held at Melbourne, was under the presidency of Mr. W. H. Archer, the Registrar-General of the Colony, who gave an interesting introductory address, in which he showed the great field there is for fresh work in that comparatively unexplored country.

WE noticed in NATURE last week the announcement of a work by Sir Bartle Frere, G.C.B., G.C.S.I., called "The Impending Famine in Bengal; how it will be met, and how to prevent future Famines in India," with maps; to be shortly published by Mr. John Murray. Amongst Messrs. H. S. King and Co.'s forthcoming books we find the following:—"The Threatened Famine in Bengal: how it may be met, and the recurrence of Famines in India prevented," by Sir H. Bartle Frere, G.C.B., G.C.S.I., &c., with three maps. Is it not somewhat strange that two publishing firms should announce separate works by the same author, with titles that are so nearly synonymous?

MESSRS. H. S. KING & CO. will shortly publish—"Longevity: the Means of prolonging Life after Middle Age," by Dr. J. Gardner, author of "Household Medicine." "The Principles of Mental Physiology, with their applications to the training and discipline of the Mind, and the Study of its Morbid Conditions," by W. B. Carpenter, M.D., LL.D., F.R.S. "Physiology for Practical Use," by various eminent writers. Edited by James Hinton. 2 vols., with 50 illustrations. "The History of Creation:" a popular account of the development of the earth and its inhabitants, according to the theories of Kant, Laplace, Lamarck, and Darwin. With coloured plates and genealogical trees of the various groups of both plants and animals, by Prof Ernst Haeckel of Jena. "The New Chemistry," by Prof. Josiah P. Cooke, of Harvard University, with numerous illustrations.

MESSRS. WM. BLACKWOOD AND SONS have in the press the following works relating to natural science:—An "Advanced Text-book of Botany for the Use of Students," by Robert Brown, F.R.G.S., Lecturer on Botany under the Science and Art Department of the Committee of the Privy Council on Education and author of the "Races of Mankind," just published by Messrs. Cassell, Petter, and Galpin; "Domestic Horticulture, Window Gardening and Floral Decorations," by F. W. Burbidge; and "Economic Geology, or Geology in its Relation to the Arts and Manufactures," by David Page, F.G.S., Professor of Geology in the Durham University College of Physical Science, Newcastle.

MR. WILLIAM TOPLEY's interesting paper, with maps and sections "On the Relation of the Parish Boundaries in the South-east of England to Great Physical Features, particularly to the Chalk Escarpment," has been reprinted in a separate form from the *Journal of the Anthropological Institute.*

IN *Le Tour du Monde*, is appearing a French translation of the account of the voyage of the German Arctic Expedition of 1869—70, in the ships *Germania* and *Hansa*. The illustrations are plentiful and beautiful.

WE have received the following reprints of papers by Mr. F. W. Putnam, from the *Bulletin of the Essex Institute* (U.S.):—"Description of a Stone Knife found at Kingston, N.H.," "Description of a Carved Stone representing a Cetacean, found at Seabrook, N.H.," and "Descriptions of Stone Knives found in Essex County, Massachusetts."

THE success of Professor G. W. Hough, of the Dudley Observatory, in constructing self-recording barometers and thermometers, lends additional interest to his announcement of the successful construction of an automatic evapometer and rain-gauge. The apparatus consists of a vessel two feet square and one foot deep, suspended on levers, and held in equilibrium by a small spring, the amount of change in the weight of the mass, either from rainfall or evaporation, being indicated on the scales of a delicate balance. In order to secure the mechanical record of the hourly variations in the weight of the vessel and of its contents, the professor causes the lever to vibrate between two platinum points so placed that whenever a change in the weight of the vessel by a given amount (say ten grains) takes place, a magnetic circuit will be established passing through an electro-magnet. A micrometer screw will then be operated by means of clock-work, thereby tracing a curve on a revolving drum, precisely as in the case of the self-recording barometer and thermometer.

THE principal articles in the last number of the *Canadian Journal of Science, Literature, and History* are—on "An Ancient Carved Stone, found at Chesterholm, Northumberland, England," by the Rev. Dr. M'Caul; an article by Dr. Daniel Wilson, on the work done by Alexander Gordon, the Scottish antiquary, author of the *Itinerarium Septentrionale*, and a paper, also published separately, by Prof. H. A. Nicholson, on "The Species of Favosites of the Devonian Rocks of Western Ontario." Appended are meteorological tables for Toronto for the half-year May to October 1873.

THE addition to the Zoological Society's Gardens, during the past week, include an Ocelot (*Felis pardalis*) from America, presented by Mr. J. Ryde; a White-headed Sea Eagle (*Haliaetus leucocephalus*) from Nova Scotia, presented by Mr. H. Walpole; two Grey-breasted Parrakeets (*Bolborhynchus monachus*) from Monte Video, presented by Mrs. C. Dawkins; a Bernicle Goose (*Bernicla leucopsis*), European, presented by Mr. T. P. Tyndale; two Sclater's Curassows (*Crax sclateri*) from Maranham, and a Prince Albert's Curassow (*C. alberti*) from Columbia; a Capybara (*Hydrochœrus capybara*) from South America; a Rhea (*Rhea americana*) from Rosaria, and a Chimachima Milvago (*Milvago chimachima*) from Brazil, purchased or deposited, the last-named bird being new to the collection.

THE ACOUSTIC TRANSPARENCY AND OPACITY OF THE ATMOSPHERE *

THE cloud produced by the puff of a locomotive can obliterate the noonday sun; it is not therefore surprising that in dense fogs our most powerful coast lights, including even the electric light, become useless to the mariner.

A disastrous loss of life and property is the consequence. During the last ten years, for example, the number of total wrecks on the coasts of the United Kingdom, which were reported to have been caused by fog and thick weather, amounted, I am informed, to 273 vessels.

Of late years various efforts have been made, both on our own coasts and on the American seaboard, where trade is more eager and fogs more frequent than they are here, to furnish warning and guidance to ships by means of sound signals of great power established along the coast. Regarding the performance of such signals, the most conflicting evidence exists; and no investigation has been hitherto instituted sufficiently exhaustive to remove the uncertainty.

The problem has occupied for some time the attention of the Elder Brethren of the Trinity House; and soon after my return from America they requested me, as their official adviser in scientific matters, to superintend an investigation of the entire subject. They had appointed a committee under whose auspices two stations had been established at the South Foreland. I entered upon the inquiry with such ardour as I could derive from a sense of duty, rather than from the pleasure of hope, for I knew it would be long and difficult, and that I was at the mercy of a medium, the earth's atmosphere, which could not be put into the witness-box and cross-examined scientifically. The experimenter can usually impose his own conditions upon Nature, and force her to reply. In the present case we were forced to accept the conditions which Nature imposed.

Nevertheless, if the student only holds on faithfully to any natural problem, intending his mind upon it, and not falling into hasty despair, he is sure to be rewarded in the end; and after a time results, important not only in a practical but in a purely scientific point of view, appeared to grow out of the investigation. I mentioned this to the Deputy Master of the Trinity House, saying that I thought such results might, without impropriety, be communicated to the Royal Society and the Royal Institution. His response was prompt and cordial, and he was seconded by his colleagues in this response. They gave not only the requested permission (which on various pleas they might have withheld), but they have aided me in every way in the preparation of this discourse.

I would add that the Elder Brethren themselves have had a large share in the executive portion of this investigation, and whatever success has attended the inquiry is in a great measure due to the cheerful promptness and thoroughness with which my wishes and suggestions were carried out by the gentlemen with whom I had the honour to act. It is not necessary to mention names when all have been so sympathetic and so helpful, but I should like to refer to a few gentlemen on the working staff of the Trinity House, who have aided me with all assiduity and all zeal. They are the able Trinity House engineer, Mr. Douglass, his assistant engineer, Mr. Ayres, and Mr. Price Edwards, the private secretary of the Deputy Master of the Trinity House.

On Monday, May 19, the experiments began. The instruments employed had been previously mounted at the top and bottom of the South Foreland Cliff. They were two brass trumpets, or horns, 11 ft. 2 in. long, 2 in. in diameter at the mouth-piece, opening out at the other end to a diameter of 22 in. They were provided with vibrating steel reeds, 9 in. long, 2 in wide, and ¼ in. thick, and were sounded by air of 18 lbs. pressure. They were mounted vertically on the reservoir of compressed air; but within about 2 ft. of their extremities they were bent at a right angle, so as to present their mouths to the sea. These horns were constructed by Mr. Holmes. There were also two whistles shaped like those in use on locomotives, one 6 in. in diameter, sounded by air of 18 lbs. pressure; the other constructed by Mr. Baily of Manchester, 12 in. in diameter and sounded by steam of 64 lbs. pressure.

We embarked on the steamer *Irene*, and placed ourselves abreast of the signal-station, halting at a distance of half a mile from it. The wind was strong, the sea rough. The superiority of the trumpets to the whistles was very marked, and I may say continued marked throughout. Their sound was exceedingly fine and powerful. At 1 mile's distance their sound was clear and strong; at 2 miles they were heard distinctly, though not loudly. The whistles were also heard, but as fog-signals they had become useless. At 3 miles the horns became also useless. It required great attention to hear them distinctly. At a distance of 4 miles, with the paddles stopped, we listened long and attentively, but heard nothing.

On May 20, at 3 miles' distance, the steam whistle was not at all heard, the horns but faintly. At 4 miles' distance, the air being very light, the sea calm, and the circumstances generally to all appearances highly favourable, we halted and listened. The horns were so heard as to render it unmistakeable that a sound was there. At 4·8 miles the sounds were faintly heard; at 5 miles an occasional murmur reached us. At 6 miles the faint hum of a horn was wafted to us at intervals A little farther out, though local noises were absent, and though we listened with stretched attention, we heard nothing.

This position, clearly beyond the range of whistles and trumpets, was chosen with the view of making a decisive comparative experiment between horns and guns as instruments for fog-signalling. Through the courtesy of General Sir A. Horsford we were enabled to carry out this comparison. At 12·30 precisely the puff of an 18-pounder, with a 3-lb. charge, was seen at Dover Castle, which was about a mile farther off than the South Foreland. Thirty-six seconds afterwards the loud report of the gun was heard, its complete superiority over the trumpets being thus to all appearance demonstrated.

We clinched this observation by steaming out to a distance of 8½ miles, where the report of a second gun was well heard. At 10 miles the report of the gun was heard by some and not by others. At 9·7 miles a fourth report was heard by all observers.

There was nothing, far as I am aware of, in our knowledge of the transmission of sound through the atmosphere, to invalidate the founding upon these experiments of the general conclusion that, as a fog-signal, the gun possessed a clear mastery over the horns. No observation, to my knowledge, had ever been made to show that a sound once predominant would not always be predominant; or that the atmosphere on different days would show preferences to different sounds. A complete reversal of the foregoing conclusion was therefore not to be anticipated; still, on many subsequent occasions, it was completely reversed.

On June 2 the maximum range, at first only 3 miles, afterwards ran up to about 6 miles.

Optically June 3 was not at all a promising day; the clouds were dark and threatening; and the air filled with a faint haze, nevertheless the horns were fairly audible at 9 miles. An exceedingly heavy rain-shower approached us at a galloping speed.

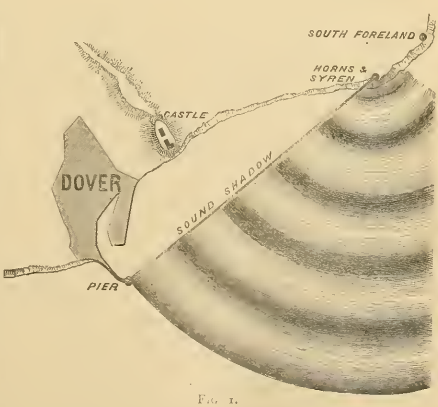


Fig. 1.

The sounds were not sensibly impaired during the continuance of the rain. This state of the atmosphere, according to hitherto

* Royal Institution, Friday evening Discourse by Prof. Tyndall, D.C.L. LL.D., F.R.S. Jan. 16.

expressed opinions, should have deadened the sound. It rather aided the sound, and this added to my perplexity.

On June 10 the maximum range was 9 miles. An extraordinary sinking of the sound was, however, noticed on the Dover side of the Foreland. At a mile's distance from the station the sounds rapidly fell. Surprised at the suddenness of the effect, and thinking it might be due to some peculiarity of the horns, at 2 miles' distance I signalled for the guns. With a 3 lb. charge not one of them was heard.

On June 11 we steamed towards the South Sound Head lightship. At the distance of $2\frac{3}{4}$ miles, and even at 2 miles and less from the station, the sounds were not so strong as at $3\frac{3}{4}$ miles. We steamed abreast of the station and on to the line joining the South Foreland to the end of the Admiralty Pier. At three-quarters of a mile from the station the sound fell, and a little farther on was scarcely audible. This weakening of the sound between the pier and the Foreland was invariable. This needs a word of explanation. The fall of the sound is not caused directly by an acoustic shadow, for it occurs when the instruments are in view, but the limit of an acoustic shadow is close at hand. A little within the line joining the Foreland and the pier end, the instruments are cut off by a projection of the cliff near the station; all the sea space between this limit and the cliff under Dover Castle is in the shadow. Into this, however, the direct waves diverge, and lose intensity by their divergence, the portion of the wave nearest the shadow suffering most. To this must be added the effect of interference.

On June 25 the range was $5\frac{1}{2}$ miles. On June 26 the range was 10 miles. The former day the wind was in the direction of the sound; on the latter the wind was opposed. Plainly there must be something besides the wind which determines the sound-range. This something was now the object of search.

Is it the clearness of the atmosphere? All previous writers have extolled a clear atmosphere as best for sound; but on July 18 we steamed out to a distance of 10 miles and heard sounds, the white cliffs of the Foreland being at the same time entirely hidden in thick haze. Nay, more: we spoke the *Triton* tender on its way from the *Varne* lightship, and took the master of the *Varne* on board. He reported that the sounds had been heard at the lightship, though it is $12\frac{3}{4}$ miles from the Foreland. It was, moreover, dead to windward of the Foreland, so that both haze and wind were then in opposition; still the sound ranged at least twice as far as it had done on days when neither haze nor wind was there to interfere with the sound.

On July 2, a sudden acoustic darkness, if I may use the term, settled upon the atmosphere. The range was only 4 miles. The magnitude of the fluctuations, from $3\frac{1}{2}$ to $12\frac{3}{4}$ miles, observed up to this date, was striking: but I was unable to fix upon any meteorological element that could be held accountable for them. The wind, the clearness of the air, the barometer, the thermometer, the hygrometer, gave me no help. All was perplexity. I longed for light, but saw little prospect of obtaining it.

July 3 was a lovely morning: the sky was of a stainless blue, the air calm, and the sea smooth. I thought we should be able to hear a long way off. We steamed beyond the pier end and listened. The steam clouds were there, showing the whistles to be active; the smoke puffs were there, attesting the activity of the guns. Nothing was heard. We went nearer; but at two miles horns and whistles and guns were equally inaudible. This however being near the limit of the sound shadow, I thought that might have something to do with the effect, so we steamed right in front of the station, and halted at $3\frac{3}{4}$ miles from it. Not a ripple nor a breath of air disturbed the stillness on board, but we heard nothing. There were the steam-puffs from the whistles, and we knew that between every two puffs the horn sounds were embraced, but we heard nothing. We signalled for the guns: there were the smoke puffs apparently close at hand, but not the slightest sound. It was mere dumb show on the Foreland. We steamed in to 3 miles, halted, and listened with all attention. Neither the horns nor the whistles sent us the slightest hint of a sound. The guns were again signalled for; five of them were fired, some elevated, some fired point blank at us. Not one of them was heard. We steamed in to two miles, and had the guns again fired: the howitzer and mortar with 3 lb. charges yielded the faintest thud; and the 18-pounder was quite unheard.

In the presence of these facts I stood amazed and confounded, for it had been assumed and affirmed by distinguished men who had given special attention to this subject, that a clear, calm atmosphere was the best vehicle of sound: optical clearness and acoustic clearness were supposed to go hand in hand: indeed, it had been proposed to make the one a measure of the other. But here was a day perfectly optically clear, proving itself to be a day of acoustic darkness almost impenetrable. I was driven slowly to the conclusion that all I had read upon this subject was wrong, and that for 165 years, namely since 1708, when Dr. Derham published his celebrated paper on this subject, succeeding generations of scientific men had gone on repeating the same errors. This knowledge, however, did not help me much. The problem was still there challenging solution.

I ventured, two or three years ago, to say something regarding the function of the Imagination in Science, and notwithstanding the care that I took to define and illustrate its real province, many persons, amongst whom were one or two able men, deemed me loose and illogical; in fact, merely poetic, when I referred to the imagination. The history of science, however, numbers many men of strong poetic temperament, who, in the presence of a scientific problem, became as cold and clear as the light of stars. Look at these two pieces of polished steel. Have you a sense, or the rudiment of a sense, to distinguish the inner condition of the one from that of the other? And yet they differ materially, for one is a magnet, the other not. What enabled that noble philosopher, and pure and elevated character, Ampére, to surround the atoms of such a magnet with channels in which electric currents ceaselessly run, and to deduce from these pictured currents all the phenomena of ordinary magnetism? What enabled Faraday to visualise his lines of force, to follow them through magnets and through space until his mental picture became a guide to discoveries which have rendered this place immortal? What but imagination? I have reason to know but too well the fantastic, and even scandalous use that is made of the faculty when it is divorced from the disciplined understanding and handed over to the undisciplined passions and emotions. But this is not the scientific use of the imagination.

And now to return. Figure yourself on the deck of the *Irene*, with the invisible air stretching between you and the South Foreland, knowing that it contained something which stifled the sound, but not knowing what that something is. Your senses are not of the least use to you; you are unable to see, or hear, or feel, or taste, or smell the object of your search; nor could all the philosophical instruments in the world, as it now is, render you the least assistance. You cannot take a single step towards the solution without the formation of a mental image, in other words, without the exercise of the imagination. Let me unfold my own exact course of thought and action.

Sulphur in homogeneous crystals is exceedingly transparent to radiant heat, whereas the ordinary brimstone of commerce is highly impervious to it. Why? Because the brimstone of commerce does not possess the molecular continuity of the crystal, but is a mere aggregate of minute grains not in pefect optical contact with each other. When this is the case, a portion of the heat is always reflected on entering and quitting a grain. Hence when the grains are minute and numerous, this reflection is so often repeated that the heat is entirely wasted before it can plunge to any depth in the substance. A snowball is opaque to light for the same reason. It is not optically continuous ice, but an aggregate of grains of ice, and the light which falls upon the snow being reflected at the limiting surfaces of the snow granules, fails to penetrate the snow to any depth. Thus by the mixture of air and ice, two transparent substances, we produce a substance as impervious to light as a really opaque one. The same remark applies to foam, to clouds, to common salt, indeed to all transparent substances in powder. They are all impervious to light, not through the real absorption or extinction of the light, but through internal reflection.

Humboldt, in his observations at the Falls of the Orinoco, is known to have applied these principles. He found the noise of the Falls three times louder by night than by day, though in that region the night, through beasts and insects, is far noisier than the day. The plain between him and the Falls consisted of spaces of grass and rock intermingled. In the heat of the day he found the temperature of the rock to be 30° higher than that of the grass. Over every heated rock, he concluded, rose a column of air rarefied by the heat, and he ascribed the deadening of the sound to the reflections which it endured at the limiting surfaces of the rarer and denser air. This philosophical explanation made it generally known that a non-homogeneous atmosphere is unfavourable to the transmission of sound

But what on July 3, over a calm sea, where neither rocks nor grass existed, could so destroy the homogeneity

of the atmosphere as to enable it to quench, in so short a distance, so vast a body of sound? As I stood upon the deck of the *Irene*, pondering this question, I became conscious of the exceeding power of the sun beating against my back and heating the objects near me. Beams of equal power were falling on the sea, and must have produced copious evaporation. That the vapour generated should so rise and mingle with the air as to form an absolutely homogeneous mixture, I considered in the highest degree improbable. It would be sure, I thought, to streak and mottle the atmosphere with spaces, in which the air would be in different degrees saturated, or it might be displaced, by the vapour. At the limiting surfaces of these spaces, though invisible, we should have the conditions necessary to the production of partial echoes, and the consequent waste of sound.

Curiously enough, the conditions necessary for the testing of this explanation immediately set in. At 3.15 P.M. a cloud threw itself athwart the sun, and shaded the entire space between us and the South Foreland. The production of vapour was checked by the interposition of this screen, that already in the air being at the same time allowed to mix with it more perfectly; hence the probability of improved transmission. To test this inference the steamer was turned and urged back to our last position of inaudibility. The sounds, as I expected, were distinctly though faintly heard. This was at 3 miles' distance. At $3\frac{3}{4}$ miles we had the guns fired, both point blank and elevated. The faintest thud was all that we heard, but we did hear a thud, whereas we had previously heard nothing, either here or three-quarters of a mile nearer. We steamed out to $4\frac{1}{4}$ miles, when the sounds were for a moment faintly heard, but they fell away as we waited; and though the greatest quietness reigned on board, and though the sea was without a ripple, we could hear nothing. We could plainly see the steam-puffs which announced the beginning and the end of a series of trumpet-blasts, but the blasts themselves were quite inaudible.

It was now 4 P.M., and my intention at first was to halt at this distance, which was beyond the sound range, but not far beyond it, and see whether the lowering of the sun would not restore the power of the atmosphere to transmit the sound. But after waiting a little, the anchoring of a boat was suggested; and though loth to lose the anticipated revival of the sounds myself, I agreed to this arrangement. Two men were placed in the boat, and requested to give all attention so as to hear the sound if possible. With perfect stillness around them, they heard nothing. They were then instructed to hoist a signal if they should hear the sounds, and to keep it hoisted as long as the sounds continued.

At 4.45 we quitted them and steamed towards the South Sand Head lightship. Precisely fifteen minutes after we had separated from them the flag was hoisted. The sound, as anticipated, had at length succeeded in piercing the body of air between the boat and the shore.

On returning to our anchored boat we learned that when the flag was hoisted the horn sounds were heard, that they were succeeded after a little time by the whistle sounds, and that both increased in intensity as the evening advanced. On our arrival of course we heard the sounds ourselves.

The conjectured explanation of the stoppage of the sounds appeared to be thus reduced to demonstration, but we pushed the proof still further by steaming farther out. At $5\frac{3}{4}$ miles we halted and heard the sounds. At 6 miles we heard them distinctly, but so feebly that we thought we had reached the limit of the sound range. But while we waited the sound rose in power. We steamed to the Varne buoy, which is $7\frac{3}{4}$ miles from the signal station, and heard the sounds there better than at 6 miles distance.

Steaming on to the Varne lightship, which is situated at the other end of the Varne shoal, we hailed the master, and were informed by him that up to 5 P.M. nothing had been heard. At that hour the sounds began to be audible. He described one of them as "very gross, resembling the bellowing of a bull," which very accurately characterises the sound of the large American steam whistle. At the Varne lightship, therefore, the sounds had been heard towards the close of the day, though it is $12\frac{3}{4}$ miles from the signal station.

What is the full meaning of this result? Imagine a man in an anchored boat at 2 P.M. at a distance of 2 miles from the Foreland, and suppose him possessed of instruments which would enable him to measure the growing intensity of the sound. Applying the law of inverse squares, to carry the sound to six times the distance, its intensity at 2 miles would have to be augmented 36 times. But the Varne lightship is more than 6 times 2 miles from the Foreland. Supposing no absorption or partial reflection to occur, the observer would have found that by the lowering of the sun the sound at his position had at 6 P.M. risen to more than forty-fold the intensity which it possessed at 2 P.M. In reality the augmentation was still greater.

(*To be continued.*)

BIRMINGHAM NATURAL HISTORY AND MICROSCOPICAL SOCIETY

AT the annual *soirée*, held on Tuesday, December 16, 1873, celebrating the sixteenth year of the existence of the society, Mr. W. R. Hughes, F.L.S., the president, gave, at the request of the committee, an address on "The recent Marine Excursion made by the Society to Teignmouth." After alluding to the apt and graceful remarks of his predecessor in office (Rev. H. W. Crosskey, F.G.S.) twelve months ago, on the advantages of the study of Natural History, and then describing the preliminary arrangements in connection with the excursion which have already been detailed in NATURE, vol. viii. pp. 334 and 469, Mr. Hughes stated that upwards of 20 members of the society, including several ladies, proceeded from Birmingham and assembled at the headquarters at Teignmouth on Monday, September 1, on which day the dredging operations commenced on board the yacht *Ruby* with satisfactory results. These were carried on during the week, and have already been described in NATURE; the principal feature being the capture of the pedunculate form of *Antedon rosaceus* (*Comatula rosacea*), the rosy feather star, including representatives of 12 genera of Echinodermata and about 40 species of Hydrozoa and Polyzoa, the last of which had been mounted and presented to the society by his friend and colleague, Mr. A. W. Wills, to whom the Society were also indebted for life-like drawings of the *Antedon* in various stages of development.

Mr. Hughes then proceeded to speak of the moral of the marine excursion. So far as he was informed it was the first of its kind that had been undertaken by any society carrying on its operations in an inland district like Birmingham, far removed from the sea, and that point was in itself noteworthy, and might contribute to raise the status of the society and cause its example to be followed by others of a kindred nature. He thought it was pretty well agreed among the members that the excursion was attempted properly, and on the whole carried out successfully. The members who took part in it had been stimulated and encouraged in their project by the hearty and unanimous way in which it was adopted by others whose studies lay in different directions, by praise from NATURE, that most cultivated of scientific serials, and by "good words" from the local press. The results might not have satisfied all. Circumstances rendered the absence of many old supporters of the society unavoidable. It was planned a little too late in the season, and many of the microscopic animals they dredged had played their part in the great problem of life, and empty cells alone remained where many a delicate and beautiful organism had spread its feathery plumes "in the dark unfathomed caves of ocean." Too much time was devoted to the dredging, and not sufficient for subsequent investigation of the proceeds. Still the members had enjoyed the rare opportunity of examining many beautiful marine animals under the microscope which they could not have hoped for at home. And the excursion had done much to promote exchange of thought and friendliness among those taking part in it. Doubtless if a similar one were planned in 1874 the members would profit by the experience of the late one, and Mr. Hughes commended such to the consideration of the committee, and suggested that the members should make it the subject of their annual holiday, especially as ladies were now for the first time admissible as members. The President stated he could not close his remarks to an assembly composed of naturalists and those who had evinced a taste in their pursuits, without alluding to the fact that must have impressed most of them, viz.: that the study of marine zoology had in these days attained an interest second to that of no other branch of natural history, and that the existence and habits of the denizens of "the great and wide sea" were discussed as familiarly in the newspapers of the day as the events of social and political life. As further evidence, Mr. Hughes alluded to the record, almost surpassing any story in the "Thousand and One Nights" contained in that most charming of books "The Depths of the Sea," of the researches in deep-sea dredging, by Prof. Wyville Thomson, F.R.S., and Dr.

Carpenter, F.R.S., refuting the old theories of the non-existence of animal life at great depths, and bringing to light (with others) animals such as *Pentacrinus wyville-thomsoni* and *Bathycrinus gracilis*, pedunculate star-fishes allied to the *Comatula*, from 2,435 fathoms, whose very existence was unsuspected, and who were supposed "in the lapse of ages to have been worsted in the struggle for life." And following these investigations came the exploring expedition of H.M.S. *Challenger*, the most important mission of its kind that Great Britain had ever engaged in, from whence we now and then got stray tidings of yet more remarkable animals,—animals of comparatively high organisation, allied to the lobster, dredged up from 2,000 fathoms: in one individual, a gigantic amphipodal crustacean, "the eyes of the creature extended in two great facettic lobes over the whole of the anterior part of the cephalo-thorax, like the eyes *Æglina* among Trilobites" (NATURE, vol. vii. p. 388). In another, *Deidamia leptodactyle*, there were no traces whatever of eyes of sight or their pedicels (NATURE, vol. viii. p. 52). Further, from the enormous depth of 3,000 fathoms, or nearly $3\frac{1}{2}$ statute miles, "a depth which does not appear to be greatly exceeded in any part of the ocean," have been taken a tube-building annelid, its tube formed of the gritty matter which occurs but sparingly in the clay at the bottom, affording, in fact, as Prof. Wyville Thomson remarks, "conclusive proof that the conditions of the bottom of the sea to all depths are not only such as to admit of the existence of animal life, but are such as to allow of the unlimited extension of the distribution of animals high in the zoological series, and closely in relation with the characteristic faunæ of shallower zones (NATURE, vol. viii. p. 53).

Contemporaneously with these expeditions and what would appear to be not an inappropriate *sequitur*, marine aquaria of extensive size, and constructed on scientific principles, had been established in some of our principal towns, thus affording a new source of enjoyment and an intellectual gratification to the people—that of the examination of living marine animals as they exist "in the depths of the sea"—and combining with this in some instances a source of pecuniary benefit to the promoters. The public interest in these establishments seemed so great that the arrival of the octopus had attracted almost as much attention as the visit of a foreign emperor, and the death of the porpoise was mourned as a national calamity.

In conclusion the president said he hoped he had said something suggested by the recent marine excursion to interest the members in marine zoology. For his own part he could say that the little attention he had been able to devote to it had been a most acceptable relief to official duties (as Treasurer of the Borough), always laborious and responsible, and at the same time it had brought him in contact with fellow-workers in natural history from whose friendship and kindly intercourse he had derived the most lasting pleasure.

Mr. Hughes ventured to express his opinion that a Marine Aquarium, if constructed properly and managed efficiently—for instance like that beautiful one at the Crystal Palace under the direction of his friend, Mr. W. Alford Lloyd, who had done more for the advancement of public aquaria than any man living—would be most acceptable to Birmingham, where the great Priestley carried on his scientific researches, and in 1773 obtained the Copley medal of the Royal Society for the discovery of the mutual dependence of plants and animals on each other—the grand principle of all aquaria. It occurred to him after much thought, and as a successful student of marine aquaria for many years, that no greater attraction or means of intellectual recreation for the working classes and their neighbours in the mining districts could be devised, because it would be so utterly different from any other exhibition now existing, and so suitable as a relief and mental refreshment for those in crowded courts to whom the sea was but a name. It was indisputable that "the sea and its living wonders" had irresistible fascination to us far away from it. The peculiar central inland position of Birmingham would be highly advantageous by allowing ready and rapid modes of conveyance of rare animals from almost any part of the coast. He commended the project to the earnest consideration of the many wealthy and intellectual men in the town, and could not help believing and hoping—although his views as a naturalist might be sanguine—that Birmingham would sooner or later possess a marine aquarium worthy of it, and follow the example of London, Brighton, Liverpool, Manchester, Plymouth, and other large towns, which, besides others on the Continent, had already taken the matter up.

We understand that Mr. Hughes' suggestion has been acted upon, and that an influential committee has since been appointed to make inquiries with the view to the promotion of an efficient marine aquarium for Birmingham.

SCIENTIFIC SERIALS

Astronomische Nachrichten, No. 1,969, Jan. 9.—This number contains a paper by Prof. Spoerer on M. Faye's theory of solar spots. He refers to M. Faye's statement that spots are below the surface of the sun, and to his reliance on his treatment of Carrington's observations; for if a spot be observed for two or more revolutions its distance from the limb can be calculated on the assumption that the spot is on the surface of the sun. Should, however, the observed plan of the spot not agree with the calculated position, the assumption will be that the spot is below or above the vurface of the sun. Prof. Spoerer informs us that, on the whole, his observations show that the observed distance from the limb of the sun are too great; this he ascribes to the effect of refraction altering the position of the sun's limb to a greater degree than that of the spot.—On the identity of Coggia's Comet of Nov. 10, with Comet 1818 I. by Prof. Weiss. In this paper the author gives the elements of Coggia's comet as lately determined, together with the recorded observations of Comet 1818 I. from which he considers the two comets to be identical.—In a second paper by Prof. Weiss he gives elements calculated on a parabolic orbit and on two elliptic orbits of 55·82 and 6·9775 years respectively, being on the assumption in the first case thai one revolution has happened since 1818, and in the other that eight have taken place.—Observations on variable stars, by G. T. G. Schmidt. From observations up to the end of 1873, given at length in his paper, we extract the epochs of maxima and minima of the following stars:—

		Max.		Min.	
Mira Ceti	about	May 25		Jan. 30·5, 1873, mag. 9·5	
S Scorpii	,,	Sept. 13, mag. 10		—	,,
R Scorpii	,,	Aug. 27, mag. 10·8		—	,,
R Bootis	,,	Sept. 15,	—	—	,,
R Virginis	,,	July 27,	—	May 13	,,
S Coronæ	,,	July 6,	—	—	Period, 363 days.

	Max.	Min.	
R Leonis	May 18	—	
R Leporis	—	Jan. 29	
χ Bygni	Oct. 5	—	Period 404·7 days.
RScuti ...	May 13	June 16	
	July 9	Aug. 21	
	Sept. 20	Oct. 13	
	Nov. 4	—	

Wilhelm Schur gives an opposition ephemeris for Arethusa. The opposition happening Jan. 21, the R. A. being then

8 . 2 . 52.78 and Dec. + 4 . 1 . 54

The fourth line of the spectrum of the nebula in Orion, by D'Arrest. The author refers to a note on this line by Dr. Vogel in Astron. Nach., No. 1963, mentioning the fact that the fourth line of the nebula coincided with Hγ, and goes on to mention that this line was known to Huggins in 1864, and by Capt. Herschell in 1868, and was brought to the notice of the Royal Society in 1872 by Huggins. Its wave-length he gives as 4343. The author also mentions a peculiarity in the spectrum of B. Durchm + 22° 4203.—Mr. J. Birmingham states in a note that he believes that 252 Schjellerup has disappeared, and he thinks this star a remarkable variable.

Medizinische Jahrbücher: k.k. Gesellsch. d. Aerzte: Vienna, 1873, Heft 3 and 4.—The last two issues of this quarterly journal for 1873 contain the following papers of scientific interest:—Researches into the minute structure of the Tendon, by Arnold Spina, with an illustration; the Nerves of the Knee-Joint in the Rabbit, by Dr. C. Nicoladoni (with a figure); contributions to the Anatomy of the Human Bladder, by Dr. Gustav Jurie; Quarantine in Cholera, a report to the International Medical Congress, by Dr. Oser.

SOCIETIES AND ACADEMIES

LONDON

Zoological Society, Jan. 20.—Prof. Newton, F.R.S., vice-president, in the chair.—Mr. Sclater exhibited two skulls of Baird's Tapir (*Tapirus bairdi*) received from Mr. Constantine

Rickards, of Oaxaca, Mexico. The receipt of these specimens proved that this Tapir extended from Panama through Central America into Southern Mexico, and was probably the only species of this genus to be met with in America, north of the Panamanic Isthmus.—Mr. Sclater also exhibited and made remarks on skulls of *Ovis arkar*, from the Altai Mountains, and the stuffed skin of a specimen of the Wild Ibex of Crete.—Mr. E. Ward exhibited two feet of a Fawn, the mother of which had had double hind feet, and had for several years brought forth fawns having the same malformation.—A communication was read from Dr. O. Finsch containing a description of an apparently new species of Parrot from Western Peru, which was proposed to be called *Psittacula andicola*.—A second paper by Dr. Finsch contained the description of a new species of Fruit Pigeon from the Pacific Island of Rapa or Opara. This unique specimen had been sent to the author by Mr. F. W. Hutton, of Otago, New Zealand, after whom it was proposed to name the bird *Ptilonopus huttoni*.—A note was read by Major O. B. C St. John, on the locality of the Beatrix Antelope (*Oryx beatrix*), which was believed to be the south of Muscat.—Mr. Edward R. Alston read the description of a new Bat of the genus *Pteropus*, which had been sent to him from Samoa for identification by the Rev. S. J. Whitmee. Mr. Alton proposed to call this species *Pteropus whitmeei*.—A communication was read from Mr. A. G. Butler, containing a list of the species of *Fulgora*, with descriptions of three new species in the collection of the British Museum.—A communication was read from Mr. Herbert Druce, containing an account of the Lepidopterous Insects collected by Mr. E. Layard, at Chentaboon and Mahconchaisee, Siam, with descriptions of new species.

Meteorological Society, Jan. 21.—Dr. R. J. Mann, president, in the chair.—The date of the annual meeting having been altered in June last to January, the report of the Council was shorter than usual. The Council have been making efforts to render the operations of the Society more extended. They took advantage of the presence of their foreign secretary, Mr. Scott, as one of the delegates from this country, at the Meteorological Congress at Vienna, to request him to represent the Society. The congress was duly held from September 1st to 16th, when Mr. Scott presented a report on the replies received in answer to a series of questions which the Council issued to the Fellows on several important points in connection with the hours of observation, instruments, &c., and which has been printed in the report of the Congress. The report concluded by stating that the Council have to mark, with some measure of satisfaction, the maintenance of the numbers of the Society during a somewhat critical and transitional period in its history, when changes of detail have been entered upon with a view to increased energy of action, and when the beneficial results of the alterations have not yet had time to be practically felt. The president then delivered his address. After alluding to the loss which the Society had recently sustained in the death of Mr. Beardmore, and marking the place that gentleman had filled as president at the transition era of the Society's history, the president drew attention to a misconception that is largely entertained of the primary aims of meteorological science, and pointed out that desirable as a comprehensive and reliable theory is, the immediate object of observational work is none the less certainly the determination of climate in different regions of the earth, and the investigation of the method by which the action of the great natural forces that determine temperature, direction and force of wind, and rainfall, is influenced by physical conditions. This argument was supported by evidence of the valuable practical results that are secured in these particulars by the labours of meteorologists. The address then proceeded to note briefly the chief landmarks that had marked the yearly progress of meteorological science since the period of Mr. Beardmore's presidency, when the Society, in its remodelled form, had just reached the half-way stage of its history. From this review it appeared that the photographic method of record has been largely extended; that the discussion of the Greenwich observations from 1848 to 1868 is being steadily pursued; that the influence of meteorological conditions upon the public health is carefully investigated in the metropolitan district; that telegraphic intercommunication of meteorological aspects is now regularly made throughout the United States of America; and from the Meteorological Office of London through England, and through France to the shores of the North Sea and Baltic in one direction, and to Corunna in the other; and that storm-warnings are displayed and fishermen's barometers maintained at 129 coast stations. The methodical investigation of the connection of sun-spot periods with atmospheric phenomena, such as rainfall, auroræ, and magnetic storms and earth-currents was also alluded to. Among other topics of special interest connected with the recent progress of meteorological science, the president dwelt with special favour and affection upon the discovery and establishment of Buys Ballot's law and Mr. T. Stevenson's barometric gradient; the extension of the influence which indicates this law to the great vertical circulation of the oceans, traced out by Dr. Carpenter and Prof. Wyville Thomson; the marine charts, and especially the mapping out of the mid-Atlantic area of the Doldrum calms, by Capt. Toynbee; Mr. Meldrum's Mauritius investigations of the movements of the cyclones of the Indian Ocean; the daily weather charts of the Meteorological Office; the deleterious physiological influence of the recent heavy fog in London; Mr. Symond's examination of the rainfall of the British Islands, with a volunteer staff of 1,700 observers systematically distributed; Mr. Draper's deductions as to the invariability of the climate of the United States, and to the orderly progress of storms across the entire breadth of the Atlantic; the establishment and work of International Meteorological conferences; and the barometric compensation of clock-rates for altering pressure and resistance of the atmosphere.—The following gentlemen were elected officers and council for the ensuing year:—President—R. J. Mann, M.D., F.R.A.S. Vice-Presidents—C. Brooke, M.A., F.R.S.; G. Dines; H. S. Eaton, M.A.; Lieut.-Col. A. Strange, F.R.S. Treasurer—H. Perigal, F.R.A.S. Trustees—Sir Antonio Brady, F.G.S.; S. W. Silver, F.R.G.S. Secretaries—G. J. Symons; J. W. Tripe, M D. Foreign Secretary—Robert H. Scott, F.R.S. Council—Percy Bicknell; A. Brewin, F.R.A.S.; C. O. F. Cator, M.A.; R. Field, B.A., Assoc. Inst. C.E.; F. Gaster; J. K. Laughton, F.R.A.S.; R. J. Lecky, F.R.A.S.; W. C. Nash; Rev. S. J. Perry, F.R.A.S.; Capt. H. Toynbee, F.R.A.S.; C. V. Walker, F.R.S.; E. O. Wildman Whitehouse, Assoc. Inst. C.E.

Entomological Society, Jan. 5.—Prof. Westwood, president, in the chair.—Mr. Meldola exhibited some photographs of minute insects taken with the camera-obscura and microscope. —Mr. McLachlan called attention to a paper in the last part of the "Annales de la Soc. Ent. de France," by M. Bar and Dr. Laboulbène on a species of moth belonging to the *Bombycidæ*, described and figured by M. Bar as *Palustra laboulbenei*, and of very extraordinary habits, the larva being aquatic, living in the canals of the sugar plantations in Cayenne, and feeding upon an aquatic plant. The hairy larva breathed by means of small spiracles, a supply of air being apparently entangled in its hairs. —Mr. Butler remarked that Mr. J. V. Riley, in the *Journal* of the St. Louis Academy of Sciences, had alluded to *Apatura lycaon* Fab. and *A. hyrse* Fab. as distinct species, whereas he believed them to be identical with the *A. alicia* Edwards.—A letter from M. Ernest Olivier stated that he had recently come into possession of a portion of the collection of his grandfather, the celebrated French coleopterist, and that he would be happy to show it to any entomologist who might desire to examine the types.—Mr. Smith communicated a paper on the hymenopterous genus *Xylocopa*; and Mr. D. Sharp a paper on the *Pselaphidæ* and *Scydmænidæ* of Japan, from the collections of Mr. George Lewis.

EDINBURGH

Royal Society, Jan. 19.—Principal Sir Alex. Grant, vice-president, in the chair.—The following communications were read:—Additional remarks on the fossil trees of Craigleith quarry, by Sir Robert Christison, Bart.—On a method of demonstrating the relations of the convolutions of the brain to the surface of the head, by Prof. Turner.—On some peculiarities in the embryogeny of *Tropæolum speciosum*, Endl. and Poepp., and *T. peregrinum*, L., by Prof. Alex. Dickson.—Notes on Mr. Sang's communication of April 7, 1873, on a singular property possessed by the fluid enclosed in crystal cavities. (1) By Prof. Tait; (2) By Prof. Swan.—Preliminary note on the sense of rotation, and the function of the semicircular canals of the internal ear, by Prof. Crum-Brown.

DUBLIN

Royal Zoological Society of Ireland, Jan. 13.—His Excellency, Earl Spencer, president, in the chair.—The report was read by the Rev. Prof. Haughton, M.D., secretary, who referred, among other matters, to the loss by death of an old pelican (*Pelicanus onocrotalus*) "who had been domiciled in the Gardens for forty-two years. He was supposed to have been

eight years of age upon his admission, so that he was a bird of over fifty at the time of his death.—Every effort was made to prolong his valuable existence by feeding him on live eels and whisky punch; but old age prevailed, and he died peaceably on the approach of the cold weather. He drank the punch with great relish; in fact he had resided so long in Dublin that it must have come naturally to him, and this and the live eels prolonged his life for at least a fortnight." We are sorry to see the funds of the society are not in a very thriving condition.

VIENNA

I. R. Geological Institute, Nov. 18.—The director, F. v. Hauer, stated that towards the end of the international exhibition he had asked almost all Austrian and a great many of the foreign exhibitors of ores, coals, or other useful minerals, to present these objects to the museum of the Institute. This request was very successful, more than a hundred exhibitors have offered the whole or parts of their expositions to the Institute, and the number of the donators is increasing still every day. Out of the objects obtained in this way will be formed a particular collection of useful minerals from Austria and from abroad, embracing ores, coals, salts, building-stones, all sorts of useful clays, limestones, &c., minerals used for colours, for dung, &c. This collection, which will contain generally specimens of large size, will form quite a new and, as he hopes, very interesting branch of the museum.—Dr. R. v. Drasche: Geological observations on a journey to the west coast of Spitzbergen during the summer of 1873. The journey was made in a schooner chartered especially for the purpose. Dr. Drasche left Tromsöe on June 30, went to the north till Amsterdamö in 79° 45′ N. lat., and returned to Hammerfest on August 27. Many very interesting observations and large collections of rocks and fossils are the fruit of the expedition. Here we will give only a few particulars: On the flat land which forms the eastern part of Danskö and Amsterdamö, Dr. Drasche found very large masses of erratic boulders, which consist partly of certain varieties of granites, syenites, and gneiss, unobserved till now on the shores of Spitzbergen. Probably they are brought down by glaciers out of the interior of the island. The Hekla Hook formation (Nordenskiöld), which is probably Devonian, is formed in the Belsund by black limestones and chloritic slates, which resemble very much the Taunus-slates. The mountain limestone formation is developed in large masses and with many fossils in the Belsund and on the island of Azelö. On Cape Staratschin the mountain limestone alternates with very fine Hyperith. The Triassic formation was accurately studied on Cape Thordsen; it contains here many Ceratites, Nautilus, Halobia, &c, besides which were found the remains of a saurian. The Jurassic and the Tertiary formation are formed by marly beds in the Ice-fiord, and can scarcely be separated from each other whenever they do not contain fossils. On the Goose Island in the Ice-fiord Dr. Drasche found proofs of a very recent levation of the ground. From 8 ft. to 10 ft. above the highest level of the sea the ground is covered with shells of *Mytilus edulis*, which have preserved perfectly well their bluish colour.—M. Niedzwiedzki has examined the microscopical structure of a large number of the eruptive rocks of the Banat which by Prof. Cotta had been united under the name "Banatites." He found that the mineral which mostly prevails is a plagioklastic feldspar out of the Andesin series. He concludes therefore that the rocks from Dognacska, Oravitza, and Csiklova, which hitherto generally had been called Syenites, are rather to be considered as quartz-bearing Diorites. The basalt, which transverses in small veins the "Banatite" from Moldova contains, besides a vitreous ground-mass, only Augite, Olivine, Biatite, and Magnetite, and therefore cannot be united with any one of the great divisions of the basalt rocks.

PHILADELPHIA

Academy of Natural Sciences, Sept. 23.—"Exceptional Conditions in the Vegetation of Forest Seed," by Mr. Thomas Meehan.—Mr. T. Meehan also presented some specimens of a malformed clover, *Trifolium pratense*.—Mr. Gentry made the following remarks regarding the nest of *Vireo solitarius* (Vieil). Audubon, in describing the nest of *Vireo solitarius* (Vieil.) affirms it "is prettily constructed and fixed in a partially pensile manner between two twigs of a low bush, on a branch running horizontally from the main stem, and formed externally of grey lichens, slightly put together, and lined with hair chiefly from the deer and racoon." My experience has been quite different. I have five nests of this species, four of which are perfectly similar in structure; the remaining one formed of the culms of a species of *Aira*, constituting an exceptional case, and the only one that has ever fallen under my notice. They are all shallow, loose in texture, scarcely surviving the season for which they were designed, and placed between two twigs of a cedar or a maple tree at a considerable elevation from the ground, on a branch nearly horizontal to the main axis. They are built entirely of clusters of male flowers of *Quercus palustris*, which, having performed their allotted function, don their brownish hue at the very period when they can be utilised. Here is evidently a change within a moderately short period, rendered necessary by external causes. This necessity may have grown out of inability to procure the favourite materials, or a desire for self-preservation. I am satisfied, however, that the former has not been the leading one, but that self-preservation has operated in this case for individual and family good.

PARIS

Academy of Sciences, Jan. 19.—M. Bertrand in the chair.—The following papers were read:—On the theory of shocks, by M. H. Resal.—Memoir on the temperatures observed by means of electric thermometers, at the Jardin des Plantes, from the surface of the ground to a depth of thirty-six metres during the meteorological year 1873, by M.M. Becquerel and E. Becquerel.—On the formation, in the gaseous state, of the oxides of nitrogen from their elements by means of heat, by M. Berthelot. The paper dealt with the thermal phenomena accompanying these formations.—On the discovery of a deposit of bismuth in France, by M. Ad. Carnot.—On organogenesis compared with androgenesis, &c., by M. Ad. Chatin.—On the geometrical properties of rational fractions, by M. F. Lucas.—On the vibratory movement of an elastic wire fastened to a tuning-fork, by M. E. Gripon.—On the measurement of the magnetic movement in very small magnetised needles, by M. E. Bouty.—On the modes of forming black phosphorus, by M. E. Ritter. The author stated that certain samples of phosphorus refuse to blacken when heated to 70°, while others show that property. The latter contain a trace of arsenic, and to arsenide of phosphorus the author attributed the blackening. He gave analysis of the arsenide which agree with the formula As_2P.—On the existence of two isomeric modifications of anhydrous sodic sulphate, by M. L. C. de Coppet.—On the solubility of succinic acid in water, by M. E. Bourgoin.—On a new cause of spontaneous gangrene accompanied by obliteration of the capillary arteries, by M. L. Tripier.—On the pathological development of the eye in the so-called telescope fish, by M. G. Camuset.—During the meeting, the places of MM. Petit and Valz, in the Astronomical section, were filled up. For the first, Dr. Huggins obtained 38 votes, M. Stéphan 2, and Mr. Newcomb 1; for the second, Mr. Newcomb obtained 46 votes, and M. Stéphan, 1; Messrs. Huggins and Newcomb were accordingly elected.

CONTENTS

THURSDAY, FEBRUARY 5, 1874

SCIENTIFIC WORTHIES

II.—Thomas Henry Huxley

THOMAS HENRY HUXLEY was born at Ealing, on May 4, 1825. With the exception of two and-a-half years spent at the semi-public school at Ealing, of which his father was one of the masters, his education was carried on at home, and in his later boyhood, was chiefly the result of his own efforts. In 1842 he entered the medical school attached to Charing Cross Hospital, where, at that time, Mr. Wharton Jones, distinguished alike as a physiologist and oculist, was lecturing on Physiology. In 1845 Mr. Huxley passed the first M.B. examination at the University of London, and was placed second in the list of honours for Anatomy and Physiology, the first place being given to Dr. Ransome, now of Nottingham. After some experience of the duties of his profession among the poor of London, in 1846 he joined the medical service of the Royal Navy, and proceeded to Haslar Hospital. From thence he was selected, through the influence of the distinguished Arctic traveller and naturalist, Sir John Richardson, to occupy the post of Assistant-Surgeon to H.M.S. *Rattlesnake*, then about to proceed on a surveying voyage in the Southern Seas. The *Rattlesnake*, commanded by Captain Owen Stanley, with Mr. MacGillivray as naturalist, sailed from England in the winter of 1846. She surveyed the Inner Route between the Barrier Reef and the East Coast of Australia and New Guinea, and after making a voyage of circumnavigation, returned to England in November 1850. During this period Mr. Huxley investigated with a success known to all naturalists, the fauna of the seas which he traversed, and sent home several communications, some of which were published in the "Philosophical Transactions" of the Royal Society. The first which so appeared, presented by the late Bishop of Norwich, and read June 21, 1849, bears the title "On the Anatomy and Affinities of the Family of the Medusæ." This was, however, not Mr. Huxley's first scientific effort. While yet a student at Charing Cross Hospital, he had sent a brief notice to the *Medical Times and Gazette*, of that layer in the root-sheath of hair which has since borne the name of Huxley's Layer. Shortly after his return he was (June 1851) elected a Fellow of the Royal Society.

In 1853 Mr. Huxley, after vainly endeavouring to obtain the publication by the Government of a part of the work done during his voyage, left the naval service, and in 1854, on the removal of Edward Forbes from the Government School of Mines to the chair of Natural History at Edinburgh, succeeded his distinguished friend as Professor of Natural History in that institution, a post which he has continued to hold up to the present day. Since that time Mr. Huxley has lived in London a life of continued and brilliant labour. From 1863 to 1869 he held the post of Hunterian Professor at the Royal College of Surgeons. He was twice chosen Fullerian Professor of Physiology at the Royal Institution of Great Britain. In 1869 and 1870 he was President of the Geological Society, having previously served as Secretary. During the same period he was President of the Ethnological Society. In 1870 he filled the office of President of the British Association for the Advancement of Science, and in 1872 was elected Secretary to the Royal Society. He has been elected a corresponding member of the Academies of Berlin, Munich, St. Petersburg, and of other foreign scientific societies, has received honorary degrees from the Universities of Breslau and Edinburgh, and last year was presented with the Order of the Northern Star by the King of Sweden. Since 1870 he has been one of the Members of the Royal Commission on Scientific Instruction and the Advancement of Science. From 1870 to 1872 he served on the London School Board as one of the members for Marylebone, and during that time was Chairman of the Education Committee which arranged the scheme of education adopted in the Board Schools. In 1872 he was elected Lord Rector of the University of Aberdeen.

In this skeleton narrative of the career of this distinguished naturalist we have purposely omitted any list or any critical estimate of his writings; but we have great pleasure in laying before our readers, as a token of what is thought of him by those who are labouring in the same field of Science, the following communication from one who ranks in his own country as well as among ourselves as one of the very first of German naturalists.

The more general, year by year, the interest taken by all educated people in the progress of Natural Science, and the wider, day by day, the field of Science, the more difficult is it for the man of science himself to keep pace with all the advances made—the smaller becomes the number of those who are able to take a bird's-eye view of the whole field of science, and in whose minds the higher interest of the philosophical importance of the whole is not lost amid a crowd of fascinating particulars. Indeed if at the present moment we run over the names distinguished in the several sciences into which Natural Knowledge may be divided —in Physics, in Chemistry, in Botany, in Zoology—we find but few investigators who can be said to have thoroughly mastered the whole range of any one of them. Among these few we must place Thomas Henry Huxley, the distinguished British investigator, who at the present time justly ranks as the first zoologist among his countrymen. When we say the first zoologist, we give the widest and fullest signification to the word "zoology" which the latest developments of this science demand. Zoology is, in this sense, the entire biology of animals; and we accordingly consider as essential parts of it the whole field of Animal Morphology and Physiology, including not only Comparative Anatomy and Embryology, but also Systematic Zoology, Palæontology and Zoological Philosophy. We look upon it as a special merit in Prof. Huxley that he has a thoroughly broad conception of the science in which he labours, and that, with a most careful empirical acquaintance with individual phenomena, he combines a clear philosophical appreciation of general relations.

When we consider the long series of distinguished memoirs with which, during the last quarter of a century, Prof. Huxley has enriched zoological literature, we find that in each of the larger divisions of the animal kingdom we are indebted to him for important discoveries.

From the lowest animals, he has gradually extended his investigations up to the highest, and even to man. His earlier labours were, for the most part, occupied with the lower marine animals, especially with the pelagic organisms swimming at the surface of the open sea. He availed himself of an excellent opportunity for the study of these, when on board H.M.S. *Rattlesnake* on a voyage of circumnavigation, which took him to many most interesting parts of tropical oceans little investigated, previously, by the zoologist; especially the coasts of Australia. Here he was able to observe, in their living state, a host of lower pelagic animals, some of which had not at all been studied, others but imperfectly. In the Protozoa, he was the first to lead us to satisfactory conclusions concerning the nature of the puzzling Thalassicollidæ and Sphærozoida. Our knowledge of Zoophytes has be n greatly extended by his splendid work on "Oceanic Hydrozoa," in which, chiefly, the remarkable S phenophora, with their largely developed polymorphism and the instructive division of labour in their individual organs, are described with very great accuracy.

Already in his first work "On the Anatomy and the Affinities of the Medusæ," 1849, he directed attention to the very important point, that the body of these animals is constructed of two cell layers—of the Ectoderm and the Endoderm—and that these, physiologically and morphologically, may be compared to the two germinal layers of the higher animals. He has made us better acquainted with several interesting members of the class Vermes, Sagitta, Lacinularia, some lower Annulosa, &c. He was the first to point out the affinities of Echinodermata with Vermes. In opposition to the old view, that the Echinodermata belong to the Radiata, and, on account of their radial type, are to be classed with corals, medusæ, &c., Huxley showed that the whole organisation of the former is essentially different from that of the latter, and that the Echinoderms are more nearly related, morphologically, to worms. Further he has essentially enlarged our knowledge of the important group of Tunicata by his researches on the Ascidians, Appendicularia, Pyrosoma, Doliolum, Salpa, &c.

Many important advances in the morphology of the Mollusca and Arthropoda are also due to him. Thus, *e.g.*, he has greatly elucidated the controverted subject of the homology of regions of the body in the various classes of Mollusca. He has considered the generation of vinefretters from quite a new point of view, based on his "genealogical conception of animal Individuality." But it is the comparative anatomy and classification of the Vertebrata which, during the last ten years, he has especially studied and advanced. His excellent "Lectures on the Elements of Comparative Anatomy" afford abundant proof of this, to say nothing of his numerous important monographs, especially those on living and extinct fish, amphibians, reptiles, birds, and mammals.

Huxley's works on the comparative anatomy of the Vertebrata are the only ones which can be compared with the otherwise incomparable investigations of Carl Gegenbaur. These two inquirers exhibit, particularly in their peculiar scientific development, many points of relationship. They both belong to that small circle of morphologists which is marked by the names of Caspar Friedrich Wolff, George Cuvier, Wolfgang Goethe, Johannes Müller, and Carl Ernst von Baer.

More important than any of the individual discoveries which are contained in Huxley's numerous less and greater researches on the most widely different animals are the profound and truly philosophical conceptions which have guided him in his inquiries, have always enabled him to distinguish the essential from the unessential, and to value special empirical facts chiefly as a means of arriving at general ideas. Those views of the two germinal layers of animals which were published as early as 1849 belong to the most important generalisations of comparative anatomy; they already contain in germ, the idea of the "perfect homology of the two primary germinal layers through the whole series of animals (except protozoa)," which first found its complete expression, a short time since, in the "Gastræa theory;" also his researches on animal individuality, his treatment of the celebrated vertebral theory of the skull, in which he first opened out the right track, following which Carl Gegenbaur has recently solved in so brilliant a manner this important problem, and above all his exposition of the Theory of Descent and its consequences, belong to this class. After Charles Darwin had, in 1859, reconstructed this most important biological theory, and by his epoch-making theory of Natural Selection placed it on an entirely new foundation, Huxley was the first who extended it to man, and in 1863, in his celebrated three Lectures on "Man's Place in Nature," admirably worked out its most important developments. With luminous clearness, and convincing certainty, he has here established the fundamental law, that, in every respect, the anatomical differences between man and the highest apes are of less value than those between the highest and the lowest apes. Especially weighty is the evidence adduced, for this law, in the most important of all organs, the brain; and by this, the objections of Prof. Richard Owen are, at the same time, thoroughly refuted. Not only has the Evolution Theory received from Prof. Huxley a complete demonstration of its immense importance, not only has it been largely advanced by his valuable comparative researches, but its spread among the general public has been largely due to his well-known popular writings. In these he has accomplished the difficult task of rendering most fully and clearly intelligible, to an educated public of very various ranks, the highest problems of philosophical Biology. From the lowest to the highest organisms, from Bathybius up to man, he has elucidated the connecting law of development.

In these several ways he has, in the struggle for truth, rendered Science a service which must ever rank as one of the highest of his many and great scientific merits.

ERNST HAECKEL

ZOOLOGICAL NOMENCLATURE

The Object and Method of Zoological Nomenclature. By David Sharp. (E. W. Janson and Williams and Norgate, 1873.) Pp. 39.

ZOOLOGISTS and botanists universally adopt what is termed the binomial system of nomenclature invented by Linnæus. The essential principle of this system is, that every species of animal or plant is to have a name made up of two words, the second word—which is

called the specific or trivial name, having exclusive reference to the species itself, the first word—which is called the generic name, indicating the genus, or small natural group, which comprises the species in question along with others. Thus the cat, the tiger, and the lion, belonging to one genus or small natural group of closely-allied animals, are called respectively, *Felis cattus*, *Felis tigris*, and *Felis leo*. The name of each species, therefore, shows us what group it belongs to, and thus gives us a clue to its affinities ; and the system of nomenclature is to this extent classificatory. But, as the true natural grouping of species has not yet been agreed upon by naturalists, and genera have been in a state of incessant change from the time of Linnæus to the present hour (or for about a century), the names of an immense number of species have been repeatedly altered ; and one of the first requisites of a good system of nomenclature—that the same object shall always be known by the same name—has been lost, in the attempt to make the name a guide to classification, while the classification itself has ever been fluctuating and still remains unsettled. As an example let us take the Snowy Owl. This has been placed by different ornithological authors in the genera Bubo, Strix, Noctua, Nyctea, Syrinium, and Surnia ; and at the same time, owing to carelessness or error, a number of different specific or trival names have also been used, such as *scandiaca*, *artica*, *nivea*, *erminea*, *candida*, and *nyctea;* and the various combinations of these two sets of names have led to the use of about twenty distinct appellations for this single species of bird. This example is by no means a very extreme one ; and it represents what occurs over and over again, in varying degrees, in every department of zoology and botany.

In order to determine in every case which of the names which are or have been in use is the right name, and so arrive at uniformity of nomenclature, certain rules have been pretty generally agreed upon, the most important of which is that of "priority." This means that the first name given to a species is to be the name used, even when it has never come into general use, but is now discovered in some scarce volume dated 80 or 100 years ago. But this absolute law of priority only applies to the specific or trivial name ; in the case of the generic name no such absolute priority has been thought possible, because the genera of the old authors were very extensive groups, which have now been divided, in some cases into hundreds of genera. This process of division has, however, gone on step by step, one author dividing an old genus into three or four new ones, with new names ; another dividing some of these still further, with more new names ; another perhaps discovering that these genera were not natural, and grouping the species into genera on altogether different principles, and again giving new names. Genera have been thus subdivided to such an extent that the owls, for example, which Linnæus classed as one genus, now number more than fifty ; and the ten British owls have to be placed in nine distinct genera.

In the very ingenious and careful essay which has led to these remarks, Mr. David Sharp, a well-known entomologist, advocates a mode of attaining the great desideratum of naturalists—a fixed and uniform nomenclature of species—which has not, so far as we are aware, been suggested before, although it is at once simple and logical. He proposes that, not merely one-half, but the entire name of every species once given, should be inviolable, until by general consent some permanent classificatory system of naming species, analogous to that used in chemistry, is arrived at. The insect named by Linnæus *Papilio dido* should, for example, retain that name, although it must find its classificatory place in the genus Colœnis and the family Nymphalidæ ; while the glossy starling of the East should retain the name *Turdus cantor*, given to it by Gmelin, although it is no thrush, and belongs to the genus Calornis. The name would thus remain fixed, however the place of the species in our classifications might be changed ; and the very errors of the original describers might help us to remember the object referred to by directing our attention to the cause of their error in classifying it. A beginner might, it is true, be misled, but the mistake once pointed out, the very inappropriateness of the name would serve us an aid to memory, as in the well-known "*lucus a non lucendo*." It is also pointed out that the value of the binomial nomenclature as a guide to the affinities of a species is now almost lost, owing to the minute subdivision of the old well-marked groups and the consequent multiplication of genera. No one can remember the names of all the genera of beetles now that they exceed ten thousand, unless he devotes his life to their study ; and even then the fixity of the names of all the old and well-known species would be a great help in the study of new classifications, or the use of modern catalogues.

A great evil of the present system is, that while professing to keep the specific or trivial name inviolable, it often compels an entire change of name. This happens whenever, by a new arrangement, a species has to be placed in a genus which already contains the same trivial name. Two species thus come to have the same name, and one of these must be wholly changed. The evil of this system of perpetually changing names is not so much the trouble it gives us to find out what object a name really refers to (though that is serious) as the enormous waste of labour involved in the elaborate working out of synonomy, rendered many fold more difficult by the complication of changes in both the generic and specific names, from a variety of causes. These difficulties are much greater in the case of genera than in that of species; and this portion of synonomy would be almost got rid of if it were decided that the first binomial name given to a species should never be changed. We should then avoid the absurdity of having hundreds of familiar names abolished, because a mere compiler of an early catalogue, who had perhaps never seen the objects themselves, divided them up almost at random into a number of named groups, or because some modern student thinks it advisable to split up every large genus into dozens of smaller ones.

These appear to be weighty arguments in favour of Mr. Sharp's proposal, yet we are far from thinking that it will be adopted. For, after all, the changed names are but few in comparison with those which remain unchanged for considerable periods ; and the charm of a nomenclature which is to a considerable extent classificatory is so great, that most naturalists will strongly object to giving it up. So long as the old name keeps within the bounds of the modern family (which is in most cases a

stable and well-defined group) there might be little objection to retaining it; but when it leads to the use of a name indicating a distinct and often quite unrelated family—as *Silpha scabra* for one of the Lamellicornes, (*Trox scabra*) in the example given by Mr. Sharp—the system will, we apprehend, be almost unanimously rejected.

Many minor details of nomenclature are discussed in the essay before us, and on some of these the author's views are more likely to meet ultimately with general acceptance. He objects strongly, for example, to the common practice among classical purists of altering all names which they consider to be not properly spelt or not constructed on true classical principles. For, as he justly remarks, the emenders can give no guarantee that their alterations will be permanently accepted, since others may come after them who will have different views as to classical orthography and propriety of nomenclature. He points in particular to the inconvenience of placing an H before many names which were originally spelt with a vowel, thus altering their places in an alphabetical arrangement, and creating a synonym for no useful purpose whatever.

Although it appears to us pretty certain that the plan of returning to the first generic name given to a species will not be adopted, the proposal to do so may lead to a reconsideration of the practice of applying the law of priority to generic names, as all are agreed it must be applied to specific or trivial names. If the generic part of the name may be altered any number of times in accordance with altered views as to classification, the principle of priority in the mere name is so totally given up, that it seems absurd to use it for the purpose of resuscitating the obsolete appellations of early writers. When an author is admitted to have defined a natural genus, he should have full power to give a name to that genus, because it is really a new thing; and it is both illogical and inconvenient to reject his name because some former writer has given another name to a group, not the same, but which merely happened to contain some one or more of the same species. Again, we think Mr. Sharp's arguments suggest the advisability of opposing the splitting up of large genera into many smaller ones otherwise than provisionally; the old generic name continuing to be used till there is a concurrence of opinion as to the necessity of adopting the new ones. The older authors were often modest enough to do this; indicating natural divisions of large genera, but not naming them; whereas modern naturalists, as a rule, feel bound to give a new name to every fragment they can split off an established genus.

It appears, then, to the present writer, that the plan best adapted to lead speedily to a fixed nomenclature, and at the same time one that will least offend the prejudices of zoologists, is as follows:—

1. To adopt, absolutely and without exception, the principle of priority as regards specific or trivial names.

2. To adopt the same principle for genera only so long as the generic character or definition of the genus remains unaltered; but whenever an original investigator defines a genus more completely than has been done before, he is to be left free to name it as he pleases. Every consideration of utility and common sense will of course lead him to retain a name already in use when the new genus does not materially differ from an older one: but of that he is alone the judge, and it should be absolutely forbidden to any third party to say that a name so given must be changed.

3. Whenever genera which are widely recognised are split up into a number of proposed smaller ones, the old generic name should continue in use till further investigation determines whether the new groups are sufficiently well defined and natural to supplant the old one.

In conclusion, it may be suggested that if zoologists who have paid attention to this subject would, after a careful consideration of Mr. Sharp's paper, state their own conclusions in the form of short propositions, accompanied by their reasons for them, a notion might be obtained, not only as to which system is intrinsically the best, but, what is of equal or perhaps greater importance, which is most likely to command general assent.

ALFRED R. WALLACE

RESULTS OF THE FRENCH SCIENTIFIC MISSION TO MEXICO

Mission Scientifique au Mexique et dans l'Amerique Centrale. Recherches Zoologiques publiées sous la direction de M. Milne-Edwards. Livraisons 4. (Paris: 1870-72.)

THE ill-fated attempt of the Second Empire to establ Imperialism in Mexico has had at least one good result in the work now before us, in which the labours of a Scientific Mission originally sent out under the shadow of the French Army are given to the world. The materials accumulated by M. Bocourt and his Fellow-Naturalists, were deposited in the National Museum of the Jardin des Plantes, and the elaboration of them entrusted to special workers in the different branches of science. In 1870 three livraisons were issued, each forming the commencement of a separate section of the work, as planned out under the direction of M. Milne-Edwards. These relate to the terrestrial and fluviatile Molluscs, by MM. Fischer and Crosse; to the Orthopterous Insects and Myriapods, by M. Henri de Saussure; and to the Reptiles and Batrachians, by MM. Auguste Duméril and Bocourt. The fall of the Empire and German occupation stopped the immediate progress of the work, but we are glad to see it has now been resumed. A second livraison of the section devoted to the Myriapods, prepared by MM. H. de Saussure and Humbert, has been lately issued, and we believe it is fully intended to bring the work to a conclusion. It will be observed that authors engaged on the various sections are all well-known authorities on the subjects of which they treat, and that the figures and illustrations are of an elaborate character. We are the more glad to call the attention of our readers to the revival of this work, because it does not appear to be very generally known to naturalists, and because it has lately been the subject of a most unjustifiable attack in an English scientific periodical.* After a general condemnation of the work we are there informed that it is "a lamentable exhibition of the very backward state of zoological science in

* Ann. Nat. Hist. for August 1873.

the French capital." As to the justice of this remark we need only appeal to the recent numbers of the "Annales des Sciences Naturelles" and the "Nouvelles Annales du Musée," which are replete with zoological memoirs of the highest interest, and to the great work on fossil birds, by Alphonse Milne-Edwards, recently completed, which is alone sufficient to refute such a sweeping accusation. That the spirit of scientific enterprise is still alive in France is, moreover, sufficiently manifest by the grand researches of Père David in Chinese Tibet, and of Grandidier in Madagascar, while there is certainly no lack of scientific experts to bring their discoveries before the public. A more baseless and unjust attack was certainly never penned against the savants of a sister nation.

But when our English critic proceeds to suggest that either the general editor of the present work, Prof. Milne-Edwards, or the joint author of the part devoted to the Reptilia—the late Prof. Dumeril (for his remarks may be intended for either of these gentlemen)—has appropriated the funds devoted to its preparation and left the labour to be performed by some inferior subordinate, the matter becomes still more serious. It is, however, sufficient to reply that no sort of evidence is given to support these statements, and that the value of Dr. Gray's *ipse dixit* is not sufficiently appreciated among naturalists to induce them to accept such an impossible supposition.

OUR BOOK SHELF

Sahara and Lapland. Travels in the African Desert and the Polar World. By Count Goblet D'Alviella. Translated from the French by Mrs. Cashel Hoey. (London: Asher and Co., 1874.)

AT first sight it would seem that no two countries had less in common than the two about which this book is written; but Count D'Alviella ingeniously and correctly shows, in his thoughtful preface, that they, or rather the Lapps and Arabs, have many circumstances in common. These two peoples "lead the same vagabond existence; they live exclusively upon their herds, they carry with them all they have and that they possess, and they make analogous migrations at the changes of the seasons—the Lapps from the Swedish steppes to the Norwegian valleys, the Arabs from the plains of Sahara to the pastures of Tell. In this manner of life they have both acquired the same strength of constitution, or rather the same power of resisting such fatigue, privations, and weather as would kill the most robust European. . . . Both the Lapps and the Arabs—who are rather the slaves than the masters of Nature—owe their consciousness of isolation and powerlessness to the same superstitions, the same beliefs in spirits, to the 'evil eye,' in amulets, and in incantations. . . . Both races—restricted for centuries to a form of society unsuitable to any kind of progress—affect the same respect for the routine of their ancestors, and the same disdain for the arts of civilisation." The author concludes rightly, we think, that both peoples, incapable as they are of transformation or civilisation, are doomed to disappearance. Many attempts have been made by the Swedish and French Governments to get these nomads to settle down into civilised life, but invariably without success. The author, on the authority of M. Charles Martins, relates that the French Government gave to a number of the poorest Arabs of the Sahara some fertile fields with a ready-built village, and even a mosque in the middle of it. They reserved the houses for their flocks, and pitched their tents in the streets; until one day the nostalgia of the desert seized upon them, and they returned rejoicing to their wandering life.

Count D'Alviella tells the narrative of his travels in these two regions very pleasantly. He is a cheerful and observant and somewhat philosophic guide, and we can assure anyone who cares to buy this work, that he will get the value of his money in enjoyment and information. The narrative of the Lapland journey is especially interesting, and contains information about a people and a country that we believe many know but little about. Here will be found an account of the mode of life of a people that in many respects may be taken as the living type of the men who, ages ago, struggled for existence amid conditions very different from those which now obtain in Europe, and whose implements and remains come within the province, not of the historian, but of the geologist.

Mrs. Hoey deserves credit for her excellent translation. The volume contains a number of fairly executed illustrations.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

M. Barrande and Darwinism

IN the article in NATURE (vol. ix. p. 228) on M. Barrande's "Trilobites," published in 1871, several statements are made which require not only considerable modification as to the facts then known, but which are entirely misleading when made to appear to represent the state of our knowledge of these acts at the present time. M. Barrande is well known to be a determined opponent to the theory of evolution, and doubtless this strong bias has prevented him from seeing and accepting many facts which would otherwise, to so keen and careful an observer, have seemed inconsistent with such strong views. The list of fossils given by him from the Cambrian formation, and which is reproduced in NATURE, is most incomplete and inaccurate when made to refer to the Cambrian fauna of this country, as will be evident at once by referring to p. 249 of the same work, where a list of fossils discovered by me in the "Harlech or Superior Longmynd" group of Wales is given, and which includes several trilobites; and yet in the above-mentioned article it is stated "that no trace of a trilobite has been found in the Cambrian formation." Surely no English geologist will be bold enough to deny to the name Cambrian its right to these Harlech and Longmynd rocks, whatever else it may not be entitled to. Nor, indeed, did Sir R. Murchison and the Geological Survey ever attempt such a breach, and I cannot believe that M. Barrande has realised what such an assumption means, or what it would lead to; nor can I believe that it is possible for him to have followers in this country in such a "violation of historic truth," and, as observed by Prof. Sterry Hunt (in the *Canadian Naturalist*, vol. vi. p. 448), for no other reason than "that the primordial fauna has now been shown by Hicks to extend towards their base." Surely this country, which has not only given to scientific nomenclature the name Cambrian, but which has given to all other countries the groundwork upon which to build up theirs, should have a right to explain the succession in its own way, and especially when it is proved that its succession of these rocks is clearer and more natural than has been hitherto found to be the case in any other country. Indeed it is quite clear that M. Barrande has not yet succeeded, in Bohemia, in reaching this early fauna, and it is evident also that his first zone of life is only equal in order of appearance to the latter part of our *second zone*, and hence the mistake to attempt to correlate our fauna with his zone.

At St. David's in South Wales, the Cambrian of the Geological Survey, consisting of red, purple, and green rocks, attains a thickness of over five thousand feet of beds resting conformably, and of these beds over four thousand feet have yielded evidence, in the form of fossils, of life having existed in the seas in which they were deposited. The forms of life comprised annelids, brachiopods, pteropods, bivalve crustaceans, trilobites, and sponges, and I think it would be seen on examination that the picture offered by this early fauna is not one in discordance with Darwinism, as assumed in the article in question. But as M.

Barrande and the author of the article have restricted their remarks almost entirely to the trilobites, I will only ask to be allowed space to reply to the facts stated with regard to these forms of life. Trilobites have now been discovered as low down as 4,000 ft. in these red and green rocks at St. David's, that is, in the very earliest fauna known, and amongst them are forms hitherto not discovered in any other country; still if we are to believe with some that we are here near the beginning of life on the globe, or even of trilobitic life, we can expect but little evidence to support or to disprove Darwinism. For, considering the frequent changes in the sea bottom which must have taken place at this period, to produce at one time a shingle, then a sand or grit, and then a fine muddy deposit, and such beds frequently repeated, we cannot possibly expect that during all these physical changes an unbroken record of these forms should be preserved to us. No, rather we should expect to find that the necessary migrations would produce alterations in the forms, and that they should now and again return modified and altered in proportion to the time which had intervened and the circumstances which surrounded them. And this is really what we do find, and which is apparent at once to the palæontologist, who is prepared to allow and to recognise in these very marked physical changes a controlling influence capable of greatly affecting the life of the period. Again, can any one really believe, when thinking of the enormous time which must have elapsed during the accumulation of the great Laurentian series, and possibly of other series previous and succeeding, all antecedent to the time when the Cambrian fauna made its appearance, that the seas in which these were deposited were entirely barren of life? Surely not; therefore, why so readily jump at conclusions when there is so much room for doubt? Again, this Cambrian fauna is not without evidence in favour of evolution. Trilobites we know develope by increase of the body segments, and therefore M. Barrande says that the earliest trilobites should have the smallest number of segments in the thorax—"but that those of the primordial fauna are generally characterised by the opposite condition, while the number is less in those of the succeeding faunas." Now it does not seem to have occurred to M. Barrande that trilobites show every indication of having culminated at or about this period, that they had attained their maximum size and development, and that from this time they seem to have gradually diminished in size, and to have degenerated, doubtless much in the order in which they had previously progressed. This will explain also why the number of segments should, as he says, diminish in number in the genera of succeeding faunas. One of the very earliest trilobites we know of is the little *Agnostus*. It is also the simplest and apparently the most rudimentary of the group. It has no eyes, only two segments to the thorax, and usually an ill-defined glabella. In tracing a species of *Paradoxides* from the earliest stage upwards, I was struck with the very great resemblance which, at an early stage, it had to the little *Agnostus*. The glabella was indistinct, and much shorter in proportion to the length of the head than in the fully grown specimen, and the eye very faint, scarcely marked out, and the outline of the head more evenly rounded, with scarcely any indication of spines. Before the discovery of the Cambrian fauna at St. David's, no genus of trilobites had been found with four segments to the thorax, therefore we had to jump from one with two to one with six, as in *Trinucleus* or *Ampyx*. Now, however, since the discovery of *Microdiscus* with four segments, the gap has been filled up, and the genus, unfortunately for those holding M. Barrande's views, appears in our earliest fauna, and where the evolutionist would be most inclined to look for it. It is also a most interesting and instructive genus. It is somewhat larger than *Agnostus*, but like it, has no eyes. The *glabella* is better formed, more distinctly marked off from the cheeks, and instead of being irregularly grooved, as is usually the case with *Agnostus*, it is furrowed regularly as in an advanced stage in the development of *Paradoxides*. In the caudal portion the axis is partly divided into segments, and in one species the lateral lobes are slightly grooved as if into rudimentary pleuræ. It is very plentiful in the beds at St. David's, and since its discovery there, species have also been found in Canada and elsewhere.

From this stage forms have been found to represent every step in development as to the number of segments, and indeed often to show marked stages in other parts. *Anopolenus* is really a *Paradoxides* with enormous eyes, reaching to the hinder margin, and with several of the hinder pleuræ consolidated together to form a large spinous pygidium. Another *Paradoxides* has the eyes nearly as large as *Anopolenus*, but with a few more segments to the thorax, and a smaller pygidium. Other species show various gradations in the eyes and in the pygidium until we attain to *P. Davidis*, which has small eyes, a small pygidium, and the greatest number of thoracic segments. Indeed there are forms to represent almost every stage, and there can I think be no doubt that in the fauna of the Tremadoc group, which is separated from the earlier Cambrian by several thousand feet of deposits indicating a period of very shallow water in which large brachiopods and phyllopod crustaceans were the prevailing forms of life, we witness a return to very much the same conditions as existed in the earlier Cambrian periods, and with these conditions a fauna retaining a marked likeness to the earlier one, and in which the earlier types are almost reproduced, though of course greatly changed during their previous migrations. The *Niobe* (?) recently found in the Tremadoc rocks is truly a degraded *Paradoxides*, retaining the glabella and head spines, but with the rings of the thorax, excepting eight, consolidated together to form an enormous tail. Instead therefore of having here, as stated by M. Barrande, "a very important discord between Darwinism and facts," we find in these early faunas facts strongly favouring such a theory, and in support of evolution.

Hendon, Jan. 27 HENRY HICKS

ACCORDING to a notice in NATURE, vol. ix. p. 228, a distinguished continental naturalist finds an important discordance between Darwinism and certain facts connected with Trilobites and other fossil crustaceans. But his argument appears to be based on an assumption that we are acquainted with a "primordial fauna," that we are justified in dating the beginnings of life at or near some known geological period. This, however, the whole history of geology ought to make us less and less inclined to believe. It is one of those assumptions, essentially based on ignorance, on which so little dependence can rightly be placed. We have no right to call any fauna the *earliest*, merely because, as it happens, we know of none *earlier*.

A point is made of the fact that the earlier known Trilobites have more segments than the later, while individual Trilobites, as they develope, increase in number of their body segments. It may be granted at once that in this case the development of the individual is not an accurate picture of the past development of the species. But Fritz Müller has long ago shown that we could not, on principles of Darwinism, expect it always to be so; and surely, if Trilobites have been gradually developed rather than abruptly created, there must have been Trilobites with *few* before there were Trilobites with *many* segments, so that after all, the development of the individual will carry us back to an early stage in the history of the family. It could scarcely be expected to give us all the alternations and complications which that history may have presented in its whole course.

Those who on other grounds accept the theory of evolution, far from finding any obstacle to it in the large number of genera of Silurian Trilobites, will consider the largeness of that number clear evidence that life in general, and Trilobite life in particular, must have flourished on the globe for a very long period prior to the Silurian age.

The argument that we do not find connecting links between different genera has little immediate force. It must await the verdict of time and further investigation. Of 252 species o Trilobites, 61 are assigned to England. The true reading of this piece of statistics must surely be that that which great research has done for a small area may be equalled, and far surpassed, when as close a scrutiny is applied to the whole available surface. If no gaps between species, and genera, and orders are filled by the results of such a search, then it will be time to say that we have "an important discord between Darwinism and facts."

Torquay, Jan, 27 THOMAS R. R. STEBBING

Perception in Lower Animals

I RELATE the following, as it has some bearing on a question lately ventilated in NATURE.

A friend and myself were watching on one occasion the actions of two half-bred Persian cats on seeing for the first time a freshly caught cobra, which had been placed in a wire-gauze covered box near the verandah. First of all one of the cats, a black one, stalked carefully up to the box in which the snake was keeping up a perpetual "swearing," with extended hood, and after a

minute survey, crept away about 7 or 8 ft. off and sat down with its back to the snake. The other cat, a white one, now caught sight of the strange object, and, in a like stealthy manner, advanced to within a few inches of the gauze, and was in the act of examining the cobra, when my friend, to see the result of a sudden sound—for up to this time we had both been still as mice—moved his feet on the gravel. Had the effect been due to electricity, it would not have been more instantaneous, nor more startling. At the first grate of the pebbles the white cat flung himself backwards, tumbling—to use expressive terms—"heels over head" and "all of a heap" for about a couple of yards; whilst the black cat shot vertically upwards to somewhere near four feet in height, the impulse given by the spring of his hind legs being sufficient to throw these and his tail higher than his head.

Now both these cats are tame, and bold to such a degree that they reign supreme over all the dogs in the house, so that their great timidity on this occasion was evidently due to a perception of danger. I have since found, however, that all snakes are not equally feared by them. They will let the harmless green tree snake (*Passerita mycterizans*) twine round them without showing any signs of repugnance, and some other harmless snakes receive but little notice from them. Why is this? Is it that the hood of the cobra renders it so frightful an object, or have the cats in their nocturnal wanderings been struck at by cobras? Such is possible, for we know that in nine cases out of ten the strike is made without intention to exert the deadly power of the fangs. I believe indeed that unless irritated by an attacking enemy, or to secure active prey such as rats, &c., the cobra never strikes viciously. Experience of the ease with which its fangs are drawn and its helplessness without them would teach it to be careful of them.

Mangalore, Sept. 17 E. H. PRINGLE

Earthquake in New Guinea

WHEN crossing the main land of New Guinea, from the Geelvinks Bay in the north, to the south coast, I slept on the night of the 12th to the 13th of June, 1873, in the swamps of the MacCluer Gulf (famous for the murder of some of the crew and the ship's-doctor of H.M.S. *Panther* and *Endeavour*, Capt. MacCluer, in 1791, and by the attack on Signor Cerruti, the Italian traveller, several years ago). About 2 A.M. of the 13th I awoke, in consequence of a rattling noise like that of gun-shooting. I roused my six Malay companions, who slept around me in a small native prouw, seized my guns, and listened to what would follow. But nothing happened. It was unintelligible to me what had been the cause of this noise, the natives of these parts having no guns, so far as I knew, and even if they had intended an attack, would not announce their arrival by firing their guns, instead of approaching in silence. On the other hand, when sleeping in a virgin forest like that which bordered these swamps, crashing noises from falling trees and from animals breaking down rotten branches often occur, but never so many together.

Nothing more being heard we fell asleep again. At about 4 A.M. the same thing happened once more. I remained awake. At dawn the Papooas, whom I had brought with me from the north coast—ten men—came back to my resting-place; they had left me, to sleep apart, had heard the noise, but could not understand it either.

When on the 13th I came back to Papooan houses at the River Takasi, which falls into the MacCluer Gulf—a minute description of which will be published very soon in "Petermann's Mittheilungen"—I heard the account of a heavy earthquake, which had taken place the night before; this of course explaining the noises we had heard: many trees having broken down at the same moment in consequence of the movement of the ground. We did not feel the earthquake in our small boat, because it lay entirely in the swamp, which had not propagated the shock.

On the 18th I was back at my little schooner, which was at anchor in the Geelvinks Bay, near a place called Passim. The earthquake had been felt here at the same time, accompanied by heavy underground thunder, and I could make out that the direction had been N.W. to S.E.

After some days I came to a place just at the foot of the so much spoken of Arfak Mountains, called Audai; the earthquake had been heavy here, and even more shocks were felt on the following day. The direction had been W.E. Several native houses, built on very high poles near the slope of a hill, were destroyed, the Papooas (Arfaks) still frightened and of opinion that the earthquake had been "made" by their enemies, another tribe on the mountains.

But in the Bay of Dorey, which has so often been visited by expeditions to New Guinea and by naturalists, where I arrived a fortnight later, the shocks appeared to have been the heaviest. All the Papooas in the different settlements there were living on shore in small shelters or huts, hastily erected, whereas they are known always to live in those large houses on the water so often described. Several of these large houses had broken down, and the natives were still very much frightened; they would not remove into their houses on the water. On the island of Manaswari (Mansinam), in the Bay of Dorey, the seat of a missionary, the shocks had been from S.W. to N.E. I afterwards sought information about the extent of this earthquake, and made out that it was felt at Amberbaki, on the North coast of New Guinea, at Salwatti, the island in the North-west, and on the island of Tobie, in the east. The centre had been undoubtedly on the Arfak Mountains. Light earthquakes sometimes occur in New Guinea, heavy ones seldom. The destruction by the last heavy one in 1864 could even be seen by me in 1873 along the seashore from Dorey to Wariab, and up the Arfak Mountains, in the south of the bay of Dorey. Volcanic eruptions in these parts are not known or recorded from earlier times. But one of the tops of these mountain chains bears in the native language the name of "Fire Mountain," and some of my hunters pretended to have seen on one of their excursions (some thousands of feet high) the ground split open quite fresh, in consequence of the earthquake, as they believed.

This earthquake has not been felt in Halmabeira and the Molukkos Islands, where shocks occurred some weeks afterwards, so that the convulsions, referred to above, appear to have been local ones in New Guinea. DR. A. B. MEYER

Sensitive Flames at the Crystal Palace Concerts

LAST Saturday, Jan. 31, at the Crystal Palace, while Mr. Vernon Rigby was singing Beethoven's "Adelaida," I heard what I thought was strangely out of place—an accompaniment to the song played on the highest notes of a violin, sometimes closely following the air note for note, at other times being one-third lower. I soon found that this proceeded from one or two sensitive gas jets, notwithstanding they were at the end of the winter concert-room farthest away from the orchestra. The very perfect manner in which they responded to every note, no matter how *piano*, was curious.

It happened that the gas pressure had just been increased. Had this occurred earlier the effect of Mdme. Norman-Neruda's fine performance of Mendelsohn's violin concerto would have been totally destroyed, as far as regards a large part of the audience. This shows that it is a matter of no small importance in a concert-room to have the size and number of the gas-burners properly proportioned to the gas supply.

King's College, Feb. 3 W. N. HARTLEY

THE PHOTOGRAPHIC SOCIETY

THE metropolitan photographic journals contain evidence that the Photographic Society of London is menaced with revolution or dissolution. If both were to befall it, the interests of Science would hardly suffer, since a more singularly inefficient organisation, under the guise of a scientific body, it would be difficult to find, or one whose results in the scientific world are so trivial.

It is difficult indeed to conceive that a society into whose hands, *faute de mieux*, the recognition and fostering of research in so important a branch of science as photography has fallen, should have done absolutely nothing for so many years but organise itself into a pocket borough in the direction of which no man of eminent scientific capacity takes part; which not only has no scientific reports or even investigations, but seems to care only to make of itself a weak mimicry of an art club, the chief objects of which are to prove that a photographer ought to have a chance for the Royal Academy, to discuss the most effective style of getting up portraits to

revive the trade demand, and to discuss such questions as to whether portraits may be re-touched or not, and whether the printing of a photograph from a half-dozen negatives, more or less, is to be regarded as a work of design or not.

It is not sufficient to put the names of two or three well-known men of science on the council of a society if the society show no care for science; and if the Photographic Society can do nothing more to merit the nominal position which it holds (without filling it), it is time that it should retire and give place to another. Photography has now become one of the most important aids to research in many fields of Science; every new discovery which shall develop this assistance and make its efficiency more complete is of importance to the whole world—of an importance which makes it almost incredible that the Photographic Society should not only take no part in the investigations which would lead to discovery, but should never even take recognition of them even when made, while the petty jealousies of the dominant clique have driven out of the society most of the really capable and successful investigators who have ever been in it. If the efforts at reform now being made should lead to success and the society become what it should be, a scientific body, so much the better; but if not, it is time that some new organisation should be formed to take in hand seriously the exploration of the still untried fields of chemical research, and make Photography a real branch of Science, and not deal with it merely as an amusement or a trade.

ASTRONOMY IN THE ARGENTINE CONFEDERACY

DR. GOULD, the director of the new Observatory in the Argentine Confederacy, continues to send encouraging accounts of the progress of the great astronomical works that he has there undertaken. Having laboured to determine accurately the relative brightness of all the stars in the southern heavens visible to the naked eye, he announces that a few weeks will enable him to begin the preparation of this work for publication. Great care has been taken to make a thorough and accurate comparison of the results of the four assistants, and the rule has been to determine the brightness of all the stars down to the 7·3 magnitude, in order to make sure of losing none as bright as the seventh.

The labour of the Uranometry was undertaken before the arrival of the large meridian instrument, and as soon as the latter was established (namely, on Sept. 9, 1872), the observations of the zones of all stars as bright as the ninth magnitude were commenced in earnest. Each night three zones are observed whose lengths average about one hundred minutes, the entire observations for the year occupying at least eight hours. The weather is described as having been exceedingly unfavourable for astronomical work during the winter and early spring, until March, April, and May of the present year, when magnificent opportunities were enjoyed. Dr. Gould states that he has observed in all during the past year about fifty thousand stars, and considers that somewhat more than half of the work of observing is already finished.

Astronomers, however, know how great a labour of computation still awaits Dr. Gould and his assistants before his results can be put into that form which is most convenient for use. The photographic work undertaken by him at his own private expense has been prosecuted with all the success that could be expected with a broken lens. Finally, however, he concluded to bespeak another object-glass, which will be purchased for the use of the observatory; and the new lens having arrived in perfect order, he hopes before long to be able to resume his labours under better auspices.

The Cordoba Meteorological Bureau, established at his urgent representation by the national Government, has been organised and brought into working condition as rapidly as was practicable; but as the instruments were necessarily ordered from foreign countries, not more than half of them had arrived at the latest advices. Dr. Gould has, however, had the gratification of finding two gentlemen who have each carried on an uninterrupted series of observations for some dozen years past—one in Buenos Ayres, and the other near the Patagonian frontier—and he has secured the co-operation of about fifteen correspondents. The programme issued for the instruction of his observers differs apparently but little from that of the Smithsonian Institution, the hours of observation being seven, two, and nine, local time.

*THE COMMON FROG**
IX.

THE muscles connected with the human lingual apparatus are sufficiently complex. One such muscle—the *stylohyoid*—passes downwards on each side, from a process of the base of the skull to the corniculum of the os-hyoides

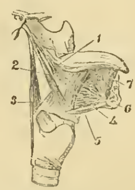


FIG. 63.

FIG. 64.

FIG. 63.—Muscles of the Right Side of the Tongue. 1, stylo-glossus; 2, stylo-hyoid; 3, stylo-pharyngeus; 4, hyo-glossus; 5, genio-hyoid; 6, genio-glossus; 7, lingualis.

FIG. 64.—Head of the Frog *Phyllomedusa*, showing the tongue fixed in front, but free posteriorly.

or tongue-bone. The tongue-bone of the frog is, as we have seen, relatively far greater than is that of man, and the same may be said for the muscles attached to it, since we have no less than four muscles descending from the skull, and implanted into it, on each side.

This fact might well be supposed to bear direct relation to the size and mobility of the frog's tongue. This organ in the frog and toad is singularly different from the tongues of most familiar animals, in that it is not free and moveable in front, but *behind*. These Batrachians take their food by suddenly throwing forwards, out of the mouth, the free hinder end of the tongue. The insect or other small animal struck by it, adheres to it, on account of a viscid saliva with which it is coated. The prey is then suddenly drawn into the mouth and swallowed.

Here then is a ready explanation of the development of the *os-hyoides* and its muscles. There is a difficulty however in that two toads already described, the Pipa and the African form *Dactylethra* (Figs. 11 and 12), have no tongue whatever.

Moreover, there is another toad (*Rhinophrynus*) which is even more exceptional in its order than these two; in that its tongue is not free behind, but, like that of ordinary vertebrates, in front (Fig. 13.)

The fact is, that the large tongue-bone of these animals serves, with the muscles attached to it, as much to facilitate respiration as nutrition.

It has already been said that the frog has no ribs by the elevation and depression of which it may alternately fill and empty its lungs. Neither does it possess that transverse muscular partition, the diaphragm, or midrif, which in man's class is the main agent in carrying on that function.

The lungs of the frog are inflated as follows:—The

* Continued from p. 189.

mouth is filled with air through the nostrils and kept shut while the internal openings of the nostrils are stopped by the tongue, and the entrance to the gullet is closed. Then, by the contraction of the muscles attached to it, the os-hyoides is elevated; and every other exit from the mouth being closed, except that leading to the larynx, air is thus driven down the glottis into the lungs.

Thus for pulmonary respiration it is necessary to the frog to keep the mouth shut; and in this way, but for the action of the skin, the animal might be choked by keeping its mouth open.

It has been already stated that the typical segmentation of the limbs is wanting in all fishes, but present in all Batrachians that have limbs at all. Similarly in all Batrachians that have limbs at all the muscles of those limbs have essentially and fundamentally the same arrangement as in higher animals. In the higher animals, as in man, the muscles of the limbs belong to different categories named from the kinds of motion to which their contractions give rise.

Thus, when two bones are united by a moveable joint (as the thigh-bone and shin-bone) muscles which, by their contraction, tend to make the angle formed by such bones

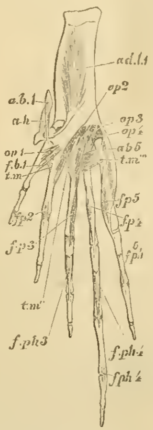


FIG. 65.—Deep muscles of exor surface of Frog's hind foot. (The numbers indicate the digits to which the muscles belong.—No. 1 indicating the first digit or great toe). *ab*, abductors; *ad*, adductor; *fb*, flexor brevis; *fp*, flexores profurdi; *fph*, flexores phalangium; *op*, opponens muscles; *tm*, transverse muscles.

acute are termed "flexors." Those, on the contrary, which tend to open out such an angle are termed "extensors."

In the forearm of man, and allied animals, there are muscles which tend by their contraction to place the hand in a position either of *pronation* or of *supination*.

When the arm and hand hang down, the *palm* being directed forwards, the position is that of supination, and the bones of the forearm are situate side by side.

When the arm and hand hang down, but the *back* of the hand is turned forwards, the position is that of pronation, and the radius crosses over the ulna. When we rest on the hands and knees, with the palms to the ground, the forearms are in pronation.

Muscles which tend to place the forearm and hand in the position of pronation are termed *pronators*; those which, by their contraction, tend to render it supine are called *supinators*.

It is somewhat surprising to find in an animal so nearly related to fishes as *Menobronchus* definite flexors, extensors, pro- and supi-nators essentially like those of higher animals; and these distinctions once established persist up to man himself with increasing complications.

The muscular conformity between the highest and lowest of typically-limbed vertebrates is strikingly shown by the structure of the thigh and leg, the leading muscles of these parts in the frog being so like those of man that the practice of calling them by the same name is abundantly justified.

The perfection of man's hand has been justly the theme of panegyric, esteemed as widely as it is known. The delicacy and multiplicity of the motions of which it is capable are of course greatly due to the number and arrangement of the muscles with which it is provided.

One of the most important of these motions is that of the thumb as placed in opposition to the fingers, and effected by a muscle termed *opponens pollicis*.

An "opponens" muscle is one which passes from the bones of the wrist to one or other of the bones of the middle of the hand called *metacarpals*, and the *opponens pollicis* passes of course, as its name implies, to the metacarpal of the pollex or thumb.

No other finger of man's hand is furnished with such a muscle except the little finger, which possesses an *opponens minimi digiti*, passing from the wrist to the fifth metacarpal. The same condition obtains in the apes, though in them the opponens of the thumb is smaller and weaker than in man. Though the foot of man is furnished with many muscles, like the hand, yet not one of the toes is provided with an "opponens" or muscle, passing from the bones of the ankle to one or other of the bones of the middle of the foot, which latter are called metatarsals. The same is the case with the apes, except that the Orang-utan has a small "opponens" attached to the great toe.

This being premised, the foot of the Frog may well excite surprise as to its rich muscular structure. In addition to very numerous other muscles on both surfaces every one of the toes is provided with a separate opponens muscle, each having a muscle which passes from the bones of the ankle to its middle foot bone or metatarsal.

The question naturally occurs on beholding this prodigality of muscles—What special purpose is served by the Frog's foot? Surely mere jumping and swimming cannot require so elaborate an apparatus.

In fact, however, the Frog *aoes* make use of his feet for a purpose requiring actions no less dexterous and delicate than nest-building.

In 1872 Dr. Günther observed a Frog busily occupied, and industriously moving its hind legs in a singular manner. On approaching closely he found it had constructed for itself a shelter in the shape of a little bower, constructed of dexterously interwoven blades of grass. The circumstances have been kindly transmitted to the author by the observer, in a private letter, as follows:—

"The 'nest-building' Frog was a large example of *Rana temporaria*, or *esculenta* (I forget which), which I had brought into the garden behind my house. It had taken up its abode in grass, near the edge of a tank, from which the turf sloped abruptly to the level of the garden. When I first disturbed the Frog from its lair, I found that it had lain in a kind of nest, which I cannot better describe than by comparing it to the form of a hare, with the grass on the edges so arranged that it formed a sort of roof over it. Sometimes the animal returned to it, sometimes it prepared a new form close to the old one, which remained visible for several days until it was obliterated by the growing grass.

"When in its nest, nothing could be seen of the Frog but the head.

"One day I poked the Frog out of its lair; after two or three jumps it returned to the old spot, and, squatting down on the grass, by some rapid movements of the hind legs it gathered the grass nearest to it, pressing it to

its sides, and bending it over its body so as to be partially hidden.

"In all these operations no material was collected by the animal for its nest, but only the growing grass was either pressed down, or arranged so as to form a complete retreat.

"Unfortunately, the Frog soon disappeared altogether."

It is very probable that other functions, as yet unnoticed, may be performed by these members, since though the observation just above related is the first known observation of the kind, yet the manœuvre recorded is no doubt a constant habit of the animal.

Doubtless, also, the very singular actions performed by the male *Pipa* and *Obstetricans* are performed by the help of the hinder extremities.

At the same time that the Frog shows so startling a resemblance in its leg muscles to higher animals, it shows

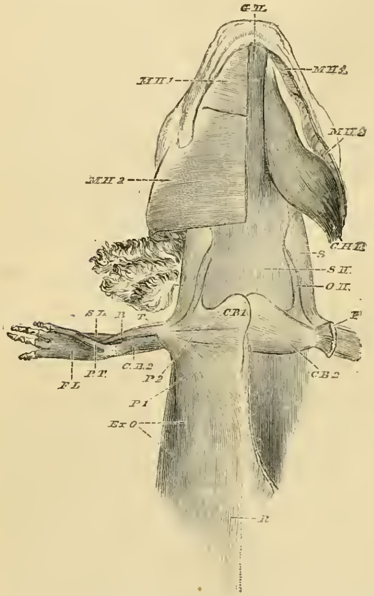


FIG. 65.—Muscles of Ventral Surface of *Menobranchus*. On the right side, superficial muscles; on the left side, deeper muscles, the mylohyoidei, pectoralis, and external oblique being removed. Also superficial flexor muscles of right pectoral limb of *Menobranchus*. *B*, biceps; *CB*[1] and *CB*[2], coraco-brachialis; *CHE*, cerato-hyoideus externus; *EO*, external oblique; *FL*, flexor longus; *GH*, genio-hyoid; *MH*[1] and *MH*[2], mylo-hyoideus; *OH*, omo-hyoid; *P*, *P*[1], and *P*[2], pectoralis; *R*, rectus; *S*, subclavius; *SH*, sterno-hyoid; *SL*, supinator longus; *T*, triceps.

as striking a difference from the leg muscles of animals with which it is nearly allied,—namely, with those of its class-fellows, the *Urodela*.

In Reptiles we meet with a muscle which takes origin from beneath the joints of the tail, and is inserted with the thigh-bone, and which has no certain representation amongst mammals, and is called the *femoro-caudal*.

In the Urodela we also meet with a *femoro caudal*, but no such structure exists in the Anoura. This is not so surprising when we recollect the abortive condition of the tail of the Frog. It might, however, have been expected that in the Tadpole, during the co-existence of the tai with the hind legs, and while it thus externally resemble an eft—such a muscle would transitorily exist. Such, however, is not the case, and the distinction is a very remarkable one.

In one point, however, the Efts resemble the Frogs, namely, in the greater number and greater complexity as well as the greater size of the muscles of the hind-limbs than of the fore-limbs. It is well known that the Efts

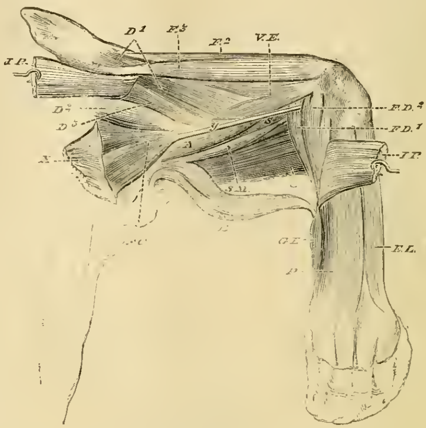


FIG. 67.—Deeper Muscles of Outer Aspect of Right Pelvic Limb of Parson's Chameleon; the ilio-peroneal cut reflected. *A*, adductor; *B*, biceps; *D*[1], gluteus primus; *D*[2], gluteus secundus; *D*[3], gluteus tertius; *EL*, extensor longus digitorum; *F*[2] and *F*[3], rectus femoris; *FC*, femoro-caudal; *FD*[1], flexor longus digitorum; *FD*[2], flexor tertius digitorum; *G*, gracilis; *GE*, gastrocnemius externus; *IP*, ilio-peroneal; *P*, peroneus; *S*, tibial adductor; *SM*, semi-membranosus; *VE*, vastus externus; *X*, gluteus maximus; *y*, tendon of femoro-caudal.

make use of their hind-limbs in attaching their eggs to the leaves and branches of aquatic plants; and further observations may show with regard to these animals facts as to

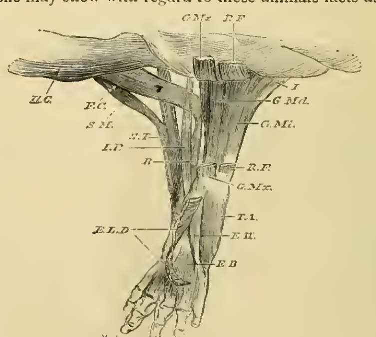


FIG. 68.—Deeper Muscles of Extensor Surface of Right Leg of Menopoma. *B*, biceps; *EB*, extensor brevis; *EH*, extensor hallucis; *ELD*, extensor longus digitorum; *FC*, femoro-caudal; *GMd* and *GMi*, muscles like the lesser glutei; *GMx* and *RF*, great extensors of the thigh; *I*, muscle resembling the iliacus; *IlC*, ilio-caudal; *IP*, ilio-peroneal; *SM* and *ST*, muscles like the semi-membranosus and semi-tendinosus respectively; *TA*, tibialis anticus.

the use of the members, as novel and interesting as the one just cited with regard to the nest-building actions of the Frog.

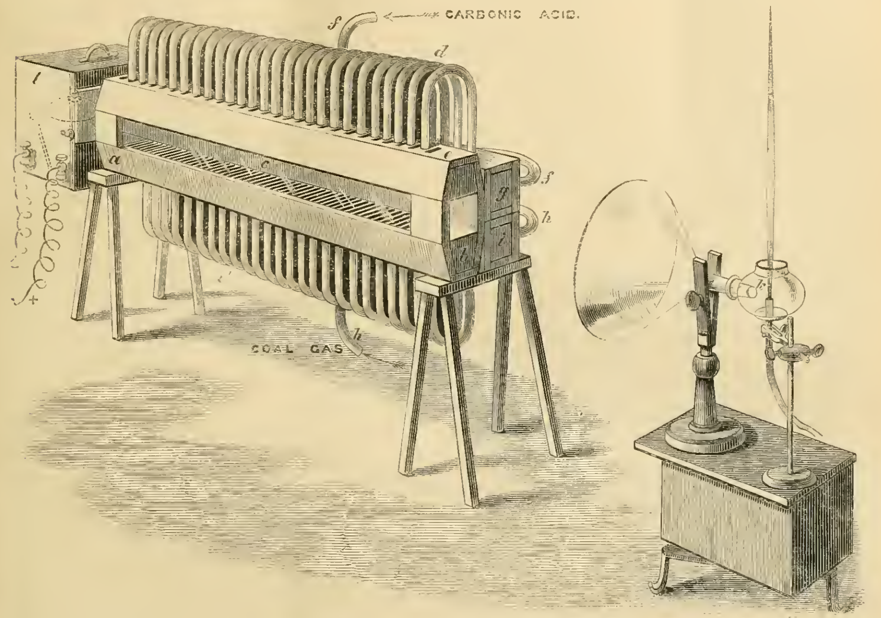
ST. GEORGE MIVART

(*To be continued.*)

THE ACOUSTIC TRANSPARENCY AND OPACITY OF THE ATMOSPHERE *

II.

WE have now to consider the complementary side of the phenomena. A stratum of air, 3 miles thick, on a perfectly calm day, has been proved competent to stifle both the cannonade and the horn-sounds employed at the South Foreland; while the observations just recorded, one and all, point to the mixture of air and aqueous vapour as the cause of this extraordinary phenomenon. Such a mixture could fill the atmosphere with an impervious *acoustic cloud* on a day of perfect *optical* transparency. But, granting this, it is incredible that so great a body of sound could utterly disappear in so short a distance, without rendering any account of itself. Supposing, then, instead of placing ourselves behind the acoustic cloud, we were to place ourselves in front of it, might we not, in accordance with the law of conservation, expect to receive by reflection the sound which had failed to reach us by transmission? The case



[A tunnel 2 in. square, 4 ft. 8 in. long, open at both ends, and having a glass front, runs through the box *a b*. The space above and below is divided into cells opening into the tunnel by oblong orifices exactly corresponding vertically. Each alternate cell of the upper series—the 1st, 3rd, 5th, &c.—communicates by a tube (*d d*) with the upper reservoir (*g*), its counterpart in the lower series having a free outlet into the air. In like manner the 2nd, 4th, 6th, &c., of the lower series of cells are connected with the lower reservoir (*i*); and each has its direct passage into the air through the cell immediately above it. The gas distributors are filled from both ends at the same time; the upper with carbonic acid gas, the lower with coal-gas, by branches from their respective supply pipes (*f*, *h*). A well-padded box (*l*) opening upon the end of the tunnel forms a little cavern, whence the sound-waves are sent forth by an electric bell. A few feet from the other end of the tunnel, in a direct line, is a sensitive flame (*k*), provided with a funnel as sound collector, and guarded from chance currents by a shade.

The bell was set ringing. The flame, with quick response to each blow of the hammer, emitted a sort of musical roar, so regular were its alternate shortenings and lengthenings as the successive sound-pulses reached it. The gases were then admitted. Twenty-five flat jets of coal gas ascended from the tubes below, and twenty-five cascades of carbonic acid poured down from the tubes above. That which was a homogeneous medium had now fifty limiting surfaces, from each of which a portion of the sound was thrown back. In a few moments these successive reflections became so effective that not a single sound-wave having sufficient power to affect a flame so sensitive as to be knocked down, crushed, as it were, by a chirrup, or jingle, at twenty feet distance, could pierce the clear, optically-transparent, but acoustically-opaque atmosphere in the tunnel. So long as the gases continued to flow, the flame remained perfectly tranquil. When the supply was cut off, the gases rapidly diffused into the air. The atmosphere of the tunnel became again homogeneous, and therefore acoustically transparent, and the flame bowed down to each sound-pulse as before. Alternate layers of common air and air saturated with various vapours produce the same effect.]

would then be strictly analogous to the reflection of light from an ordinary cloud to an observer placed between it and the sun.

My first care, in the early part of the day in question, was to assure myself that our inability to hear the sound did not arise from any derangement of the instruments. At one P.M. I was rowed to the shore, and landed at the base of the South Foreland cliff. The body of air which had already shown such extraordinary power to intercept sound, and which manifested this power still more impressively later in the day, was now in front of us. On it the sonorous waves impinged, and from it they were sent back to us with astonishing intensity. The instruments, hidden from view, were on the summit of a cliff

* Royal Institution, Friday evening Discourse by Prof. Tyndall, D.C.L. LL.D., F.R.S. Jan. 16. (Continued from page 253.)

235 feet above us, the sea was smooth and clear of ships, the atmosphere was without a cloud, and there was no object in sight which could possibly produce the observed effect. From the perfectly transparent air the echoes came, at first with a strength apparently but little less than that of the direct sound, and then dying gradually and continuously away. The remark of my companion, Mr. Edwards, was: "Beyond saying that the echoes seemed to come from the expanse of ocean, it did not appear possible to indicate any more definite point of reflection." Indeed, no such point was to be seen; the echoes reached us as if by magic, from absolutely invisible walls. Arago's notion that clouds are necessary to produce atmospheric echoes is therefore untenable.

The reflection from aërial surfaces has never been experimentally demonstrated. It is wholly a matter of inference, and I wished very much to reduce it to demonstration. I made one or two rough experiments on the transmission of sound through a series of flames; and no doubt by proper arrangement such experiments might be made successful. I then thought that alternate layers of carbonic acid and coal gas, the one rising by its lightness, the other falling by its weight, would supply a heterogeneous medium suitable for the demonstration. To my assistant, Mr. Cottrell, who possesses in an eminent degree the skill of devising apparatus, I communicated this idea, leaving the realisation of it wholly to him, and he has carried it out in the most admirable manner. (For a sketch and description of the apparatus, see previous page).

During my recent visit to the United States I accompanied General Woodruff, the engineer in charge of two of the lighthouse districts, to the establishments at Staten Island and Sandy Hook, with the express intention of observing the performance of the steam-syren, which, under the auspices of Prof. Henry, has been introduced into the lighthouse system of the United States. Such experiments as were possible to make under the circumstances were made, and I carried home with me a somewhat vivid remembrance of the mechanical effect of the sound of the steam syren upon my ears and body generally. This I considered to be greater than the similar effect produced by the horns of Mr. Holmes; hence the desire, on my part, to see the syren tried at the South Foreland. The formal expression of this desire was anticipated by the Elder Brethren, while their wishes were in turn anticipated by the courteous kindness of the Lighthouse Board at Washington. Informed by Major Elliott that our experiments had begun, the Board forwarded to the Corporation, for trial, the noble instrument now mounted at the South Foreland. The principle of the syren is easily understood. A musical sound is produced when the tympanic membrane is struck periodically with sufficient rapidity. The production of these tympanic shocks by puffs of air was first realised by Dr. Robison. But the syren itself is the invention of Cagniard de la Tour. He employed a box with a perforated lid, and above the lid a similarly perforated disc, capable of rotation. The perforations were oblique, so that when wind was driven through the disc was set in motion. When the perforations coincided a puff escaped, when they did not coincide the current of air was cut off. The regular succession of impulses thus imparted to the air produce a musical note. Even in its small form, the instrument is capable of producing sounds of great intensity. The syren has been improved upon by Dove, and notably developed by Helmholtz.

In the steam syren patented by Mr. Brown of New York, a fixed disc and a rotatory disc are also employed, radial slits being cut in both discs instead of circular apertures. One disc is fixed across the throat of a trumpet-shaped tube, $16\frac{1}{2}$ ft. long, 5in. diameter where the disc crosses it, and gradually opening out till at the other extremity it reaches a diameter of 2 ft. 3 in. Behind the fixed disc is the rotating one, which is driven by separate mechanism. The trumpet is mounted on a boiler. In our experiments steam of 70 lbs. pressure has for the most part been employed. Just as in the air-syren, when the radial slits of the two discs coincide, a puff of steam escapes. Sound-waves of great intensity are thus sent through the air; the pitch of the note produced depending on the rapidity with which the puffs succeed each other; in other words, upon the velocity of rotation.

On October 8 I remained some time at the Foreland, listening to the echoes. Of the horn-echoes I have already spoken: those of the syren were still more extraordinary. Like the others they were perfectly continuous, and faded as if into the distance gradually away. The single sound seemed rendered complex and multitudinous by its echoes, which resembled a band of trumpeters first responding close at hand, and then retreating rapidly from us towards the coast of France. The syren echoes had eleven seconds duration, those of the horn eight seconds. With sounds of the same pitch the duration of the echo might be taken as a measure of the penetrative power of the sound.

I moved away from the station so as to lower the power of the direct sound. This was done by dropping into the sound-shadow behind an adjacent eminence. The echoes heard thus were still more wonderful than before. In the case of the syren, moreover, the reinforcement of the direct sound by the echo was distinct. One second after the commencement of the syren blast, the echo struck in as a new sound. This first echo, therefore, must have been flung back by a body of air not more than 600 or 700 ft. in thickness.

There appears to be a direct connection between the duration of the echoes and the distance penetrated by the sound. On October 17 the perfect clearness of the afternoon caused me to choose it for the examination of the echoes. The echoes of that day, when our transmitted sound reached its maximum, exceeded in duration those of all other days. We heard the syren fifteen miles off. On the close of the day we found its echoes fourteen to fifteen seconds in duration, this long duration indicating the distance from which they were thrown back.

The visual clearness of the atmosphere on the morning of Oct. 8, was very great, the coast of France was very plainly seen, the Grisnez lighthouse, and the monument and cathedral of Boulogne, were distinctly visible to the naked eye. At $5\frac{1}{4}$ miles from the station, the horn was heard feebly, the syren clearly. At 2.30 P.M., a densely black scowl overspread the heavens to the W.S.W. At this hour, the distance being 6 miles, the horn was heard very feebly, the syren more distinctly, all being hushed on board during the observations. A squall now approached us from the west. In the Alps, or elsewhere, I have rarely seen the heavens blacker. Vast cumuli floated in the N.E. and S.E.; vast streamers of rain were seen descending W.N.W.; huge scrolls of cloud to the N.

At 7 miles distance the syren was not strong, and the horn was very feeble.

The heavy rain at length reached us, but although it was falling all the way between us and the Foreland, the sound, instead of being deadened, rose perceptibly in power. Hail was now added to the rain, and the shower reached a tropical violence. We stopped. In the midst of this furious squall both the horn and the syren were distinctly heard, and as the shower lightened, thus lessening the local pattering, the sounds so rose in power that we heard them at a distance of $7\frac{1}{2}$ miles distinctly louder than they had been heard through the rainless atmosphere at 5 miles. This observation is entirely opposed to the statement of Derham, which has been repeated by all writers since his time, regarding the stifling influence of falling rain upon sound. But it harmonises perfectly with our experience of July 3, which proved water in a state of *vapour* so mixed with air as to form non-homogeneous parcels, to be a most potent influence as regards the stoppage of sound. Prior to the violent shower, the air had been in this flocculent condition, but the descent of the rain and hail restored in part the homogeneity of the atmosphere, and augmented its transmissive power. There may be states of the atmosphere associated with rain unfavourable to sound, but to rain itself I have never been able to trace the slightest deadening effect.

The observations continued till November 25. Up to that date we had no fog, but the experience of July 1 and of October 30, entirely destroy the notion that optical transparency and acoustic transparency go hand-in-hand. Both were days of haze sufficiently thick to hide the cliffs of the Foreland, but on the former the sounds reached $12\frac{3}{4}$, and on the latter $11\frac{1}{2}$ miles.

Reflection from the particles of fog and haze has been hitherto held to blot out sound. The late dense fog in London enabled experiments to be made which entirely controvert this conclusion. On December 10 I made some experiments over the Serpentine. The fog was very dense. Mr. Cottcrell stood on the walk below the south-west end of the bridge dividing Hyde Park from Kensington Gardens, while I went to the eastern end of the Serpentine. He blew a dog-whistle, and an organ-pipe sounding Mi_3, which corresponds to 380 waves a second. I heard both distinctly. I then changed places with him, and listening attentively at the bridge, heard for a time the distinct blast of the whistle only. The organ-pipe at length sent its deeper note to me across the

water. It sometimes rose to great distinctness, and sometimes fell to inaudibility. These fluctuations, of which various striking examples have been observed, are due to the drifting of acoustic clouds, which act upon a source of sound, as the drifting of ordinary clouds upon the sun. The whistle showed the same intermittence as to period, but in the opposite sense, for when the whistle was faint the pipe was strong, and *vice versâ*.

There seemed to be an extraordinary amount of sound in the air. It was filled with a resonant roar from the Bayswater and Knightsbridge roads. The railway whistles were extremely distinct, while the fog-signals exploded at the various metropolitan stations kept up a loud and almost constant cannonade. I could by no means reconcile this state of things with the statements so categorically made regarding the influence of fog.

The water was on this day warmer than the air, and the ascending vapour was instantly in part condensed, thus revealing its distribution. Instead of being uniformly diffused, it formed wreaths and striæ. I am pretty confident that had the vapour been able to maintain itself as such, the air would have been far more opaque to sound. In other words, I believe that the very cause which diminished the optical transparency of the atmosphere augmented its acoustical transparency.

This conclusion was confirmed by numerous observations made while the fog lasted.*

On Dec. 13 the fog was displaced by a thin haze. We could plainly see from one bank of the Serpentine to the other, and far into Hyde Park beyond. There was a wonderful subsidence of the sound of the carriages, church bells, &c. Being at the bridge I listened for the sounds excited at the end of the Serpentine. With the utmost stretch of attention I could hear nothing. I walked along the edge of the water towards Mr. Cottrell, and when I had lessened the distance by one half, the sound of his whistle was not so distinct as it had been at the bridge on the day of the densest fog. Hence the optical cleansing of the air by the melting of the fog had so darkened it acoustically, that a sound generated at the end of the Serpentine was lowered to at least one-fourth of its intensity at a point midway between the end and the bridge.

This opportune fog enabled me to remove the last of a congeries of errors which, ever since the year 1708, have attached themselves to this question. As regards phonic coast-signals, we now know exactly where we stand.

It is worth observing here that the solution of the deportment of hail, rain, snow, haze, and fog, as regards sound, depends entirely upon observations made on the 3rd of July, which was about the last day that one would have chosen for experiments on fog-signals. Indeed, it had been distinctly laid down that observations on such a day would be useless; that they might indeed enable us to weed away bad instruments from good ones, but could throw no light whatever on the question of fog-signaling. That the contrary is the case, is an illustration of the fact that the solution of a question often lies in a direction diametrically opposed to that in which it appears to lie. †

* Since the first notices of this lecture appeared in the newspapers, strong confirmatory evidence has been received.

† The foregoing report was compiled from the notes of Prof. Tyndall. It is published with Prof. Tyndall's sanction, but was not written by himself.

EXTRACTS FROM AN ADDRESS BY SIR W. THOMSON, TO THE SOCIETY OF TELEGRAPHIC ENGINEERS

I HAVE advisedly, not thoughtlessly, used the expression "terrestrial electricity." It is not an expression we are accustomed to. We are accustomed to "terrestrial magnetism;" we are accustomed to atmospheric electricity. The electric telegraph forces us to combine our ideas with reference to terrestrial magnetism and atmospheric electricity. We must look upon the earth and the air as a whole—a globe of earth and air—and consider its electricity whether in rest or in motion. Then, as to terrestrial magnetism, of what its relation may be to perceptible electric manifestations we at present know nothing.

You all know that the earth acts as a great magnet. Dr. Gilbert, of Colchester, made that clear nearly 300 years ago; but how the earth acts as a great magnet—how it is a magnet,—whether an electro-magnet in virtue of currents revolving round under the upper surface, or whether it is a magnet like a mass of steel or load-stone, we do not know. This we do know, that it is a variable magnet, and that a first approximation to the variation consists in a statement of motion round the axis of figure—motion of the magnetic poles, round the axis of figure, in a period of from 900 to 1,000 years. The earth is not a uniformly magnetised magnet with two poles, and with circles of symmetry round those poles. But a first expression—as we should say in mathematical language the first "harmonic term"—in the full expression of terrestrial magnetism is an expression of a regular and symmetrical distribution such as I have indicated. Now, this is quite certain, that the axis of this first term, so to speak, or this first approximation, which, in fact, we might call the magnetic axis of the earth, does revolve round the axis of figure.

When the phenomena of terrestrial magnetism were first somewhat accurately observed about three hundred years ago, the needle pointed here in England a little to the east of north; a few years later it pointed due north; then, until about the year 1820, it went to the west of north; and now it has come back towards the north. The dip has experienced corresponding variations. The dip was first discovered by the instrument maker, Robert Norman, an illustration, I may mention in passing, of the benefits which abstract science derives from practical applications—one of the most important fundamental discoveries of magnetism brought back to theory by an instrument maker who made mariner's compasses. Robert Norman, in balancing his compass cards, noticed that after they were magnetised one end dipped, and he examined the phemonenon and supported a needle about the centre of gravity, magnetised it, and discovered the dip. When the dip was first so discovered by Robert Norman it was less than it is now. The dip has gone on increasing, and is still increasing; but about 50 years ago the deviation from true north was greatest. Everything goes on as if the earth had a magnetic pole revolving from west to east round the true North Pole, at a distance of 20° from it. About three hundred years ago its azimuth from England was a little to the east of the north pole: then it came round, moving eastwards on the far side of the north pole, and round in a circle towards us on the left-hand side of the north pole, as looked to from England. That motion in a circle round the north pole has already been experienced within the period during which somewhat accurate measurements have been made—has been experienced to the extent of rather more than a quarter of the whole revolution; and we may expect that about 200 years from the present time the magnetic pole will be between England and the North Pole; so that the needle will thus point due north, and the dip be greater than it has been for 1,000 years, or will be for another. It is one of the greatest mysteries of science, a mystery which I might almost say is to myself a subject of daily contemplation—what can be the cause of this magnetism in the interior of the earth? Rigid magnetisation, like that of steel or the load-stone, has no quality in itself in virtue of which we can conceive it to migrate round in the magnetised bar. Electric currents afford the more favoured hypothesis; they are more mobile. If we can conceive electric currents at all, we may conceive them flitting about. But what sustains the electric currents? People sometimes say, heedlessly or ignorantly, that thermo-electricity does it. We have none of the elements of the problem of thermo-electricity in the state of underground temperature which could possibly explain, in accordance with any knowledge we have of thermo-electricity, how there could so be sustained currents round the earth. And if there were currents round the earth, regulated by some cause so as to give them a definite direction at one time, we are as far as ever from explaining how the channel of those currents could experience that great secular variation which we know it does. Thus we have merely a mystery. It would be rash to suggest even an explanation. I may say that one explanation has been suggested. It was suggested by the great astronomer, Halley, that there is a nucleus in the interior of the earth, and that the mystery is explained simply by a magnet not rigidly connected with the upper crust of the earth, but revolving round an axis differing from the axis of rotation of the outer crust, and exhibiting a gradual precessional motion independent of the precessional motion of the outer rigid crust. I merely say that has been suggested. I do not ask you to judge of the probability: I would not ask myself to judge of the probability of it. No other explanation has been suggested.

But now, I say, we look with hopefulness to the practical telegraphist for data towards a solution of this grand problem. The terrestrial magnet is subject, as a whole, to the grand secular variation which I have indicated. But, besides that, there are

annual variations and diurnal variations. Every day the needle varies from a few minutes on one side to a few minutes on the other side of its mean position, and at times there are much greater variations. What are called "magnetic storms" are of not very unfrequent occurrence. In a magnetic storm the needle will often fly twenty minutes, thirty minutes, a degree, or even as much as two or three degrees sometimes, from its proper position—if I may use that term—its proper position for the time; that is, the position which it might be expected to have at the time according to the statistics of previous observations. I speak of the needle in general. The ordinary observation of the horizontal needle shows these phenomena. So does observation on the dip of the needle. So does observation on the total intensity of the terrestrial magnetic force.

The three elements, deflection, dip, and total intensity, all vary every day with the ordinary diurnal variation, and irregularly with the magnetic storm. The magnetic storm is always associated with a visible phenomenon, which we call, habitually, electrical;—aurora borealis, and, no doubt, also aurora of the southern polar regions. We have the strongest possible reasons for believing that aurora consists of electric currents, like the electric phenomena presented by currents of electricity through what are called vacuum tubes, through the space occupied by vacuums of different qualities in the well-known vacuum tubes. Of course, the very expression, "vacuums of different qualities" is a contradiction in terms. It implies that there are small quantities of matter of different kinds left in those nearest approaches to a perfect vacuum which we can make.

Well now, it is known to you all that aurora borealis is properly comparable with the phenomena presented by vacuum tubes. The appearance of the light, the variations which it presents, and the magnetic accompaniments, are all confirmatory of this view, so that we may accept it as one of the truths of science. Well now—and here is a point upon which, I think, the practical telegraphist not only can, but will, before long give to abstract science data for judging—is the deflection of the needle a direct effect of the auroral current, or are the auroral current and the deflection of the needle common results of another cause?

With reference to this point, I must speak of underground currents. There again I have named a household word to every-one who has anything to do with the operation of working the electric telegraph, and not a very pleasing household word I must say. I am sure most practical telegraphers would rather never hear of earth currents again. Still we have got earth currents; let us make the best of them. They are always with us; let us see whether we cannot make something of them, since they have given us so much trouble. Now, if we could have simultaneous observations of the underground currents, of the three magnetic elements, and of the aurora, we should have a mass of evidence from which, I believe, without fail, we ought to be able to conclude an answer more or less definite to the question I have put. Are we to look in the regions external to our atmosphere for the cause of the underground currents, or are we to look under the earth for some unknown cause affecting terrestrial magnetism, and giving rise to an induction of those currents? The direction of the effects, if we can only observe those directions, will help us most materially to judge as to what answer should be given.

It is my desire to make a suggestion which may reach members of this society, and associates in distant parts of the world. I make it not merely to occupy a little time in an inaugural address, but with the most earnest desire and expectation that something may be done in the direction of my suggestion. I do not venture to say that something may come from my suggestion, because, perhaps, without any suggestion from me, the acute and intelligent operators whom our great submarine telegraph companies have spread far and wide over the earth, are fully alive to the importance of such observations as I am now speaking of. I would just briefly say that this kind of observation is what would be of value for the scientific problem—to observe the indication of an electrometer at each end of a telegraph line at any time, whether during a magnetic storm or not, and at any time of the night or day. If the line be worked with a condenser at each end, this observation can be made without in the slightest degree influencing, and therefore without in the slightest degree disturbing, the practical work throughout the line. Put on an electrometer in direct connection with the line, connect the outside of the electrometer with a proper earth connection, and it may be observed quite irrespectively of the signalling; when the signalling is done, as it very frequently is at submarine lines, with a condenser at each end. The scientific observation will be disturbed undoubtedly, and considerably disturbed by the sending of messages, but the disturbance is only transient, and in the very pause at the end of a word there will be a sufficiently near approach to steadiness in the potential at the end of a wire connected with the electrometer to allow a careful observer to estimate with practical accuracy the indication that he would have were there no working of the line going on at the time. A magnetic storm of considerable intensity does not stop the working, does indeed scarcely interfere with the working, of a submarine line in many instances when a condenser is used at each end.

Thus, observations, even when the line is working, may be made during magnetic storms, and again, during hours when the line is not working, if there are any, and even the very busiest lines have occasional hours of rest. Perhaps, then, however, the operators have no time or zeal left, or, rather, I am sure they have always zeal, but I am not sure that there is always time left, and it may be impossible for them to bear the strain longer than their office hours require them. But when there is an operator, or a superintendent, or a mechanic, or an extra operator who may have a little time on his hands, then, I say, any single observation or any series of observations that he can make on the electric potentials at one end of an insulated line will give valuable results. When arrangements can be made for simultaneous observations of the potentials by an electrometer at the two ends of the line, the results will be still more valuable.

And, lastly, I may just say that when an electrometer is not available, a galvanometer of very large resistance may be employed. This will not in the slightest degree interfere with the practical working any more than would an electrometer, nor will it be more difficult to get results of the scientific observations not overpoweringly disturbed by the practical working if a galvanometer is used than when an electrometer is available. The more resistance that can be put in between the cable and the earth in circuit with the galvanometer the better, and the sensibility of the galvanometer will still be found perhaps more than necessary. Then, instead of reducing it by a shunt, let steel magnets, giving a more powerful direction to the needle, be applied for adjusting it. The resistance in circuit with the galvanometer between cable-end and earth ought to be at least twenty-times the cable's copper-resistance to make the galvanometer observations as valuable as those to be had by electrometer.

I should speak also of the subject of atmospheric electricity. The electric telegraph brings this phenomenon into connection with terrestrial magnetism with earth currents, and through them with aurora borealis, in a manner for which observations made before the time of the electric telegraph, or without the aid of the electric telegraph, had not given us any data whatever. Scientific observations on terrestrial magnetism, and on the aurora, and on atmospheric electricity, had shown a connection between the aurora and terrestrial magnetism in the shape of the disturbances that I have alluded to at the time of magnetic storms; but no connection between magnetic storms and atmospheric electricity, thunderstorms, or generally the state of the weather—what is commonly called meteorology—has yet been discovered.

The one common link connecting these phenomena hitherto known to us is exhibited in the electric telegraph. A telegraphic line—an air line more particularly, but a submarine line also—shows us unusually great disturbances, not only when there are auroras and variations of terrestrial magnetism, but when the atmospheric electricity is in a disturbed state. That it should be so electricians here present will readily understand. They will understand when they consider the change of electrification of the earth's surface which a lightning discharge necessarily produces.

I fear I might occupy too much of your time, or else I would just like to say a word upon atmospheric electricity, and to call your attention to the quantitative relations which questions in connection with this subject bear to those of ordinary earth currents and the phenomena of terrestrial magnetism. In fair weather, the surface of the earth is always, in these countries at all events, found negatively electrified. Now the limitation to these countries that I have made suggests a point for the practical telegraphists all over the world. Let us know whether it is only in England, France, and Italy that in fine weather the earth's surface is negatively electrified.

The only case of exception on record to this statement is Prof. Piazzi Smyth's observations on the Peak of Teneriffe. There, during several months of perfectly fair weather, the surface of the mountain was, if the electric test applied was correct, positively electrified; but Prof. Piazzi Smyth has, I believe, pointed out that the observations must not be relied upon. The instrument, as he himself found, was not satisfactory. The science of observing the atmospheric electricity was then so much in its infancy that, though he went prepared with the best instrument, and the only existing rules for using it, there was a fatal doubt as to whether the electricity was positive or negative after all. But the fact that there has been such a doubt is important. Now I suppose there will be a telegraph to Teneriffe before long, and then I hope and trust some of the operators will find time to climb the Peak. I am sure that, even without an electric object, they will go up the Peak. Now they must go up the Peak with an electrometer in fine weather, and ascertain whether the earth is positively or negatively electrified. If they find that on one fine day it is negatively electrified, the result will be valuable to science; and if on several days it is found to be all day and all night negatively electrified, then there will be a very great accession to our knowledge regarding atmospheric electricity.

When I say the surface of the earth is negatively electrified, I make a statement which I believe was due originally to Peltier. The more common form of statement is that the air is positively electrified, but this form of statement is apt to be delusive. More than that, it is most delusive in many published treatises, both in books and encyclopædias upon the subject. I have in my mind one encyclopædia in which, in the article "Air, Electricity of," it is said that the electricity of the air is positive, and increases in rising from the ground. In the same encyclopædia, in the article "Electricity, Atmospheric," it is stated that the surface of the earth is negatively electrified, and that the air in contact with the earth, and for some height above the earth, is, in general, negatively electrified. I do not say too much, then, when I say that the statement that the air is positively electrified has been at all events a subject for ambiguous and contradictory propositions; in fact, what we know by direct observation is, that the surface of the earth is negatively electrified, and positive electrification of the air is merely inferential.

Suppose, for a moment, that there were no electricity whatever in the air—that the air were absolutely devoid of all electric manifestation, and that a charge of electricity were given to the whole earth. For this no great amount would be necessary. Such amounts as you deal with in your great submarine cables would, if given to the earth as a whole, produce a very considerable electrification of its whole surface. You all know the comparison between the electricity of one Atlantic cable—the electro-static capacity of one of the Atlantic cables—with the water round its gutta-percha for outer coating, and the earth and air with infinite space for its outer coating.* I do not remember the figures at this moment; in fact, I do not remember which is the greater. Well, now, if all space were non-conducting—and experiments on vacuum tubes seem rather to support the possibility of that being the correct view—if all space were non-conducting, our atmosphere being a non-conductor, and the rarer and rarer air above us being a non-conductor, and the so-called vacuous space, or the interplanetary space beyond that (which we cannot admit to be really vacuous) being a non-conductor also, then a charge could be given to the earth as a whole, if there were the other body to come and go away again, just as a charge could be given to a pith ball electrified in the air of this room. Then, I say, all the phenomena brought to light by atmospheric electrometers, which we observe on a fine day, would be observed just as they are. The ordinary observation of atmospheric electricity would give just the result that we obtain from it. The result that we obtain every day in observations on atmospheric electricity is precisely the same as if the earth were electrified negatively and the air had no electricity in it whatever.

Well, now I have asserted strongly that the lower regions of the air are negatively electrified. On what foundation is this assertion made? Simply by observation. It is a matter of fact; it is not a matter of speculation. I find that when air is drawn into a room from the outside, on a fine day, it is negatively electrified. I believe the same phenomena will be observed in this city as in the old buildings of the University of Glasgow, in the middle of a very densely-peopled and smoky part of Glasgow; and therefore I doubt not that when air is drawn into this room from the outside, and a water-dropping collector is placed in the centre of the room, or a few feet above the floor, and put in connection with a sufficiently delicate electrometer, it will indicate negative electrification. Take an electric machine; place a spirit lamp on its prime conductor; turn the machine for a time; take an umbrella, and agitate the air with it till the whole is well mixed up; and keep turning the machine, with the spirit-lamp burning on its prime conductor. Then apply your electric test, and you find the air positively electrified.

Again—Let two rooms, with a door and passage between them, be used for the experiment. First shut the door and open the window in your observing room. Then, whatever electric observations you may have been performing, after a short time you find indications of negative electrification of the air. Then, during all that time, let us suppose that an electric machine has been turned in the neighbouring room, and a spirit-lamp burning on its prime conductor. Keep turning the electric machine in the neighbouring room, with the spirit-lamp as before. Make no other difference but this—shut the window and open the door. I am supposing that there is a fire in your experimenting room. Then, when the window was open and the door closed, the fire drew its air from the window, and you got the air direct from without. Now shut the window and open the door into the next room, and gradually the electric manifestation changes. And here somebody may suggest that it is changed because of the opening of the door and the inductive effect from the passage. But I anticipate that criticism by saying that my observation has told me that the change takes place gradually. For a time after the door is opened and the window closed, the electrification of the air in your experimenting room continues negative, but it gradually becomes zero, and a little later becomes positive. It remains positive as long as you keep turning the electric machine in the other room and the door is open. If you stop turning the electric machine, then, after a considerable time, the manifestation changes once more to the negative; or if you shut the door and open the window the manifestation changes more rapidly to negative.

It is, then, proved beyond all doubt that the electricity which comes in at the windows of an ordinary room in town is ordinarily negative in fair weather. It is not always negative, however. I have found it positive on some days. In broken weather, rainy weather, and so on, it is sometimes positive and sometimes negative. Now, hitherto, there is no proof of positive electricity in the air at all in fine weather; but we have grounds for inferring that probably there is positive electricity in the upper regions of the air. To answer that question the direct manner is to go up in a balloon, but that takes us beyond telegraphic regions, and therefore I must say nothing on that point. But I do say that superintendents and telegraph operators in various stations might sometimes make observations; and I do hope that the companies will so arrange their work, and provide such means for their spending their spare time, that each telegraph-station may be a sub-section of the Society of Telegraph Engineers, and may be able to have meetings, and make experiments, and put their forces together to endeavour to arrive at the truth. If telegraph operators would repeat such experiments in various parts of the world, they would give us most valuable information.

And we may hope that besides definite information regarding atmospheric electricity, in which we are at present so very deficient, we shall also get towards that great mystery of nature—the explanation of terrestrial magnetism and its associated phenomena,—the grand secular variation of magnetism, the magnetic storms, and the aurora borealis.

* The earth's radius is about 630 million centimetres, and its electrostatic capacity is therefore 630 microfarads, or about that of 1,600 miles of cable.

NOTES

We have frequently had occasion to refer to the energy and work of the Perthshire Society of Natural Science, and we rejoice to see that at its last meeting it has shown an example which we hope will be followed sooner or later by all scientific societies; it has resolved to make its influence felt in parliamentary elections. On the motion of the secretary, Dr. White, the following resolution was unanimously adopted:—"That in respect that Britain is apparently rapidly losing that commercial and

manufacturing supremacy which has heretofore distinguished her, and that it is high time that the Government of this country should take steps to retain that supremacy, and that means towards that desirable end is the appointment of a *responsible Minister of Education* whose duty it will be to see that our education machinery in all departments, both in extent and in efficiency, is kept up to the wants of the age, and that a thorough general education in the scientific principles on which the arts are founded (and without which training mere technical schools are of no use), is put within the reach of all, this society resolves that the candidates for the representation in Parliament of the County and City of Perth be respectfully requested to state, whether, in the event of their being elected they will use their influence to urge upon the Government; (1) the appointment of such responsible Minister of Education; (2) the promotion of scientific exploration expeditions, such as that of an Arctic expedition which the late Government was in vain requested to promote; (3) the providing of means for carrying on unremunerative scientific research." The secretary was accordingly directed to communicate with the candidates.

THE post of Hydrographer to the Navy has been bestowed by Mr. Goschen on Capt. J. O. Evans, R.N., C.B., F.R.S., in succession to Rear-Admiral Richards, C.B., F.R.S., who has retired.

THE first four wranglers on this year's Cambridge Mathematical Tripos, are, George C. Calliphronas, of Gonville and Caius College; Walter W. R. Ball, of Trinity College; James R. Harris, of Clare College; and Andrew Craik, of Emmanuel College.

THE following lectures in Natural Science will be given at Trinity, St. John's, and Sidney Sussex Colleges, during Lent Term, 1874:—On Sound and Light (for the Natural Sciences Tripos), by Mr. Trotter, Trinity College, in Lecture-room No. 11 (Monday, Wednesday, Friday, at 11, commencing Wednesday, Feb. 4); On Electricity and Magnetism (for the first part of the Natural Sciences Tripos and the special examination for the Ordinary Degree), by Mr. Trotter, Trinity College, in Lecture Room No. 11 (Tuesday, Thursday, Saturday, at 11, commencing Thursday, Feb. 5); On Inorganic Chemistry, by Mr. Main, St. John's College (Tuesday, Thursday, Saturday, at 12, in St. John's College Laboratory, commencing Thursday, January 29). Attendance on these lectures is recognised by the University for the certificate required by medical students previous to admission for the first examination for the degree of M.B. Instruction in practical chemistry will also be given. On Palæontology (the Annuloida, &c.), by Mr. Bonney, St. John's College (Tuesdays and Thursdays, at 9, commencing Tuesday, February 3). On Geology (for the Natural Sciences Tripos, Physical Geology), by Mr. Bonney, St. John's College (Mondays, Wednesdays, and Fridays, at 10, commencing Wednesday, February 4). Lithology: demonstrations with the microscope every Saturday at 11, commencing February 7. The class will be limited to six, and preference gived to members of the above colleges. Elementary Geology (for the First Part of the Tripos and the special examination) (Tuesdays and Thursdays, at 11. commencing Thursday, February 5). On Botany, for the Natural Sciences Tripos, by Mr. Hicks, Sidney College (Tuesday, Thursday, Saturday, at 11, in Lecture-room No. 1, beginning on Tuesday, February 3). The lectures during this term will be on Vegetable Histology and Physiology. A Course of Practical Physiol gy, by the Trinity Prælector in Physiology (Dr. Michael Foster) at the new museums. Lectures on Tuesday, Thursday, Saturday, at 12, commencing Tuesday, January, 27. This course is a continuation of that given last term.

DR. SCHMIDT, Professor of Astronomy in the University of Athens, has just completed his great map of the Moon. It is *two metres* in diameter, and is a marvel of accurate mapping and minute draughtmanship. The shading is so exquisite that any part of the map may be examined by a lens without the appearance of coarse or rough work. The map represents the labour of thirty-four years. and is without doubt one of the greatest astronomical results of the century.

THE discourse at the Royal Institution on Friday next, Feb. 6, at 9 P.M., will be by Mr. A. H. Garrod, Fellow of St. John's College, Cambridge, "On the Heart and the Sphygmograph."

A MARINE and Fresh-water Aquarium is to be established in the Central Park, New York, in connection with the Free Museum and Menagerie already erected there; it will be placed under the superintendence of Mr. W. Saville Kent, F.Z.S., who was, until a short time ago, Curator of the Brighton Aquarium. It is intended to raise the requisite funds by public subscription, and we are very pleased to be able to add that it is proposed to endow the Institution, so that it may be made available for the purposes of scientific research.

A PROJECT is on foot for the erection of a public aquarium at Liverpool, and a Company has been formed for this purpose; a suitable site has been secured close to the Philharmonic Hall, and operations will, we believe, be commenced at once. It is estimated the building will cost about 45,000*l.*

THE exhibition of appliances for the economic consumption of coal, which has been formed in the Peel Park, Salford, by the Society for Promoting Scientific Industry, was formally opened on Friday. Mr. J. Lowthian Bell, who had been announced to open the Exhibition, was prevented from being present, but forwarded the copy of an address which he had intended to deliver. This was read by the secretary, Mr. Larkins. The Exhibition will remain open for some weeks, and wil doubtless receive its share of public notice when the elections are occupying less attention than they are at present.

WE learn from the *Athenæum* that the Trustees of the British Museum have agreed to resign their patronage into the hands of the Government.

AN interesting peculiarity in the habits of some Indian Siluroid fishes has been noticed at a recent meeting of the Zoological Society by Surgeon F. Day, which will be described in full in the forthcoming Part of the Proceedings of that Society. Mr. Day, when fishing at Cassegode, found that, after having caught a large number of specimens of various species of *Arius* and *Osteogeniosus*, there were several siluroid eggs at the bottom of the boats, and in the fish-baskets. These eggs were, on an average, half-an-inch in diameter; and on looking into the mouths of several of the males of both genera, from fifteen to twenty eggs were seen in each; those in the boats and baskets having evidently dropped out from a similar situation. The eggs were in different stages of development, some advanced so far as to be just hatched. They filled the mouth, extending as far back as the branchiæ. No food was found in the alimentary canal, though in the females it was full of nutriment.

IN a paper on the Meteors of January 2, read before the American Philosophical Society, by Prof. Daniel Kirkwood, the author states, founding on data extending from A.D. 849 to 1864, that the meteors of this group have probably a period of thirteen years; that the mean distance is 5 53, aphelion 10.06; and that the source of the meteors may be the fourth comet of 1860, which in its ascending node approaches very near the point passed by the earth about January 3. If the period be thirteen years, the comet should have returned in the latter part of 1873, and the maximum fall of the associated meteors should occur about 1877.

Two legacies have recently been left to the French Academy of Sciences for the purpose of founding prizes. The one, a perpetual legacy of 2,500 francs, has been bequeathed by the late M. Gay, to be awarded as a prize in physical geography; and the other, a sum of 10,000 francs, the interest of which is to be awarded to the author of an astronomical work.

A GENTLEMAN in Glasgow who does not wish his name to be given, has just made a donation to Glasgow University of 1000*l*., for the better endowment of the chairs of astronomy, botany, and natural history.

AT the meeting of the Academy of Sciences at Paris on Monday, January 26, the place in the section of Anatomy and Zoology, vacant by the death of M. Coste, was filled up. M. P. Gervais was elected, but M. Alph. Milne-Edwards was a good second, obtaining 24 votes to M. Gervais's 33.

A NEW work by Mr. F. W. Burbidge, on "Cool Orchids, and how to grow them," is announced by Mr. Hardwicke, Piccadilly. It will be illustrated by coloured plates and wood engravings, and will be furnished with a copious list, in the shape of an index, of what are termed cool Orchids.

IN a despatch from Mr. Williams, H.M.'s Consul at Samoa, to the Foreign Secretary, dated Sydney, Oct. 28, 1873, it is stated that gold in quartz has been found in a valley in that island, about three miles from the Port of Apia; the samples assayed yielded at the rate of 3000 ozs. to the ton.

MR. J. F. GARDNER, geographer to Prof. Hayden's survey, in giving a short sketch of the method adopted by him to determine the altitude of the various points occupied by the party in the Rocky Mountains, states that the experience of the surveys of California and of the fortieth parallel show that in the determination of the altitude of any point a mercurial barometer is liable to an error varying from 150 to 300 feet, even when the base barometer is at the foot of the peak, and only 3000 feet below the summit. In connection with Professor Whitney (chief of the California Survey), the following plan was adopted for correcting the errors of barometrical work. Four points were chosen at successive levels of from one to 14,000 feet. These stations were carefully connected by levellings with a spirit level, and were occupied as permanent meteorological stations. The observations taken by field parties are classified according to their heights, and each class is referred to the base station which is nearest its own elevation; the lower station being Denver, the fourth the summit of Mount Lincoln (14,000 feet), where are a number of silver mines worked by Captain Breese. The central position of this peak admirably fits it for the base of reference. Besides the barometric determination of heights, two connected systems of trigonometric levelling have been carried over the whole area surveyed, and the check observations are so arranged that the probable error can be easily determined, and it is hoped that the system will prove accurate enough to throw some light on the amount of refraction at great elevations. By these methods the altitudes of many high points have been determined, from which to construct a map in contours 200 vertical feet apart, on a scale of two miles to one inch.

SIGNALLING between the earth and the planet Venus is a suggestion made in all good faith by a French astronomer, M. Charles Cros, who considers the coming transit of Venus to be a good opportunity for ascertaining whether there are inhabitants on that planet, and, if so, entering into relations with them. He says: "It is possible that Venus is inhabited; that amongst its inhabitants are astronomers; that the latter judge the passage of their planet across the solar disc to be an object to excite our curiosity; finally it is possible that these *savants* will strive in some way to make signals to us at the precise moment when they might suppose that many telescopes will be levelled at their planet."

IN a recent communication to the Connecticut Academy of Arts and Sciences, Prof. Marsh gave a statement of the results of his recent expedition to the Far West in search of fossil remains of extinct vertebrates. He said the richest field for exploration was found in the great basin of the pre-historic lake which is now drained by the Colorado River. This body of water was originally as large as all the present lakes of the North-West combined, and had existed so long that the sand washed down from the surrounding hills had accumulated to the depth of a mile. In the different strata of this bed at least ten distinct groups of extinct animals could be detected, among them some extremely remarkable forms. One of these was a rhinoceros with two horns; but these, not like those of the modern rhinoceros, in the axis of the body, but transversely. In a space of 10 ft. square he had sometimes found the bones of 30 different animals. The number of species of extinct mammals in these remains he estimates to be three times as great as that at present inhabiting the same locality.

A PAPER on Electrical Warfare will be read by Mr. Nath. J. Holmes, at the Society of Telegraph Engineers, on Wednesday, the 11th inst.

THE new Holmes' Shipwreck Distress Signal, of great power, will be exhibited from Primrose Hill on Thursday evening, 12th, at 8.30, in presence of the Marine Secretary of the Board of Trade. This signal is self-igniting in water, and inextinguishable.

THE Naples correspondent of the *Times*, writing on Jan. 25, states that Prof. Palmieri has just published the following letter in answer to the numerous applications sent to him for information:—"The activity of Vesuvius continues to increase in the crater towards the N.E. Frequent globes of smoke issue from the bottom of it, with a kind of hissing sound, accompanied by an unpleasant odour of chloridic and sulphuric acids. Not far from it, at the commencement of the grand fissure of 1872, alkaline sublimates make their appearance. Meanwhile the fire does not yet show greater activity at the bottom of the crater, where it will probably manifest itself, unless some eccentric eruption should occur before the internal resistance of this crater is overcome. The great subterranean energy now at work does, indeed, appear to be making an attempt at an outlet in various parts. On the 21st inst. a slight undulatory shock of earthquake was felt at Casamicciola, in the island of Ischia, and during the last week many have heard the low continuous mutterings of the mountain at a distance of 15 miles. As I write, however, the sismograph, which has been very agitated for some days, is more quiet." He also reports the melancholy death at Casamicciola of Mr. Moggridge, who having bathed in the open sea, died on his road to the hotel.

WE have received the Report of the *Senckenbergische naturforschende Gesellschaft* for 1872-73, a society of long standing, and with several eminent names in its list of members. The membership, we are glad to learn, shows a considerable increase during the year; though M. v. Fritsch states, in his report, that the efforts of the society are sadly hampered for lack of funds, and that "we exist and vegetate, rather than live." He laments, also, that the museum, which once stood fifth in importance in Europe, is being quickly surpassed by other like institutions, and thrown into the background; which is hardly creditable to a city of such wealth and culture as Frankfort. Among the researches detailed in this *Bericht*, we note a paper by Dr. Koch on the Arachnida of North Africa, especially those (hitherto unstudied) of the Atlas region, and the coast of Morocco; the

material having been collected by Drs. von Fritsch and Rein. The new types are not very numerous, but the remarkably wide distribution of spider-species is confirmed; and good illustration afforded of the influence of climate and other local conditions in modifying type forms. Dr. Rein describes some plants found in the neighbourhood of Mogador, and also furnishes a sketch of the vegetation of the Bermudas. A new species of perforating cirripede, *Kochlorine hamata* N., is described by Dr. Knoll; M. Scheidel contributes a note on lake dwellings and their inhabitants; and there are interesting accounts of journeys to Iceland, and to the Puglia Petrosa, in Italy.

WE have received the first Annual Report of the "Haileybury Natural Science Society." It contains preliminary lists of the fauna and flora of the place, together with observations on the meteorology of the locality, and a humorous description of an experimental dinner at which the principal dish consisted of esculent snails which had been specially fed and fattened for the purpose by certain members of the Society. It need scarcely be added, that the repast amply rewarded the members for their generous devotion to the cause of Science.

THE additions to the Zoological Society's Gardens during the past week include three Mauge's Dasyures (*Dasyurus maugæi*) from Australia, presented by Mr. J. Shaw; two Vulturine Guinea Fowl (*Numida vulturina*) from East Africa, presented by Dr. J. Kirk; a Chilian Sea-Eagle (*Geranoaëtus aguia*) from Bahia, presented by Mr. J. Judge; an Indian Leopard (*Felis pardus*) presented by Mr. G. D. Elphinstone; two Orang Outangs (*Simia satyrus*) from Borneo, and a Ungko Gibbon (*Hylobates variegatus*) from Sumatra, deposited; two Wanderoo Monkeys (*Macacus silenus*) from the Malabar Coast; a Brown Monkey (*Macacus brunneus*) and two Adjutants (*Leptoptilus argala*) from India, two Pheasant-tailed Pigeons (*Macropygia phasianella*) from N.S. Wales, and two Jambu Fruit Pigeons (*Ptilonopus jambu*) from the Indian Archipelago, purchased.

SCIENTIFIC SERIALS

American Journal of Science and Arts, December 1873.—In a paper on the magnetic permeability (that is "conductivity," according to Faraday), and the maximum of magnetism of iron, steel, and nickel, by Mr. Henry Rowland, C.E., the results are expressed, and the reasoning is carried out in the language of Faraday's lines of magnetic force. The quantity introduced, in mathematical theories of induced magnetisation, depending on the magnetic properties of the substance, is in these treated as a constant; but it was shown, in twelve cases of iron and two of nickel, to vary between wide limits. The author finds that the magnetisation of good iron can never exceed 175,000 times the unit magnetic field (on the metre, gramme, second, system), nor can nickel exceed 63,000 times; and from these data, and with aid of a formula of Prof. Maxwell's for tension of lines of force, it is inferred that the greatest weight which can be sustained by an electro-magnet with an infinite current, is, for iron, 354 lbs. per square inch of section, and for nickel 46 lbs. The results of experiment closely agreed with this.—Prof. Henry Draper communicates a note on diffraction-spectrum photography, accompanied with a photograph printed by the Alberttype process. (See NATURE, vol. ix. p. 223.)—We note several geological papers, one of them, by Prof. Fontaine, describing a remarkable deposit of bituminous matter, termed Grahamite, in Ritchie County, West Virginia, chemically resembling the mineral Albertite of New Brunswick, but differing considerably from this in its geological relations.—The age of the Lignitic formation of the Rocky Mountain region is far from decided, owing to the contrary evidence afforded by fossil plants and animals; and the editors propose to cite the arguments from various sources, in order, if possible, to bring about agreement. They give in this number the conclusions of M. Lesquereux from fossil plants. He refers the Lignitic beds to the Upper and Lower Eocene; and he gives a number of facts showing the disconnection of American Eocene flora from that of the Cretaceous, indicating truly separate formations.—Mr. Comstock describes the geology of Western Wyoming.—Mr. Verrill communicates the results of a recent dredging expedition on the coast of New England. It was ascertained that the body of cold bottom water approaches so nearly to the Coast of Maine as to manifest itself distinctly within twelve or fifteen miles of Cape Elizabeth, both by its highly Arctic fauna, and its icy temperature, even in summer.—In a letter from Cordoba, dated Sept. 8, 1873, Dr. Gould describes a remarkable swarm of locusts then occurring.

Astronomische Nachrichten, No. 1970, Jan. 14, contains the following papers:—On the determination of longitude by star-occultation and the telegraphically determined longitude between Madras, Singapore, and Batavia, by Dr. Oudemans. The author mentions his observations in 1859 as giving a longitude for Batavia of 7h. 7m. 12·5 s., also others in later years giving rather a less result. In 1870-71, however, the telegraphic communication with Singapore was used, giving a mean result of 11m. 40·895 s. longitude from that place. The same author gives a note on Kaiser's original proof of Foucault's pendulum researches. The proof is given by Prof. Oudemans, by which the plane of motion of the pendulum moves in azimuth in 1 sec., $15''. \sin \phi$. It is too long to give in full here, but appears simple and good. Prof. Oudemans has also two other papers on position observation made during the eclipse of Dec. 1871 at Java, and on the Spheroidal form of the earth, which consist chiefly of equations and tables which we have not space to introduce.—Dr. Holetschek gives ephemerides of a number of the minor planets.

Der Naturforscher, December 1873.—This number contains notes from the Bothkamp Observatory. In one of them M. Vogel gives observations of the spectra of several fixed stars, comparing the results obtained by Huggins and Miller. Another treats of periodic changes in the atmosphere of Jupiter. The observation that the occurrence of certain coloured stripes in Jupiter, and of bright egg-shaped spots in his equatorial zone coincided with the maximum epoch of sunspots, appears to be confirmed by a number of fresh data collected by the writer, Dr. Lohse. A third note describes observations of Venus in 1871-73, by M. Vogel, who thinks it probable that the planet is surrounded with an atmosphere in which floats a thick and dense layer of condensation products, so that little insight is afforded to the planet's surface, and the observation of spots helps but little to ascertaining the time of rotation or the position of the axis of rotation.—In physics, we have a note on the curious fact which M. Budde has recently studied, viz., that chlorine, when acted on by very refrangible rays of light, undergoes expansion and heating. Some experiments, made by M. Hirn, on the optical properties of flame, tend to show that flame is not perfectly transparent to light (as Arago and M. Offret have affirmed), but that particles in the glowing state are; the weakening of light in its transmission through flames is due to the various refractions it undergoes, and consequent dispersion. The author is led to some speculations on the sun's temperature, and he puts the case thus: If the glowing parts of the photosphere are intransparent, the temperature must (according to mathematical calculation), be nearly six million degrees; if they are transparent, it must be considerably less; and the lower, the greater the transparency. The problem is one for experimental physics, the question being, Are all solid or liquid bodies transparent and diathermanous when brought to a very high temperature? M. Hirn, we have seen, inclines to reply in the affirmative. We find accounts of Prof. Guthrie's discovery of a new relation between heat and electricity, and M. Herwig's experiments on pulverisation of electrodes in the voltaic arch.—Chemistry is represented by papers on the laws governing water of crystallisation, and the reduction of carbonic acid by phosphate of iron.—The action of camphor on plant life has been recently studied by M. Vogel at Munich, in a series of experiments which confirm an almost forgotten observation by Barton in the last century, that camphor has a stimulant effect on plants analogous to that of spirituous liquors or opium, in certain quantity, on the human system. There are also botanical notes on the influence of CO_2 on verdant growth of plants (M. Böhm), and on the geographical distribution of the Cupuliferæ (M. Oersted); and, in technology, M. Riche discusses the physical properties of certain alloys.

SOCIETIES AND ACADEMIES

London

Geological Society, Jan. 21.—Prof. P. Martin Duncan, F.R.S., vice-president, in the chair.—"The secondary rocks of Scotland (second paper). On the ancient volcanoes of the Highlands and their relations to the Mesozoic strata," by J. W. Judd, F.G.S. That the rocks forming the great plateaux of the Hebrides and the north of Ireland are really the vestiges of innumerable lava-streams, is a fact which has long been recognised by geologists. That these lavas were of *subaerial* and not *subaqueous* origin is proved by the absence of all contemporaneous interbedded sedimentary rocks, by the evidently terrestrial origin of the surfaces on which they lie, and by the intercalation among them of old soils, forests, mud-streams, river-gravels, lake deposits, and masses of unstratified tuffs and ashes. From the analogy of existing volcanic districts, we can scarcely doubt that these great accumulations of igneous products, which must originally have covered many thousands of square miles, and which still often exhibit a thickness of 2,000 ft., were ejected from great volcanic mountains; and a careful study of the district fully confirms this conclusion, enabling us, indeed, to determine the sites of these old volcanoes, to estimate their dimensions, to investigate their internal structure, and to trace the history of their formation. The following is Mr. Judd's conclusion on the subject of his paper:—It appears that during the Newer Palæozoic and the Tertiary periods, the north-western parts of the British archipelago were the scene of displays of volcanic activity upon the grandest scale. During either of these, the eruption of felspathic lavas, &c., preceded, as a whole, that of the basaltic; and in both the volcanic action was brought to a close by the formation of "puys." The range of Newer-Palæozoic volcanoes arose along a line striking N.E. and S.W.; that of the Tertiary volcanoes along one striking from N. to S.; and each appears to have been connected with a great system of subterranean disturbance. It is an interesting circumstance that the epochs of maximum volcanic activity, the Old Red sandstone and the Miocene, appear to have been coincident with those which, as shown by Prof. Ramsay, were characterised by the greatest extent of continental land in the area. The Secondary strata were deposited in the interval between the two epochs of volcanic activity, and the features which they present have been largely influenced by this circumstance. Apart from this consideration, however, the volcanic rocks of the Highlands are of the highest interest to the geologist, both from their enabling him to decipher to so great an extent the "geological records" of the district, and from the light which they throw upon some of the obscurest problems of physical geology.—Remarks on fossils from Oberburg, Styria, by A. W. Waters, F.G.S. The author noticed the limited occurrence of Eocene deposits in Styria, and referred briefly to the researches of Prof. Reuss and Prof. Stur upon them. He then indicated certain species of fossils which he had detected in these beds, adding about nine species to Stur's list.

Anthropological Institute, Jan. 27.—Prof. Busk, F.R.S., president, in the chair.—Aniversary Meeting.—Before proceeding to read his address, the president referred to the financial condition of the Institute, which, although it showed that the receipts were adequate for the necessary expenditure on the present economical principles of management, would not admit either of paying off any more of the debt or of increasing the scope and usefulness of the Institute. Until the unfortunate and utterly indefensible secession of members early in 1873, on a purely personal question, the Institute, since its formation, had paid off the combined debts of the two old societies at the rate of 100*l.* a year. He appealed to the loyalty of the members now forming the Institute to make a united effort finally to extinguish the debt of 800*l.* A year's income would do it, and it was suggested that if each member contributed one year's subscription, that great result would be attained and the Institute would certainly before long occupy a high position amongst the scientific bodies of the kingdom. As an encouragement to the body of members and as an earnest of the sincerity and vigour of his colleagues in management, the president had much pleasure in announcing that nearly 250*l.* had been promised by members present at a council-meeting held that day, provided the sum of 500*l.* be contributed by other members of the Institute.—The president then delivered the annual address, in which he viewed the work done during 1873 by English and foreign anthropologists. Amongst a large number of topics he adverted at considerable length to the important contributions to craniometry, by Dr. H. von Jhering and Dr. Paul Broca, criticising the respective methods employed by those distinguished anthropologists; and concluded that part of his address with the observation that the study of craniology is almost futile when applied to highly civilised, and consequently much mixed peoples, and that its results are the more certain in proportion to the purity of race. That purity at the present time was rapidly disappearing, and with it the surest data for the determination of the problems involved in the antiquity and physical origin of man.—The following was the list of officers and council elected to serve for 1874:—President—Prof. Geo. Busk, F.R.S. Vice-presidents—John Evans, F.R.S.; Col. A. Lane Fox, F.S.A.; A. W. Franks, M.A.; Francis Galton, F.R.S.; Prof. Huxley, F.R.S.; Sir John Lubbock, Bart., F.R.S. Director—E. W. Brabrook, F.S.A.—Treasurer—Rev. Dunbar I. Heath, M.A. Council—Dr. John Beddoe, F.R.S.; W. Blackmore; H. G. Bohn, F.R.G.S.; Dr. A. Campbell; Hyde Clarke; Dr. J. Barnard Davis, F.R.S.; W. Boyd Dawkins, F.R.S.; Robert Dunn, F.R.C.S.; David Forbes, F.R.S.; Sir Duncan Gibb, Bart, M.D.; George Harris, F.S.A.; J. Park Harrison, M.A. J. F. McLennan; C. R. Markham, C.B. F.R.S.; Frederic Ouvry, F.S.A.; F. G. H. Price, F.R.G.S.; J. E. Price, F.S.A.; F. W. Rudler, F.G.S.; C. R. Des Ruffières, F.R.S.L.; E. Burnet Tylor, F.R.S.

Edinburgh

Royal Physical Society, Jan 28.—Mr. Scot Skirving, president, in the chair.—The following communications were read: Note on the Crushed Boulders from the Old Red Conglomerate in Kincardineshire, by James C. Howden, M.D., —On Crushed Boulders from Arbroath, and other localities, by Mr. Charles W. Peach.—Report of the Dredging Committee for 1873, by James Middleton, M.B., convener. The meeting of the committee had been held conjointly with the Naturalists' Field Club. In all about 133 species of animals had been obtained, including two new to the Firth of Forth.—Note on the Suspension of Clay in Water, by Mr. William Durham. This research was undertaken in continuance of those recorded in the papers on the same subject read at the last meeting. As the general result of Mr. Durham's elaborate and careful series of experiments, it was found that clay held in suspension by water sinks more quickly if the water is slightly acidulated, and more slowly if a slight amount of an alkali is added, but that the conditions are reversed if a large amount of either substance is mixed with the water.

Manchester

Geological Society, Jan. 27.—Mr. J. Dickenson Hill in the chair.—Mr. J. Aitken exhibited some new fossil fishes from the millstone grit, Yorkshire, and read a paper descriptive of the bed whence they were obtained. He said that evidences of fossils had been brought to the surface during the excavations connected with the scheme for taking water from Widdop colliery to the borough of Halifax by a tunnel cut through Wadsworth Moor, about two miles north of Hebdenbridge. After an examination, by no means exhaustive, there had been discovered seven specimens of *Goniatites*, three of *Nautili*, two of *Orthoceratites*, two of *Avicula pecten*, two of *Posodonia*, one of *Gastropod*, one of *Milamia*, fish remains, &c. The discovery of the most remarkable character was a new species of *Acrolepis* presenting peculiar characteristics. The situation in which these remains occurred was near but somewhat above the middle of the shells which usually divided the third floors from the fourth or undermost grit.

Göttingen

Royal Academy of Sciences, Nov. 1, 1873.—M. Schering communicated a paper on the Hamilton-Jacobi theory for forces whose measurement depends on the motion of bodies.—MM. Wagner, Philippi, and Tollens described some researches on the Allyl group, made with the view of establishing the constitution of allyl alcohol, and of some of its compounds, especially acrylic acid. They find new evidence, in opposition to Wislicenus, that acrylic acid, as well as acetic acid, propionic acid, and all other organic acids, contains the group CO_2H, and may therefore be classed with them.—MM. von Grote and Tollens described an acid obtained from cane sugar by means of dilute sulphuric acid; and M. Tollens gave the first results of an investigation as to combinations of starch with alkali.

Nov. 20.—Prof. Lüroth read a paper on reckoning by projections; and Prof. Hattendorff made some observations on Sturm's theorem.

Dec. 3.—M. Enneper communicated a paper on the general theory of surfaces.

Dec. 10.—The Society celebrated its 121st anniversary. The prizes for competition in the next three years were announced. In the physical section the Society invites experiments on the artificial production of some crystallised minerals, as stephanite, pyrargyrite, grey copper ore, galena, fluor spar; in order to solution of the question how crystallised sulphur and fluor-compounds have arisen in the natural state. In the mathematical section, the Society desires an investigation of current-work, *i.e.* the work done by the electro-motive forces in their action on the current electricity, especially in its relation to the heat produced from the current, and the *vis viva* produced from it immediately in the current electricty, or mediately, in other movable particles in the conductor. Papers on these subjects must be sent before Sept. 1875, in the former case, and Sept. 1876, in the latter. The prizes offered are fifty ducats each.—Prof. Ewald communicated an interesting paper on the so-called rhetorical ornaments of Oriental speech (a subject suggested, apparently, by the late visit of the "king of kings)."—M. Riecke presented a note on the function of leaf-teeth, and the morphological value of some leaf-nectaries. In the bud, the teeth often prevent the hermetical closure of the two folded halves of the leaf; which is perhaps important, that the bud may not suffer from the want of gas. A more evident function consists in the separation of resin or mucilage. *Prunus avium* is taken as a good example; and two other types of structure are also described. The teeth of leaves of *Prunus avium* are closely allied, morphologically, to numerous nectar-secreting organs in these and other kinds of leaf.

Dec. 17.—M. Bjerknes read a paper giving a generalisation of the problem of motions produced in a still inelastic fluid by the motion of an ellipsoid.—M. Wöhler presented a list of the meteorites in the University collection at Göttingen.

Vienna

Imperial Academy of Sciences, Dec. 4, 1873.—Prof. Mach stated that he had made experiments, during the summer, on the time required for rotation of the plane of polarisation by a current—a flint glass disc being rotated between the magnetic poles; but similar experiments by Villari had been described in *Pogg. Ann.* (No. 7, 1873), and the results were almost identical. Villari used a double plate; and Prof. Mach points out another very simple method for such researches, viz., the spectral observation of a sounding glass rod placed between the magnetic poles.—A paper by Dr. Dvorak described some experiments on the velocity of sound in gas-mixtures. If a mixture is made of two different gases, with densities d and d' respectively, and both with an expansive force 1, the velocity of sound V in the mixture $= \sqrt{\frac{2}{d + d'}}$. The author's results show close agreement with the theory. Thus for mixtures of carbonic acid and hydrogen, air and hydrogen, ordinary gas and CO_2, respectively, the observed and calculated numbers for the half wave-length of a given tone were these: 71·5, 71·0; 88, 89·0; 64, 63·3. The author remarks that for a simple gas, as well as for a mixture of gases, the gas theory implies not one velocity, but a graduated series of velocities, of sound; and perhaps the prolongation in sound of a cannon shot heard at a distance may be thus explained.—Dr. Exner communicated a determination of the temperature at which water has a maximum of density. He improved on Rumford's method by using thermo-elements instead of a mercury thermometer. The value obtained was 3·945°.

Paris

Academy of Sciences, Jan. 26.—M. Bertrand in the chair.—The following papers were read: On the various reactions of the compounds of oxygen and nitrogen, by M. Berthelot.—On the production of yeast in a mineral solution containing sugar, by M. Pasteur. The author described the growth of yeast in a solution of inorganic substances such as enter into the composition of its ash added to a solution of sugar. M. Trécul replied at some length to certain of M. Pasteur's remarks.—On the liquefaction and solidification of acetylene by the silent electric discharge, by MM. P. and A. Thenard. The author found that this gas condensed at the rate of four or five cubic centimetres a minute into a solid horny body isomeric with acetylene; by varying the conditions of experiment a liquid isomer was also obtained.—Experimental researches on Newton's rings, by M. P. Desains.—Direct demonstration of the equation $\int \frac{dQ}{T} = 0$ for every closed and reversible cycle, by M. A. Ledieu. This paper formed a sequel to the author's other papers on thermo-dynamics, lately published.—Note on Poncelet's teaching of applied mechanics, by General Morin.—A note from Prof. Nordenskiöld was read; he has detected iron, nickel and cobalt in the carbonaceous dust found in 1870 on the Greenland snow; traces of phosphorus were also found.—Instructions for M. Doûmet-Adanson's travel in Tunis, by M. Cosson. The instructions are issued to M. Adanson, who is about to undertake a botanical exploration of Tunis.—On magnetism, by M. J. M. Gaugain.—New researches on the rejoining end to end of the fibres of sensory with the fibres of motor-nerves, by M. A. Vulpian.—Organogenesis compared with androgenesis in its relation to natural affinities, by Ad. Chatin. This portion of the author's paper deals with the *polygonoïd* and *cactoid* plants.—Researches on the silicified plants of Autun; study of the genus *Myelopteris*, by M. B. Renault.—On the presence of a considerable proportion of potassic nitrate in two varieties of *Amaranthus*, by M. A. Boutin. The author found that *A. atropurpureus* contained 22·7 and *A. ruber* 16·0 per cent. of the weight of the dried plant; he suggested a possible future cultivation of the plant on this account.—On the theory of the flight of birds, by MM. H. and L. Planavergne.—On a statistical chart showing the distribution of the population of Paris, by M. Vauthier.—On the geometrical properties of rational fractions, by M. F. Lucas.—On the determination of the pluckerian numbers of envelopes, by M. H. G. Zeuthen.—On the theory of numerical equations, by M. Laguerre.—On the breaking of magnetised needles, by M. Bouty. The author found that if the steel was very brittle and broke like glass the two portions are magnets of the same magnetic moment, but not so if the steel has to be bent backwards and forwards before it breaks.—On certain peculiarities in the efflorescence of the two hydrates of sodic sulphate, by M. D. Gernez.—Researches on the reaction of argentic chloride on phosphoric di-iodide, by M. Arm. Guntier.—On the isomerism of terebenthene and terebene, from a physical point of view, by M. J. Ribau.—On the alterations of the soft matter (of the brain) accompanying the tearing and cutting back of the sciatic nerve in the rabbit, by M. G. Hayem.—On the pluvial *régime* of the torrid zones in the Indian and Pacific Ocean basins, by M. V. Raulin.—Note on Professor Tyndall's experiments on the acoustic transparency of air, by M. W. de Fonvielle.—On the production of crystals of calcic oxalate and ammonic-magnesic phosphate, by M. E. Monier. During the meeting, the Academy elected M. Gervais as successor to the late M. Coste, of the section of Anatomy and Zoology.

CONTENTS

THURSDAY, FEBRUARY 12, 1874

A MINISTER FOR SCIENCE

WE are glad to see that the *Times* has at last opened its pages to the question of the propriety of appointing a responsible Minister, whose duty it shall be to look after the interests of Science and of scientific research and education, and take charge of the scientific institutions of the country—institutions whose efficiency is at present sadly crippled from the want of a single responsible head. The whole question could not be better stated than in Colonel Strange's letter which appeared in the *Times* of the 6th inst., and which we consider so admirably to the point, that we gladly reproduce it here. We hope the letter will lead to further discussion, and that whatever Government may hold the reins in the forthcoming Parliament, the important question now raised may meet with serious attention. Colonel Strange's communication runs as follows:—

"No subject affecting the material interests of England is more important at the present day than that discussed at Manchester by Lord Derby, and by yourself in your leader of the 12th ult.

"'Scientific industry' is one of those clever phrases calculated to catch the eye and ear by its novelty, while it expresses what is already well known by other antiquated names. Lord Derby defines it and explains its meaning in a variety of ways; but throughout his whole speech he is talking, while never naming it, of nothing more nor less than scientific research. The utilisation of redundant natural forces and of waste substances, on which he insists as a primary object of the new movement, is to be brought about by patient, continuous, systematic research, and by nothing else. I own I prefer the old words to the new, but if by using new words old wants come to be recognised and supplied, I shall not complain.

"I, and many who think with me, maintain that scientific research must be made a national business; that the point at which Science, in most of its leading branches, has now arrived and the problems presented for solution are such as to need for their adequate treatment, permanent well-equipped establishments with competent staffs worked continuously and systematically. Lord Derby truly describes it as a case in which what is 'everybody's business is nobody's business.' We must make it somebody's business. We must make it the State's business. We have tried individual enterprise, which so many hold to be all-sufficient. There is more individual enterprise in England than in any country in the world, and yet we are being rapidly outstripped by nations who, though they encourage private exertion, are wise enough not to rely on it, but to establish a system free from the caprice, the incompleteness, the liability to interruption and cessation incident to all individual labour in whatever field. If asked to describe the system we propose to establish, our reply is in one word, 'completeness.' A steam-engine is a system, composed of many parts, each and all essential to its useful action. Furnace, boiler, cylinder, pistons, connecting rods, beam, and fly-wheel—all controlled by a governor. Tested by the condition 'completeness,' what is Lord Derby's new society? What is any private society? A mere connecting rod—a most useful link in the system, not to be dispensed with, but still a mere link. Where are the other parts? Is there a trace of them in England?

"The first essential to any system is a head. No domestic household, no manufactory, no ship, no army or navy, no public or private establishment of any kind, and these are all 'systems,' can hold its own for a day without a head. But at the present hour there is no head to the science of England. The proposed remedy for this deficiency will have been anticipated as obviously a Minister of State, who shall be responsible to the nation through Parliament for everything connected with the scientific business of the country. For want of this head what have we done? The various scientific institutions at present maintained by the State are distributed according to the following list, which was correct some time since, but may have undergone recent changes:—1, Royal Observatory, Greenwich, under the Admiralty; 2, Royal Observatory, Edinburgh, under the Office of Works; 3, Royal Observatory, Cape of Good Hope, under the Colonial Office; 4, 5, 6, the Observatories at Madras, Calcutta, and Bombay, under the India Office; 7, Ordnance Survey of Great Britain, under the Office of Works; 8, the Great Trigonometrical Survey of India, under the India Office; 9, Exchequer Standards Office, under the Board of Trade; 10, the Royal School of Mines, under the Privy Council; 11, British Museum, under 50 irresponsible trustees; 12, Meteorological Office, governed by an unpaid, and therefore irresponsible, Committee of the Royal Society, under the Board of Trade; 13, the Royal Botanic Gardens of Kew, Edinburgh, and Dublin, under the Board of Works; 14, the Geological Survey, under the Privy Council. My list is perhaps not quite complete, but as it stands it shows that we place our scientific institutions under no less than seven different Departments of State, all of which have other matters besides science to attend to. Can anyone pretend there is any trace of a system here? Is it not a grotesque caricature of State administration?

"Granted that there must be a Minister for Science—and I am happy to say that those who have given most attention to the question now admit that there must—then the whole of the institutions I have named, besides some others now in existence, and many others that must before long be founded, would be placed under him. This would secure the great object of harmony and unity of parts, of provision for modification and extension, and of definite responsibility to the nation through Parliament, none of which objects are obtainable or seem even dreamt of at present.

"Whether such a Ministry should be created as additional to what we at present possess, or whether some existing Minister should be charged with Science; whether the Science Minister should not also take Education, Art, and Music under his care; whether he should not have permanent unparliamentary advisers, and if so on what scale and how constituted, besides many other points, are all extremely important questions, admitting of a great variety of answers; but compared with the fundamental necessity for a Minister at the head of a Department controlling the whole public scientific activity of the kingdom, they are matters of subordinate detail.

"The Royal Commission on Science, presided over by the Duke of Devonshire, has, for nearly three years, been most assiduously engaged in collecting a body of information of infinite value, and they will no doubt forward many important recommendations on the evidence they have taken; but for my part, as one deeply interested in their proceedings, to which I have contributed largely as a witness, I do not hesitate to say that if they only succeed in obtaining the creation of a Science Minister, that re ult alone will amply repay the country for the cost of their investigations.

"Let this be done, and we should cease to witness the farce of consulting the Chancellor of the Exchequer about observing eclipses of the sun, the Prime Minister about scientific Arctic expeditions, and the Treasury about tidal reductions. We should perhaps, too, then perceive that overworked Law Officers are not the best managers of a great, or what should be a great, technical Museum, and that fifty irresponsible gentlemen, however eminent individually, ought not to be entrusted with the grandest collection of Art and Natural History in the world. Nor would a wise statesman like Lord Derby fail to perceive, with all science concentrated under one view for his inspection, that a private local Society will prove no match for the complete and powerful State systems of Germany, France, and other Continental nations."

PINK AND WEBSTER'S "ANALYTICAL CHEMISTRY"

A Course of Analytical Chemistry (*Qualitative and Quantitative*). By William W. Pink and G. E. Webster. (London: Lockwood & Co., 1874.)

THIS work forms a volume of Weale's Rudimentary Series, and is advertised "as specially adapted for the use of those students who intend competing in the Advanced or Honours Stage Examinations (Inorganic Chemistry) of the Science and Art Department, also for preparing those intended to sit for the higher class examinations at Colleges, Public Schools," &c. The success which several well-known serial publications of a similarly special nature have deservedly had, appears to have stimulated the publishers of Weale's Series to embark in this enterprise. As the excellence of most of their former publications will be generally admitted, we can only regret that a literary (?) production displaying such deplorable ignorance should ever have found a place in their series. It has rarely been our duty to pass judgment on a more carelessly got-up book. Had it not been advertised as specially adapted for the use of the Science Classes under the Science and Art Department, we might have put it aside with a hearty laugh over the many absurd blunders it contains. Since a practice has, however, sprung up of late to cater for the wants of Science Classes, by printing books (sometimes obtained on commission) privately, and advertising them by means of post-cards, at so many postage stamps a copy, whereby these books manage to escape the eye of the reviewer, and as we fear that much mischief is being done by certain cheap cram-books, strung together with a view to save the teacher as much trouble as possible, our readers will perhaps bear with us if we examine the book before us somewhat closely. If rumour speaks true, some teachers manage to teach chemistry — even analytical chemistry—without ever touching a test-tube or performing the simplest experiments. Questions from previous examinations are eagerly collected and "worked" in the belief that the examiner is sure to give, if not the same questions, at least others of a similar nature. We need not fear giving offence to those earnest and hard-working men, engaged, often on a mere pittance and under most adverse and discouraging circumstances, in imparting a sound knowledge of chemistry in places which would not otherwise be reached by any educational efforts, if we conclude from the course of analytical chemistry before us, that some teachers (Mr. Webster styles himself Lecturer on Metallurgy and the Applied Sciences, Nottingham) are deplorably ignorant of the science they profess to teach.

Beginning on p. 4, we are told that "the term atom is sometimes applied to a compound as well as simple radicals, such as ammonia, hydroxyl, &c.": that "for fixed solids which do not vaporise, the atomic weights are referred to the element lithium, the atomic weight being determined by the amount of heat which any body contains, when it is at the same temperature as lithium, both being the same weight, lithium being considered as seven." On p. 7, "difference of attraction is called the bond affinity, that is, it is assumed that the different atoms possess power, lines of force, or *points of attraction*, called by Dr. Frankland *bonds*." On p. 12, we are informed, that "there are four different forms of notation, or formulæ in present use, two of which are *graphical*, viz. the *glyptic* and *graphic* formulæ. The other two, viz. the empirical and the constitutional or rational, are the symbolic representations." We give it upon the authority of our joint authors, that "Dr. Crum Brown was the first to introduce this form of formulæ, and that it has now been adopted by Dr. Frankland, and generally throughout the kingdom." And on p. 14, we are told, that "students who do not already understand the constitutional formulæ are strongly advised to obtain a complete knowledge of them, not only as an addition to their knowledge, but because the other is now not recognised by many colleges, or *allowed* in many examinations." For fear our authors' inadvertence should lead to further mischief, we may at once state that, to our knowledge, such is not the case, and that the authors are as much in the dark about what is recognised by many colleges or "allowed in many examinations" as they are about chemical analysis.

We can only pick out some of the choicest specimens from the authors' analytical bouquet. Beginning on p. 26, we are told that "deflagration is the arrangement of the crystals of a substance, and is, in ordinary terms, the crackling of a body when exposed to heat;" on p. 28, that "hardly any amount of reading or lecture-hearing can produce a practical analyst, as only practice can make perfect, and therefore the student is strongly recommended to make the experiments himself." We for once entirely agree with the theory, but strongly object to the "practice" of our joint authors. The information on p. 30, that "melted lead cannot be poured even in a cold platinum crucible without spoiling it, and that a drop of lead, tin, or bismuth, falling upon a red-hot platinum vessel invariably makes a hole in it," we owe probably to the sad experience gained by the metallurgical partner in the joint-authorship, and science-students possessing platinum

vessels must surely feel thankful for the hint. Great confusion of ideas seems to prevail, however, on the subject of platinum, for we are told on p. 31 that "platinum combines easily with silica and carbon, so that the contact of platinum crucibles with charcoal at a very high temperature must be avoided," together with several other absurd precautions which we will not quote. On p. 33, there figures an apparatus for rapid filtration in an atmosphere of steam, which we have seen before in Normandy's Introduction to his translation of Rose, and which we should have thought had been superseded long ago by more perfect methods of filtration.

As specimens of analytical knowledge (?) we quote p. 57, "hydrochloric acid gives a precipitate on dilution with water (distilled) if $BaCl_2$ or SO_2Ho_2 be present;" p. 38, "dilute sulphuric acid contains more lead, and lead is scarcely soluble in concentrated acid;" p. 42, "A solution of baric chloride must be neutral to test-paper, after precipitation by sulphuric acid;" p. 43, "sodic carbonate must completely volatilise;" p. 46, "hydrofluosilcic acid can be obtained from the chemists in india-rubber bottles."

The analytical tables on pp. 57 to 73 are equally deficient and faulty. We are told to test for ammonia, after having ignited on platinum foil; "a watch-glass becomes corroded on the addition of baric chloride to a neutral solution of salts," "hydrobromic acid turns starch-paper blue," "sodic hydrate," on p. 94, "precipitates light-coloured ferric hydrate which turns dirty-green." Upon heating chlorates, p. 115, "a very violent deflagration ensues." The authors appear never even to have prepared oxygen gas.

The quantitative knowledge displayed by the authors is quite on a par with the choice bits of qualitative chemical information so liberally and innocently volunteered by them. We will not tire our readers, however, by any further quotations, but cannot refrain from firing a parting shot or two by quoting from p. 120, where we are told that "Chlorine is prepared by the mixing of salt, hydrochloric acid and manganic oxide; this last, MnO_2, has no chemical reaction in the last equation;" and from p. 136, on which we are told that "in order to keep the edges of the balance free from rust, it is a very good practice to place inside the case a beaker, half-filled with sulphuric acid or baric chloride." A dialyser is described on p. 171 as "an apparatus having sides and top of gutta-percha, and bottom of parchment, and is used for the separation of urea and other crystallisable salts from urine."

Need we do more than recommend the authors to act upon their own advice (p. 2), and "to speedily endeavour to obtain a complete knowledge of the composition of bodies, and make themselves conversant with the formulæ &c.," of which they exhibit so deplorable an ignorance, before they again venture upon enlightening the public on the subject of chemistry.

THE RACES OF MANKIND

The Races of Mankind: being a Popular Description of the Characteristics, Manners, and Customs of the Principal Varieties of the Human Family. By Robert Brown, M.A., Ph.D., &c. (Cassell, Petter, and Galpin).

THE rapid growth of interest in Anthropology is proved by the appearance, one after another, of popular illustrated works: Mr. J. G. Wood's "Natural History of Man" in 1868-70, an English translation of M. Louis Figuier's "Human Race" in 1872, and just now (though without the date it ought to have on the title-page) this first volume of a work on "The Races of Mankind." Of these, the productive M. Figuier's book is too worthless to say much of, and the comparison lies between the first and last. Both are valuable, and the ground they cover is so far different, that they may be usefully placed side by side in the ethnologist's library. It will be remembered that Mr. Wood's account of Africa occupied the first of his two volumes, so that his account of the races of Asia, America, Polynesia, &c., had to be disproportionately condensed into the second. Dr. Brown, we trust, will be able to keep his scale more uniform. His first volume treats entirely of American races, and he speaks with personal knowledge of the Esquimaux and North-west tribes, compiling as to other tribes with discretion, and generally from not too hackneyed authorities. Such of Dr. Brown's illustrations as are taken from photographs and real drawings are good, and preferable to the too picturesque and imaginative cuts of Mr. Wood's artists. But Dr. Brown inserts some drawings which he had better for truth and good taste have left out. Thus, the Indian scalping his victim at page 68, though no doubt more like the reality than the engraving in vol. ii. of "Schoolcraft," from which it is a kind of rationalised copy, is a piece of sensational make-up; while on the next page a scene of Indians torturing a captive by a slow fire on his stomach, is still more objectionable. At page 284 is a representation of Conibos shooting turtle; this is evidently a fancy picture, and arrows shot at such an angle would glance off the animal's carapace; the arrows should have been shown of heavier make, and so sent up as to fall almost perpendicularly.

As only the first part of Dr. Brown's work is yet out, it may perhaps be a service to make some suggestions. Native words are sometimes wrongly printed, which gives an air of carelessness to the descriptions they form part of. Thus "inniut" instead of "innuit" (p. 5); "Manco Capas" and "Manià Dello" (p. 119), which appear to be intended for the usual forms, "Manco Capac" and "Mama Oello" (Mr. C. R. Markham would say that "Ccapac" and "Ocllo" are the really proper forms). At page 274, the account of the "couvade," the custom of the husband being put to bed or otherwise treated with reference to his wife's bearing a child, is compiled very inaccurately. Lastly, though references are generally given where long abstracts have been made from books of travel, Dr. Brown seems somewhat apt to make statements and use arguments without due mention of the sources whence he derived them. One consequence is, that he makes himself personally responsible for any blunder in the matter he thus appropriates. Thus, at page 147 a passage is inserted of which the following is part:—"In the Ladrone Islands, the Spaniards found the natives unacquainted with fire; and when Magellan set fire to the huts of the Marian islanders, they looked upon the flame as a living creature which fed upon wood." Unless my memory deceives me, this passage is copied out of Büchner's "Man in the Past, Present, and Future," and has been already commented on in NATURE, not only as embodying statements which have been disproved,

but as showing a certain geographical weakness in the writer, who did not know that the Ladrone and the Marian Islands are the same. E. B. T.

OUR BOOK SHELF

Typhoid Fever: its Nature, Mode of Spreading, and Prevention. By William Budd, M.D., F.R.S. Pp. 193. Three plain and one coloured lithograph. (Longmans, 1873.)

THIS handsome volume is a thesis on the question of how typhoid or enteric fever is propagated. Dr. Budd adopts what is known as the contagion theory, and believes that every case of the disease is the result of direct poison, conveyed either by the air or more frequently in water, from the intestine of one patient to that of another. This theory is generally disbelieved by the best medical authorities in London and Paris; but, as Dr. Budd points out, it is not in large towns that the transmission of disease can best be traced. He describes with minute exactness as to time, place, and other important conditions, outbreaks of this terrible disease in secluded country villages, in schools, and other isolated institutions, where he was able to trace the steps of the epidemic from house to house or from room to room. We believe that a candid perusal of these cases will bring the conviction that the theory of contagion is fairly proved. Many of them are at all events almost decisive against the theory that this enteric fever is "pythogenic," *i.e.* is the result of a poison which may be produced by any decomposing sewage under favourable circumstances, without previous contamination from a diseased person. The practical importance of the question is, that if enteric fever only spreads as Dr. Budd and other contagionists maintain, it is possible, and therefore of the utmost importance, to check its propagation. A great part of the book is devoted to this point, and the mode of destroying diseased products is carefully detailed.

One obvious objection to the contagion theory is that it only accounts for the spread, and not for the origin, of the fever. But, as Dr. Budd argues, the same applies to small-pox and every other undoubtedly contagious disease. However the first case came about, no one supposes that fresh ones now arise spontaneously, any more than naturalists who believe that worms and buttercups once came into being for the first time, expect to find a worm appear in a drop of water without an egg, or a buttercup in a meadow without a seed.

The comparison of typhoid disease to the eruption of small-pox, which is revived by Dr. Budd, has been long and deservedly abandoned: indeed the strictly pathological part of this book is the least satisfactory. Notwithstanding a somewhat "drawing-room" appearance, it is no doubt intended for pathologists and physicians to study; and for them we cannot see the advantage of the four illustrations, one of which forms an elaborately coloured frontispiece; they show nothing but what has often been figured before, and is now universally familiar. The style also is now and then too ambitious, suggesting rivalry with the wretched newspaper writing quoted on p. 110 as "lively and facile." On the whole, however, the book is as solid as it is earnest, and may be compared without detriment with Dr. Macnamara's well-known work defending an almost identical theory and practice with regard to the propagation and prevention of Asiatic cholera.

The facts and arguments contained in it will no doubt be duly weighed by the medical profession, and the public will benefit by the result. P. S.

Inorganic Chemistry, Elementary. By Raphael Meldola, F.C.S. (London: Thomas Murby, 1873.)

THE present little volume constitutes one of a series produced by the same publishers as "Science and Art Department Text-books." We must congratulate Mr. Meldola on having produced in a small compass a thoroughly good and sound introduction to the science of chemistry, and it is all the more welcome in these days of "Science Series," when so many badly done "Text-books" are being produced. The information is well and clearly stated, and is sufficiently free from technicalities to be easily understood by the beginner. The book is plainly and well printed, but we cannot congratulate the publishers on the execution of the few and simple woodcuts, every one of which has been spoiled in the cutting. We hope that in a future edition the work will receive better treatment, as a well-done woodcut is a great aid to the beginner in understanding his author's descriptions of various experiments.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

The Photographic Society

THE sweeping condemnation of the Photographic Society conveyed in an article in NATURE, vol. ix. p. 263, can only have been written under a want of knowledge or misrepresentation of facts. I will not say one word about any dissension which may exist in the Society, but as the statements you have published are calculated to injure the Society very materially, I will ask you, in common justice, to make public the transactions of the Society for the past year, so that the readers of NATURE may judge for themselves whether in a body which does not profess to be a purely scientific one, science is altogether ignored, whether "no man of eminent scientific capacity takes part," and whether the society is altogether beneath contempt as at present conducted. This I ask you to do not only in justice to the society, but to the gentlemen whose names are mentioned below.

1873. January meeting. "The Photographic Operations at the Royal Observatory in connection with Magnetical and other records," by James Glaisher, F.R.S.; "Instantaneous Microphotography," by E. J. Gayer, M.D.

February.—"On the Principles of the Chemical Correction of Object-Glasses," by Prof. G. G. Stokes, D.C.L., Sec. R.S.

March.—"A Contribution to the Early History of Photography," by H. Baden Pritchard, F.C.S.

April.—"Uranium Printing," by John Spiller, F.C.S.; "The Chemical Theory of the Latent Image," by Capt. Abney, R.E., F.C.S., F.R.A.S.

May.—"Improvements in Carbon Printing," by Mons. A. Marion.

June.—"Remarks on three Wet Processes," by Jabez Hughes; "Photo-collotype Printing," by Capt. Waterhouse, B.S.C.

December.—"Photography in the Arctic Regions," by Lieut. Chermside, R.E.

So far as investigations are concerned, I can mention two, at least, now being undertaken by members of the society, touching the process and nature of film best suited for the Transit of Venus observations.

BADEN PRITCHARD, Hon. Sec.

9, Conduit Street, W., Feb. 7

Animal Locomotion

THERE are two or three points in Dr. Pettigrew's new book as to which, perhaps, many of your readers in common with myself would be glad of a little light. First, in speaking of the gannet, he says: "Each wing, when carefully measured and squared, gave an area of 19½ square inches." But how is such an area obtained from the dimensions given? They are: "girth of trunk, 18 inches," *i.e.*, about 5 inches for its width; "expanse of wing from tip to tip across the body, 5 feet," so that each wing would stretch about 33½ inches from root to tip; "across secondaries, 7 inches," and this we may take as about the average width of the wing. Multiplying length of wing by width (33½ × 7), we get therefore an area of 234½ square inches. Similarly Dr. Pettigrew assigns the heron's wing an area of 26 square inches, although the dimensions he gives yield an area of about 311 square inches. A friend of mine has the temerity to suggest that for some reason or unreason Dr. Pettigrew has

divided the true area by 12, for so 234½ (if we neglect the half inch) gives just 19½, and 312 instead of 311 gives 26.

But (as a second matter) my friend's notion of Dr. Pettigrew's arithmetic receives some colour from the sentence following the one before quoted, viz., "The wings of the gannet, therefore [each wing being supposed 19½ square inches], furnish a supporting area of 3 feet 3 inches square." So of the heron. Having told us that the area of each wing is 26 square inches, he says, "Both wings consequently furnish an area of 4 feet 4 inches square." Here, surely, square inches have been treated as if they were linear, and only 12 of them instead of 144 reckoned to the square foot!

Once more (as was observed in your review a week or so ago), Dr. Pettigrew maintains, in opposition to all other experimenters, that in flight the downward stroke of the wing is directed forwards and not backwards. Now, to say nothing of the "singularity" of representing the wings in his own case as concavo-convex, and in that of his opponents as flat (much to the detriment of the latter), the whole of Dr. Pettigrew's "mathematical demonstration" of his position is so extremely original that I fear for the uninitiated it is only explaining *obscurum per obscurius*. Would he condescend to accepted methods and prove his case by the parellelogram of forces? As it is, his proof amounts simply to this:—"As the under surface of the wing, which is a true kite, looks upwards and forwards, it tends to carry the bird upwards and forwards." No doubt, if the wing remain still, and the bird have already a sufficient velocity. A kite is sustained or elevated by an extraneous force, either the wind impinging against its under surface, or *vice versâ* when the boy runs. But whence comes the bird's motion, before its wings can act as kites? Dr. Pettigrew nowhere tells us this, but starts with his bird already flying. Thus he says:—"The bird, when flying, is a body in motion. It has already acquired momentum. If a grouse is shot on the wing, it does not fall vertically downwards, as Borelli and his successors assume [Shade of Borelli!], but downwards and forwards. The flat surfaces of the wings are consequently made to strike downwards and forwards, as they in this manner act as kites to the falling body, which they bear or tend to bear upwards and forwards." Here it is unmistakeable that the function of the wings in generating velocity is confounded with their function in directing the velocity already generated; just as if one should confound a steamer's rudder with her screw. The question is, How do the wings generate velocity? In this respect it is immaterial whether the bird is at rest or in motion. But to this there can be but one answer, at least if we are still to believe that "action and reaction are equal and opposite;" the answer that is, that everybody gives but Dr. Pettigrew. The downward motion of the wing is wholly concerned with sustaining or elevating against gravity. A backward movement must carry the bird forward; Dr. Pettigrew's forward movement must make it fly tail first.

JAMES WARD

Trinity College, Cambridge, Feb. 2

YOUR reviewer resorts to very strong language, without, it appears to me, justifying his procedure. In reviewing my volume he exclaims, "Imagine our disappointment on finding that, instead of the work being by the hand of a master, its author is deficient in the knowledge of the first principles of physics, and of the undoubted meaning of some of the most simple terms employed in the science; his argument, if it may be so called, being but little more than a long series of vague and fanciful analogies, incorrectly stated physical facts, and untenable theories." . . . "We must say that we expected better things of Dr. Pettigrew, and regret that he has not, before now, learned that there are errors in his methods and results that cannot be tolerated by a thinking public, which prefers accurate reasoning rather than dogmatic statement, and well-grounded fact to fanciful analogy" (NATURE, vol. ix. p. 221). One would naturally have expected after such announcements an exposure of false theories and a criticism of the nomenclature employed, but Mr. Garrod condescends upon neither. He takes refuge in general statements and implies what he does not attempt to prove.

He states, *e.g.* "that it is at present impossible to obtain from any form of fuel, a sufficient percentage of the potentiality which it possesses for doing work, to work an engine sufficiently compact and light for the wings which it has to drive." Now this is utter nonsense. In 1868 Mr. Stringfellow, of Chard, Somersetshire, exhibited at the Crystal Palace a flying machine which with its engine, boiler, water, fuel, flying surfaces, and propellers only weighed 12 lbs. The engine of this machine exerted the third of a horse power and obtained the 100*l*. prize of the Aëronautical Society of Great Britain as being at once the lightest and most powerful steam-engine ever made.

What bird weighing 12 lbs. can Mr. Garrod inform me exerts a third of a horse power in flying?

This one fact proves that in the ordinary steam-engine we have a power more than equal to the production of flight.

Mr. Garrod takes exception to my statement that "weight when acting upon wings, or, what is the same thing, twisted inclined planes, must be regarded as an independent moving power."

This point will be best illustrated by an example. If a gannet drops from a cliff with *expanded motionless wings* it can sail for an incredible distance, the weight of the body dragging upon the wings, doing the principal part of the work. This is a matter of observation, and the principle may be exemplified by the following simple experiment. If an apparatus composed of two quill feathers stuck in the end of a cork be made to fall from a height it will be found to travel *downwards and forwards* in a curve, the forward curve equalling half the space through which the apparatus descends. Here we have no muscular movement to direct or influence the motion in any way, and it certainly seems to me to afford an explanation of the manner in which mere *weight*, or gravity acting upon weights, may by the aid of wings be made to propel a body from one point to another.

Mr. Garrod proceeds—"After such indications of imperfect knowledge, nothing in the way of mechanical theories could cause surprise, and we are therefore not astonished to find it laid down as the fundamental principle of flight, that *the up-stroke of the wing aids in propulsion*, and that in the down-stroke *the inferior surface of the wing is directed downwards and forwards*." If Mr. Garrod attempts to elevate a natural wing or an artificial one properly constructed, even in a strictly vertical direction, he will find that it inevitably darts upwards and forwards in a curve and carries the hand with it. In this manner, as experiment proves, *the ascent of the wing aids in propulsion*. If again Mr. Garrod attempts to depress the wing vertically downwards, he will as certainly find that it darts *downwards* and *forwards* in a curve, the hand being carried in the direction specified. The upward forward and downward forward curves, being united as they are in flight, give a *waved track*. If the wings did not dart *forwards* both during their ascent and descent the body of the bird could not be transferred from one place to another in a horizontal waved line which it is. Mr. Garrod is evidently imperfectly informed on the subject of flight, for he inquires "Who can see any close relation between the flight of birds and that of a kite?" The merest tyro in mechanics will, I think, perceive this on a moment's reflection. The kite is pulled *forwards* on the moving air by the string. The kite formed by the wings of a bird is *pushed* forwards on the moving air by the weight of the body.

I do not forget, as Mr. Garrod insinuates, that a kite requires a string. The following passage, written in 1867, will show this. "The wing of a bird acts after the manner of a boy's kite, the only difference being that the kite is pulled forwards upon the wind *by the string* and the hand, whereas in the bird the wing is pushed forwards on the wind by the weight of the body and the life residing in the pinion itself." *

Mr. Garrod's words are—"Dr. Pettigrew seems to forget that a kite needs a string, and yet, backed by his false analogy, *he has the presumption* to quote the experimental verifications and opinions of such able and ingenious thinkers as Borelli and Marey, the authors of the true theory of flight, only to reject them." To one who has experimented on the subject of flight for the last 10 years, the term *presumption* in this sentence sounds strange. One may, I venture to think, without presumption, differ from another after such mature deliberation. Marey's theory of flight, which is nearly, if not identical, with my own, was not promulgated till nearly two years after I had published mine. This point will be fully discussed in the *Athenæum* of Feb. 14. In fact Marey frankly admitted this in a letter to the French Academy of Sciences in reply to a reclamation lodged by me with that learned body.

His words are:—"J'ai constaté qu'effectivement M. Pettigrew a vu avant moi, et représenté dans son Mémoire, la forme en 8 du parcours, de l'aile de l'insecte; que la méthode optique à

* On the various modes of flight in relation to aëronautics: Proc. Roy. Instit. of Great Britain, March 22, 1867.

laquelle j'avais recours est à peu près identique à la sienne. . . . Je m' empresse de satisfaire à cette demande légitime, et je laisse entièrement la priorité sur moi, à M. Pettigrew relativement à la question ainsi restreinte." (*Comptes Rendus* for May 16, 1870, p. 1093.)

The next point which Mr. Garrod takes up is the "induced currents" of the wing. I state that "the efficiency of the wing is greatly increased by the fact that when it ascends it draws a current of air up after it, which current, being met by the wing during its descent, greatly augments the power of the down-stroke. In like manner, when the wing descends, it draws a current of air down after it, which, being met by the wing during its ascent, greatly augments the power of the up-stroke." This is simply a statement of fact, and if Mr. Garrod causes a natural or artificial wing to vibrate he will find that the wing takes a greater catch of the air when a down- and up-stroke or an up- and down-stroke are made in rapid succession, than when a single stroke is made either in the one direction or in the other. This point becomes especially clear if a large artificial wing be constructed on the insect type and made to vibrate in a horizontal direction. If such a wing have its anterior margin slightly elevated and made to travel from right to left of the operator it draws after it a current of air which, being met by the wing when it is reversed and made to pass from left to right, acts as an autumn breeze to a kite. The wing literally flies on the current which it creates. It ascends at each thrust and carries the hand of the operator with it. Similar remarks are to be made of the tail of the fish. It is in this way that the *back air* and *back water* are utilised, and herein lies the excellence of the elastic reciprocating screw, as found in Nature, and as contra-distinguished from the rigid rotatory screw employed in navigation.

Mr. Garrod, adducing no proof in refutation of this and similar experiments, states "that these *induced currents* are of no real service in flight, because in their production there is as much force lost as there may be gained from their subsequent employment on the reversal of the action of the wing, if the bird's body has not advanced sufficiently far to be in each stroke beyond the range of their action, which is probably the case." On what authority does Mr. Garrod make this assertion? When a bird flies in still air, the wing of necessity must vibrate. The quicker it vibrates the more marked the reaction obtained from the air, and the greater the elevating and propelling power. The *induced currents* powerfully contribute to this reaction from the fact that the wing and the air are both moving, and moving in opposite directions. This, as explained, is a matter of experiment, and can readily be verified.

Lastly Mr. Garrod attacks my views on muscular movements. Here again he adduces no counter-proof, and, adhering to the old doctrine, contents himself by saying, "We are not ashamed to say that such has always been and still is our idea." This is not saying much. He takes exception to my statement that muscles have a centripetal or shortening power and a centrifugal or elongating power. Can he inform me how the left ventricle of the heart opens after a vigorous contraction, in which all the blood contained in the ventricular cavity is ejected and the ventricle converted into a solid muscular mass, if not by a spontaneous *elongation* of all its fibres?

Edinburgh, Jan. 27 J. BELL PETTIGREW

Specific Gravity of Sea-water

IN reference to Mr. Strachan's letter in NATURE, vol. ix. p. 183, calling attention to the discrepancy between Dr. Frankland's results and my own, permit me to state that they were not obtained from the same series of samples, and that the figures given by Dr. Frankland were, I believe, obtained by the use of a balance on shore, and also that from the way in which his specimens were packed, they were not liable to any appreciable loss by evaporation. They were not, however, taken from that part of the North Atlantic which was examined during the time that I was on board the *Porcupine* in 1869, to which alone my observations refer. My own results were obtained, as stated on p. 503 of "The Depths of the Sea," by delicate glass hydrometers, so graduated that the sp. gr. could easily be read to the fourth decimal place. Two instruments only were employed for the 105 observations made, and though they gave identical results, I had no opportunity of comparing their indications with the results obtained by a balance from the same specimen of water. I may remark here, however, that though the *absolute* results may not be quite correct, the relations between the sp. gr. of surface, intermediate, and bottom waters, pointed out on p. 505 of "The Depths of the Sea," as well as the range of variation, are probably very near the truth, since the same instruments were employed in all the determinations, and at the end of the series they indicated the same as at the commencement, when placed in a test solution, which was preserved for the purpose of detecting possible variations in the instruments themselves.

Clifton, Bristol, Jan. 17 WM. LANT CARPENTER

THE LINNEAN SOCIETY

WE regret to hear of an unpleasant event which took place at the meeting of the Linnean Society on Thursday last (5th inst.). So far as we have been able to gather the particulars they are as follows.

When the usual minutes had been read at the commencement of the meeting, a Fellow of the Society rose in his place and endeavoured to propose a motion reflecting upon the conduct of the President at the preceding meeting. The President (Mr. George Bentham, F.R.S.) ruled that the Fellow was out of order and that his motion could not be put, and requested the would-be mover of it to sit down in his place. In spite of frequent calls to order, however, this gentleman persisted in his endeavours to bring forward his grievances, and to address the meeting. At last Mr. Bentham, finding that his efforts to preserve order were vain, and that the mover of the motion (who had given no sort of notice of his intentions) was backed up by a body of clamorous friends assembled specially for the purpose, quitted the chair and left the meeting-room, followed by the Secretary and all the other members of the Council present.

As the chair of the Linnean Society can only be taken by a member of Council, the meeting thus came to a premature end, much to the disappointment of those who had assembled to hear Mr. W. K. Parker read his paper on the osteology of the woodpeckers.

We regret to have to add that, in consequence of this untoward event, Mr. Bentham has tendered his resignation as President of the Society. But we trust that the Fellows who caused the disturbance will, upon reflection, feel that however much they might have considered themselves aggrieved by the President's decision at the previous meeting, they were not justified in the course they pursued. In all meetings the decision of a chairman upon a point of order is held to be final, at all events for the occasion. More especially should this be the case in a learned society assembled for the discussion of scientific problems, and not for vulgar wranglings and disputes upon immaterial subjects.

We trust therefore that an ample apology will be offered to the President by these gentlemen, and that he will be induced to retain his chair until the approaching anniversary meeting of the Society, when he had already given notice of his intention not to accept re-nomination. The great services which Mr. Bentham has rendered to Science generally and to the Linnean Society in particular, are too well known to the readers of NATURE to render it necessary for us to descant upon them in these columns. The Linnean Society has just acquired a new and most convenient abode in the apartments at Burlington House, recently provided for it by the liberality of the country, and it would be a great misfortune if disunion should succeed in marring the work of those who are now endeavouring to make the Society still more useful and more prosperous than it has been in past times.

POLARISATION OF LIGHT*

IV.

THE phenomena exhibited by selenite are also produced by other crystals, but the facility with which plates of the former substance can be obtained, causes them to be generally used in preference to others. There is, however, a peculiar class of crystals, of which quartz, or rock crystal, is the most notable, which gives rise to effects different from those hitherto described.

* Continued from p. 205.

If a ray of light pass through a plate of quartz which has been cut perpendicularly to the axis, or line parallel to the main planes bounding the crystal, it is as usual divided into two; but the vibrations in each ray, instead of being rectilinear and at right angles to one another, are circular and in opposite directions. That is to say, if the motion of vibration in one ray is directed like the hands of a clock, that in the other is directed in the opposite sense; and the light in each ray is then said to be circularly polarised. The motion of a series of particles of ether, which when at rest lie in a straight line, is circular, and, as in plane polarisation, successive; and consequently, at any instant during the motion such a series of particles will be arranged in a helix or corkscrew curve. The sweep of the helix will follow the same direction as that of the circular motion; and, on that account, a circularly polarised ray is spoken of as right-handed or left-handed, according to the direction of motion. A right-handed ray is one in which, to a person looking in the direction in which the light is moving, the plane of vibration appears turned in the same sense as the hands of a watch. Or, what is the same thing, to a person meeting the ray, it appears turned in the opposite sense, viz., that in which angles when measured geometrically are usually reckoned as positive.

The question, however, which mainly concerns us is the condition of the vibrations after emerging from the plate of quartz and before entering the analyser. In the passage of the ray through the plate the ether is subjected to a double circular motion, one right-handed, the other left-handed; but, as one of these motions is transmitted with greater velocity than the other, it follows that at any given point and at the same instant of time one of the revolutions will, in general, be more nearly completed than the other, or, to use an expression adopted in plane polarisation, there will be a difference of phase. The motions may be represented by two clock hands moving at the same rate in opposite directions, and the difference of phase by the angle between them when one of them is in the position from which angles are reckoned. As both are supposed to move at the same rate, they will have met in a position midway between their actual positions; and if we consider a particle of the ether (say) at the extremity of the clock-hands, it will be solicited when the hands are coincident by forces producing two opposite circular motions. Now, whatever may have been the forces or structural character within the crystal whereby this double circular motion is perpetuated, it is clear that when the ray emerges into air the particle of ether immediately contiguous to the surface of the crystal will be acted on by two sets of forces, one whereby it would be caused to follow the right-handed and the other the left-handed rotation. Each of these may, as is well known, be represented by a pair of forces, one directed towards the centre of the circle, the other in the direction of the motion and at right angles to the first, or, to use geometrical language, one along the radius and towards the centre, the other along the tangent and in the direction of the motion. The two forces acting along the tangent being in opposite directions will neutralise one another, and the resultant of the whole will, therefore, be a force in the direction of the centre. The particle in question, and consequently all those which following in succession serve to compose the entire ray until it enters the analyser, will vibrate in the direction of the diameter drawn through the point under consideration; or, to express it otherwise, the ray will be plane-polarised, and the plane of vibration will be inclined to the plane from which angles are measured by an angle equal to half the difference of phase on emergence due to the thickness of the crystal. The retardation being the same absolute quantity for all rays, will, as in the case of plane polarisation, be a different fraction of the wave-length for rays of different colours, and will be greater for the shorter waves than for the longer. Hence the planes of vibration of the different coloured rays, after emerging from the quartz, will be differently inclined. Each ray will therefore enter the analyser in a condition of plane polarisation; and if the analyser be turned round, it will cross the vibrations of the various coloured rays in succession, and extinguish each of them in turn. Each of the images will consequently exhibit a gradual change of colour while the analyser is being turned; and the tints will be, as explained before, complementary to those which are successively extinguished. For a given plate of quartz the order of the tints will be reversed when the direction of rotation of the analyser is reversed. But it should be here explained that there are two kinds of quartz, one called right-handed and the other left; and that, for a given direction of rotation of the analyser, these cause the colours to follow one another in opposite orders. A similar effect is produced by turning the polariser round in the opposite direction.

The angle of rotation of the plane of vibration for any particular colour varies, as stated above, with the thickness of the plate; while for a given thickness it increases nearly as the square (product of the quantity into itself) of the wave-length decreases. In mathematical language it varies approximately inversely as the square of the wave-length. If this law were accurately true, the product of the angles of rotation into the square of the corresponding wave-lengths (λ) would be the same for all rays. The following are some measurements made by Brock, with a quartz plate one millimetre thick, which show that the law may be considered as true for a first approximation.

Rays	Rotations	Rotations $\times \lambda^2$.
B	15° 18	7,238
C	17° 15′	7,429
D	21° 40′	7,511
E	27° 28′	7.596
F	32° 30′	7,622
G	42° 12′	7,842

If the colours exhibited by a plate of quartz when submitted to polarised light be examined by a spectroscope, in the way described when we were speaking of selenite, the spectrum will be found to be traversed by one or more dark bands, whose position and number depend upon the thickness of the plate. But there will be this difference between plane and circular polarised light, that if the analyser be turned round, the bands will never disappear, but will be seen to move along the spectrum in one direction or the other, according as the plate of quartz be right-handed or left-handed, and according to the direction in which the analyser is turned. This is, in fact, identical with the statement made before, that the analyser in its different positions successively crosses the plane of vibration of each ray in turn, and extinguishes it.

This being so, it is clear that a change of colour exhibited by a quartz plate when submitted to plane-polarised light and examined with an analyser, forms a test of a change in the plane of original polarisation. And if the plate be composed of two parts, one of right-handed, the other of left-handed quartz, placed side by side, any change in the plane of polarisation will affect the two parts in opposite ways. In one part the colours will change from red to violet, in the other from violet to red. At two positions of the polariser, or analyser, the colours must be identical. With plates, as usually cut, one of these identities will be in the yellow, the other at the abrupt passage from violet to red, or *vice versâ*. In this case the field appears of a neutral tint, *teinte sensible* or *teinte de passage*, as the French call it, and the slightest change in the plane of polarisation exhibits a marked distinction of colour, one part verging rapidly to red, the other to violet. This arrangement is called a biquartz, and affords a very delicate test for determining the position, or change of position, of the plane of polarisation, especially in cases where feebleness of light or other

circumstance interfere with the employment of prismatic analysis.

If the thickness of the plate be such that the difference of rotation of the planes of vibration of the rays corresponding to the two ends of the visible spectrum (or, as it is sometimes termed, the "arc of dispersion") be less than 180°, there will be one dark band in the spectrum; because there can then be only one plane of vibration at a time at right angles to that of the analyser. If the arc of dispersion is greater than 180° and less than 360°, there will be two bands. And so on for every 180° of dispersion.

This mode of examination by means of prismatic analysis is the most accurate yet devised for measuring the angle of rotation produced by circular polarisation; especially if solar light be employed, and the fixed lines used to form a scale of measurement.

The property of circular polarisation is, however, not confined to quartz. Among solids, chloride of sodium is the only other known instance, but among fluids and fluid solutions there are not a few.

The following list is given by Verdet. The angles have reference to the red rays given by a plate of glass coloured with oxide of copper, and are affected with the sign + in the case of right-handed, and with – in the case of left-handed rotation. The length of the column of the solution is in every case one decimetre.

Essence of turpentine . . .	−29°·6
,, lemon . . .	+55°·3
,, bergamot . . .	+19°·08
,, bigarade . . .	+78°·94
,, aniseed . . .	− 0°·70
,, fennel . . .	+13°·16
,, carroway . . .	+65°·79
,, lavender . . .	+ 2°·02
,, peppermint . . .	+16°·14
,, rosemary . . .	+ 2°·29
,, marjorum . . .	+11°·84
,, sassafras . . .	+ 3°·29
Solution of sugar 50 per cent. .	+33°·64
,, quinine 6 per cent. in alcohol .	−30°.

It will be noticed that the rotary power of all these substances is much less than that of quartz.

A mixture of liquids, one or both of which is active, generally exhibits a rotatory action represented by the sum or difference of their separate powers (a neutral liquid being considered to have a power represented by 0); but this law is true only when no chemical action takes place between the elements of the mixture. Saccharine solutions vary not only in the amount but also in the character of their power of rotation; thus cane sugar is right-handed, but grape sugar left-handed.

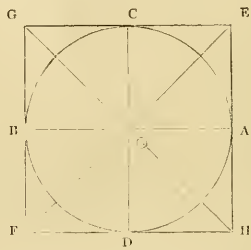
The property in question has been turned to practical use by employing the rotatory power of a saccharine solution as a measure of the strength of the solution. For this purpose a tube containing the solution to be examined is placed between two Nicol's prisms. The simple fact of circular polarisation is proved by a feeble exhibition of the phenomena shown by a plate of quartz cut perpendicularly to the axis. But for accurate measurement various expedients have been adopted. If a biquartz be inserted behind the analyser (the end of the apparatus next the eye being considered the front), then for a certain position of the analyser the two halves will appear of the same colour. When the tube for examination is inserted the similarity of colour will be disturbed; and the angle through which, right or left, the analyser must be turned in order to restore it will be a measure of the rotary power of the fluid.

Another method is as follows:—Use a single quartz instead of a biquartz; in front of it place a pair of quartz wedges, with the thin end of one opposite the thick end of the other; the outer surfaces having been cut perpendicularly to the axis. If the plate be right-handed, the wedges must be left-handed, and *vice versâ*. The wedges must be made to slide one over another so as together to form a plate of any required thickness, and a scale connected with the sliding gear registers the thickness of the plate produced. When the tube is removed the wedges are adjusted so as to compensate the quartz plate, and their position is considered as the zero point of the scale. When the tube is replaced, the wedges are again adjusted so as to compensate the action of the fluid in the tube, and the difference of the readings gives the thickness of quartz necessary for the compensation. The rotatory effect of a given thickness of quartz being supposed known we know at once the effect of a thickness of the fluid under examination equal to the length of the tube.

Another method has been based upon the principle of Savarts bands; but sufficient has perhaps here been said to illustrate the principle of the saccharometer.

Circular polarisation may, however, be also produced by other means, namely, by total reflexion, and by transmission through doubly-refracting plates of suitable thickness.

It will perhaps be best to begin with the last. And in order the better to understand the process we must consider briefly the result of compounding two rectilinear vibrations under different circumstances.



Suppose a particle of ether to be disturbed from its point of rest O in a direction O A. The attraction of the particles in its neighbourhood would tend to draw it back to O; and let O A be the extreme distance to which under these attractions it would move. Having reached A it would return to O, and passing through O with a velocity equal to that with which it started under the disturbing force, it would move to a point B equidistant from O with A, but in the opposite direction. And if, as is generally supposed, the ether is perfectly elastic, or that there are no internal frictions or other conditions whereby the energy of motion is converted into other forms of energy, the oscillations or vibrations of the particle between the points A and B will continue indefinitely. Now suppose that while these vibrations are going on, a second disturbing impulse, equal in intensity, but in a direction at right angles to the first, be communicated to the particle, it is clear that the effect on the motion of the particle will be different according as it takes place at the point of greatest velocity O, or at that of no velocity A or B, or at some intermediate point. Our object is to consider the effects under these various circumstances.

A complete vibration consists in the motion from O to A, thence to B, and finally back to O; so that if O be the starting point the passage through A will be removed one-fourth, the passage through O from A towards B will be one-half, the passage through B will be three-fourths, and the passage through O from B to A a complete vibration from the commencement. This being so, suppose that the second impulse be communicated while the particle is at O on its way towards A, then the impulses may be considered as simultaneous and the vibrations to which they give rise will commence together, and the waves of

which they form part will be coincident. If the second impulse take place when the particle is at A, the two sets of vibrations or waves to which they belong will have a difference of phase (*i.e.* the first will be in advance of the second) equal to one-fourth of a vibration or one-fourth of a wave-length. If the second impulse take place when the particle is at O on its way to B, the difference of phase will be half; if when it is at B the difference will be three-fourths of a wave-length.

The particle being at O, and subject to two simultaneous impulses of equal strength, one in the direction of A, the other in that of C, must move as much in the direction of C as in that of A, that is, it must move in a straight line equally inclined to both, namely O E in the same figure. And inasmuch as the two impulses in no way impede one another, the particle will move in each direction as far as it would have done if the other had not taken place. In other words, if we draw a square about O with its sides at distance equal to O A or O B, the extent of the vibration will be represented by O E where E is a corner of the square. The complete vibration will then be represented by the diagonal E F in the same way as it was by the line A B in the first instance. If the impulse had been communicated at the instant of passage through O on the way to B, it is clear that a similar train of reasoning would have shown that the vibration would have been in the other diagonal G H. We conclude, therefore, that if two sets of rectilinear vibrations, or plane waves, at right angles to one another combine, then when they are coincident they will produce a rectilinear vibration, or wave, whose plane is equally inclined to the two, and lying in the direction towards which the motions are simultaneously directed. In the figure this is represented by the dexter diagonal When the two sets of waves have a difference of phase equal to half a wave length, their combination gives rise to a wave represented in the figure by the sinister diagonal.

Suppose now that the second impulse is communicated at the instant when the particle is at A; in other words, that the two sets of waves have a difference of phase equal to one-fourth of a wave-length. At that instant the particle will have no velocity in the direction of A B (for convenience, say eas wards), and will consequently begin to move in the direction of the second impulse, say northwards. But as time goes on the particle will have an increasing velocity westwards and a diminishing velocity northwards, it will therefore move in a curve which gradually and uniformly bends, until when it has reached its greatest distance northwards it will be moving wholly westwards. And as the motion not only will be the same in each quadrant, but would be the same even if the directions of the impulses were reversed, it is clear that the curvature of the path will be the same throughout, that is to say, if two sets of waves of the same magnitude in planes perpendicular to one another, and with a difference of phase equal to one-fourth of a wave-length combine, they will produce a wave with circular vibrations.

If the second impulse be given when the particle arrives at B, that is, if the waves have a difference of phase equal to three-fourths of a wave-length, similar considerations will show that the motion will be circular, but in the opposite direction.

Suppose, therefore, that we allow plane-polarised light to fall upon a plate of doubly refracting crystal cut perpendicularly to the axis in the case of a uniaxal crystal, or in the case of a biaxal to the plane containing the two axes, say a plate of mica which splits easily in that direction; then the vibrations will, as before explained, be resolved in two directions, at right angles to one another. And further, if the original directions of vibration be equally inclined to the new directions, *i.e.*, if it be inclined at 45° to them, the amount or extent of vibration resolved in each direction will be equal. Further, if the thickness of the plate be such as to produce retardation or difference of phase equal to a quarter of a wave, or an odd number of quarter wave-lengths, for the particular ray under consideration; then the two sets of vibrations on emerging from the mica plate will recombine, and, in accordance with the reasoning given above, they will form a circular vibration, left-handed or right-handed according as the retardation amounts to an integral number of three-quarter wave-lengths or not.

It thus appears that a plate of mica which retards one of the sets of waves into which it divides an incident set by an odd multiple of quarter-wave lengths, affords a means of producing circular from plane polarisation. It remains to be shown that, with the same plate in different positions, right or left handed circular polarisation may be produced at pleasure. Suppose that the original vibrations are in the direction E F in the foregoing figure; the mica plate will resolve them into the two directions A B, C D, one of the rays, say the first, will be transmitted with greater velocity than the other, and the vibrations along C D will be one-fourth of a wave-length behind those along A B. This will correspond to the case discussed above, and will give rise to a circular vibration in a direction opposite to that of the hands of a clock. Suppose, however, that the plate be turned round through a right angle, so that the vibrations which are transmitted with greater velocity are placed parallel to C D, and those which are transmitted with lesser along A B. The ray whose vibrations are along A B will then be a quarter wave-length in advance, or, what comes to the same thing, they are three-quarters of a wave-length in rear of the others; and this condition of things produces, as explained before, a circular vibration in a direction the reverse of the former. It thus appears that the plate placed in one direction will convert plane into right-handed circular polarisation; and if turned round through a right angle from that position will convert plane into left-handed circular polarisation. A like change from right-handed to left-handed circular polarisation, or *vice-versâ*, may obviously be effected by turning the orginal plane of polarisation through a right angle; so that it shall lie between lines of concurrent instead of between lines of discordant motion.

W. SPOTTISWOODE

(*To be continued.*)

A COMPLETE SPECIMEN OF A PALÆOTHERIUM

FROM *La Nature* we learn that the palæontological collection of the Museum of Natural History of Paris has just been enriched by the addition of a new specimen of very great scientific interest, which is the entire skeleton of *Palæotherium magnum*, imbedded in a large block of gypsum and marl, the whole being exhibited in the anatomical department of the museum.

The *Palæotherium magnum*, whose name alone indicates its ancient existence, was first recorded by the great French naturalist Cuvier, in his celebrated "Recherches sur les Ossemens Fossiles." It is an animal which is entirely extinct, without any present representative. Individuals of the species must have been extremely abundant during the period that it existed. Modern zoologists place it among the Perissodactylates, that is to say, with the at present existing rhinoceros, tapir, and horse. It forms part of the fauna which is found abundantly embedded in the deposits of gypsum. All palæontological collections, even the most humble, have for a long time been provided with the remains, or more or less complete portions of this fossil form, but none have yet had the good fortune to obtain a complete skeleton.

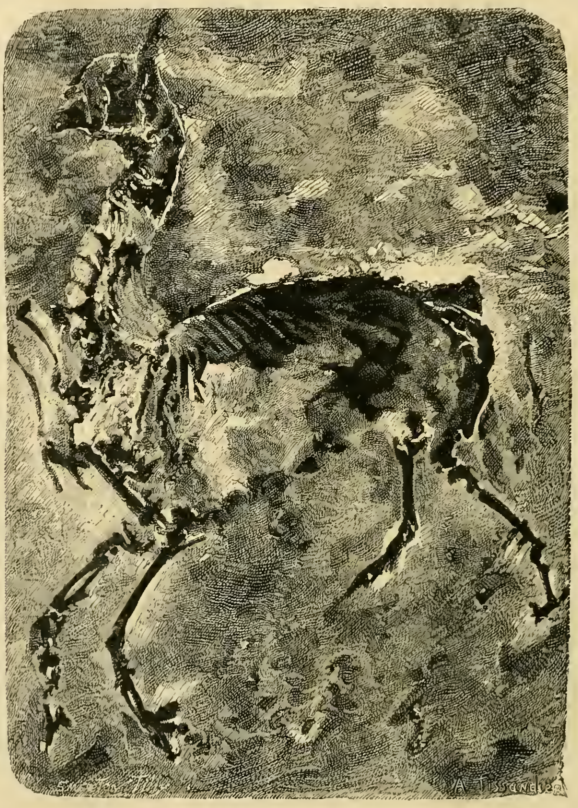
The principal result of the examination of the new specimen which we are describing has been to show that until now very inexact notions have been entertained as

to what this animal truly was when the proportions and general contour of the tapir were assigned to it, as was done even by Cuvier himself.

Far from being bulky and almost massive, as was thought, *Palæotherium magnum* is now evidently seen to be a very slender animal, with an extremely graceful carriage, with the neck longer than in the horse, and a general contour much on the same type as that of the Llama.

Without attempting a detailed study of its osteological structure, we may mention that *Palæotherium magnum* had a height a little less than that of a middle-sized horse Three toes are found on each of the feet; the head, much like that of a tapir, had most probably also the rudiment of a trunk; the femur has a third trochanter; the dentary system is composed, in each jaw, of six incisors, two canines, and fourteen molars, these latter corresponding with the same teeth in the rhinoceros.

Palæotherium magnum, like its congeners, of which about a dozen species are at present known, was herbivorous, and without doubt lived in large herds. Its existence carries us back to that age of our earth which is termed the Eocene period, and it is in the middle of that period, which comprises the gypsum deposits or their geological



PALÆOTHERIUM MAGNUM

equivalents, that its remains are discovered, as well as those of all the other species of the same genus.

Nevertheless it made its appearance even before the gypsum formation, its presence having been detected in the beds of coarse limestone, which are inferior to and therefore more ancient than that formation.

It is the plaster quarries of Montmartre, Pantin, and La Villette, near Paris, which have for a long time held the privilege of furnishing to palæontologists the numerous remains that are known of this fossil species. The Palæotherium, which forms the subject of this notice, was obtained from a plaster-quarry situated at Vitry-sur-Seine. It was, however, even a few days ago, as we see it to-day, exposed on one side, and on the other encrusted in its stony resting-place in the ceiling of a subterraneous gallery, a little more than four yards high. Only a few have visited it, although M. Fuchs, a civil engineer, the proprietor of the quarry where this magnificent specimen was found, offered to give it to the Museum.

The gift so generously offered was immediately accepted; and Prof. Gervais, with a scientific zeal which ought to be fully acknowledged, occupied himself with the direction of the important task of taking it intact to Paris.

MARS

THE characteristic appearance of this planetary body, long familiar to astronomers, has of late become generally known. Remarkable neither for situation, magnitude, brilliancy, retinue or complexity of arrangement, inferior in each of these respects to some, and in many of them to several of the members of the solar family, one circumstance alone invests it with a peculiar interest—its resemblance to ourselves. Such a resemblance obviously does not exist in the mightier and more nobly attended external planets: the banded skies of two and the strong atmospheric absorption of the two others revealed by the spectroscope, sufficiently show that they belong to classes

MARS IN 1862

mutually indeed dissimilar, but each differing, and perhaps widely, from our own. With the swift and fiery Mercury we can have as little sympathy; and though Venus would offer a more promising analogy, the configuration of her beautiful surface is not well seen or readily interpreted. Mars therefore remains; and while, fortunately for astronomers, he occupies such a position that his features are fairly accessible, they bear an aspect so comparatively intelligible that, whatever may be the case as to our other fellow-subjects in the solar monarchy, we are ready to claim that globe as a close relation of our own, inferior indeed in magnitude and importance, if importance is indicated by an attendant, but arranged in a corresponding manner by the Great Creator as the seat of life and intelligence.

Such a supposition has been gradually and surely advancing from an early period of telescopic astronomy. The polar whiteness detected by Huygens and Cassini I. as far back as 1672 would naturally suggest the idea of a snowy deposit, which assumed almost the form of certainty, when the elder Herschel showed that its extent was regulated by the Martial seasons, and that it wasted steadily down with the advance of vernal heat. From the obvious division of the surface into brighter and darker portions, the existence of an atmosphere at least would be inferred, so long as they were supposed to be variable; but as the evidence of their general permanence increased under the eye of Herschel I. about a century ago, this impression gave place to the more definite recognition of something corresponding to the outlines of lands and oceans, with occasional variation from atmospheric condensations; and thus by degrees we have been led to acknowledge, in that remote and otherwise unimportant globe, a most interesting counterpart of our own.

This conclusion has not, however, been attained by an uninterruptedly continuous or an uniformly satisfactory process of deduction; and even at the present time it is perhaps not universally received. Schröter referred the darker portions to atmospheric obscuration, a notion which pervaded others of his investigations, not to their advantage; and a more recent observer of considerable ability, the late Prof. Kaiser, of Leiden, whose decease in his 64th year took place July 28, 1872, has, in a very elaborate and interesting report of the work done on the planet at that observatory, expressed his doubts as to the certainty of the more customary inference. Whatever may be our own impressions on the subject, his criticisms and conclusions exhibit so much of the genuine spirit of an impartial student that some notice of them, as they are found in vol. iii. of the Annals of the Leiden Observatory, may be worth the attention of our readers. This observatory, it should be noted, is provided with a Merz achromatic of 7 (French?) inches aperture, and was therefore, under Kaiser's superintendence, fairly competent for physical researches commensurate with the present demands of science; as it is well known, and indeed especially brought out by the observations we are about to notice, that much larger telescopes are not invariably, or even generally, available in proportion to their magnitude. The addition, in 1872—too late therefore for a share in the professor's observations—of an $8\frac{1}{2}$ inch With-Browning reflector, will hereafter not only afford an interesting comparison of instruments, but if the result corresponds with others obtained elsewhere, will be found a step in advance as regards efficiency.*

In selecting Mars as the subject of special inquiry, Prof. Kaiser laid a solid foundation by consulting every work within his reach, representing or describing the physical aspect of the planet, from the earliest and rudest efforts in 1636 to the elaborate delineations of the present day. No less than 412 drawings thus passed through his hands: upwards of 320 others he could not procure; and the aggregate is doubtless much in defect of the existing total. He did however well in securing so many; more, probably, than any other areographer, if such a word may be allowed. But the result of their comparison and discussion was not as satisfactory as might be wished. The first specimens of representation were of course mere rude attempts. Those of Huygens, however, in 1659, discovered by Kaiser in his "day-book" (of which the most valuable portion was edited by him in 1847) are comparatively well drawn; and Hook, in 1666, caught the true character of what he saw, though Kaiser doubts whether his spots could be as readily identified as has been supposed. We next find Herschel I. taking up the subject

* A curious error on the part of Prof. Kaiser may here be noticed. He has referred (p. 23) to a drawing of Mars by Browning as having been taken with a silvered mirror by Barnes. This gentleman was merely the proprietor of the speculum, which, like the others mounted by that optician, was th work of a most accomplished artist, Mr. With, of Hereford.

in 1777, and continuing his observations till 1783. He first noticed the eccentric position of the two white spots in the polar regions, as well as their diminution from solar action; 5 out of his 31 figures show a broad white band passing obliquely across the disc, and he speaks of changes in the markings from passing clouds and vapours: some of his dark spots can be identified with more recent representations, but not the whole. Of the numerous drawings (217) of Schröter, Kaiser was unable to avail himself, as the Areographische Fragmente, rescued from the disastrous fire at Lillenthal in 1813, were left unpublished at his death. These, however, through the intervention of Dr. Peters of Altona, have subsequently been traced to their safe custody in the hands of Schröter's descendants, and have recently been thoroughly examined by Dr. Terby of Louvain, whose report has been published by the Belgian Académie Royale des Sciences. From the figures contained in this, and another interesting essay by the same astronomer, it appears that many coincidences may be traced between the views of Schröter and other observers, though his preconceived idea of the vaporous nature of the darker features deprived his observations of some of the value otherwise due to them as the results of eminent zeal and perseverance.

Passing by several observers of minor note, of whom Kaiser has given a minute enumeration, we reach the opposition of 1830, which the near concurrence of the aphelion of the Earth and the perihelion of Mars rendered eminently favourable, enlarging the apparent diameter of the latter to 23″·1. The close and systematic investigation then entered upon by Beer and Mädler forms a most important epoch in the progress of areography, and for the first time a series of drawings were executed, little resembling anything previously known, which have ever since been referred to with confidence as a starting point for future inquiries, and which, it might have been hoped, would have set many questions at rest: and so they did; but as Kaiser remarks, later representations have again unsettled points which had been supposed to have been then decided. The comparative failure of the same observers in subsequent oppositions admitted of explanation from the increased distance and altered presentations of the planet; and little advance was made by Mädler in 1841, even with the renowned refractor at Dorpat, to the care of which he had succeeded: the apparent diameter, then, however, was only 15″·1, its minimum, attained in 1837, being 13″·3. Of the near approach in 1845, when the disc was enlarged to 23″·5, no observations seem to have fallen into Kaiser's hands, excepting those of the American astronomer Mitchell. Confining ourselves still to the more important representations, at the expense of doing scanty justice to the Professor's elaborate memoirs, we find that 1854 produced the beautiful designs of Jacob, and 1856 the still more delicate ones of De La Rue, both great advances on anything previously published. In 1858, Secchi, who had been for some years at work at Rome, brought out a series of drawings in much harmony with themselves, but only partial agreement with previous delineations. At length came the favourable opposition of 1862, when the point was taken up by many of the first observers armed with some of the most powerful telescopes in existence; but the result, we regret to add, was very different from what might have been anticipated. Secchi, with his magnificent achromatic, Lassell and Rosse with their colossal reflectors, produced such an unsatisfactory and in part contradictory set of drawings as had never been published before. The weather was not always in fault; and though Mars was rather low, Lassell repeatedly found very sharp definition; Lord Rosse's excellent draughtsman once used a power of 1,200; and the quality of Secchi's instrument and sky compensated to a great extent for his smaller aperture; but then the expected clearing up of difficulties terminated in the annoyance of disappointment. Kaiser assures us that nowhere are there such discrepancies as between Rosse and Lassell, even when the same hemisphere was obviously in sight; it could hardly be imagined that they had the same spot in view: and Secchi is so far from setting the matter straight, that his figures scarcely seem to refer to the same body; and for any purpose of accurate deduction the Leiden Professor felt obliged to put all three aside. He is even induced to say, "the largest telescopes give the worst results, and show themselves very liable to mislead the observer: correct delineations of the celestial bodies require before all things a very practical designer that gives way to no fancies; and such a designer is not apt to possess the most powerful telescopes of the earth." We are here merely reproducing the censor's words, without venturing an opinion as to the soundness of his criticism.

But, fortunately as it would seem for areogrophy, instruments of more moderate dimensions were employed to better purpose during that and the subsequent opposition of 1864; and the agreement of the beautiful designs of Lockyer in the former year with those taken by Kaiser himself, then and in 1864, as well as with those of Schmidt and Phillips, was far more satisfactory: and the same might be said to a considerable extent as to Dawes, whose instrument, however, was of a superior rank.* The difference between Lockyer and Lassell, in one instance, was so wide, that identity of date alone proves that they had the same hemisphere under their eyes; while, on the contrary, the concurrence between Lockyer and Kaiser, though the latter speaks with great diffidence of his own designs, justified him in believing that a pretty correct representation had been attained of a broad girdle round the equator.

The labour which the Leiden professor has bestowed upon a comparison of all the least discordant drawings, and the punctilious accuracy of his protracted discussions, would be little appreciated from so brief a sketch of them as can be attempted here. He was himself so little pleased with the result as to express an opinion that the only safe inference from the oppositions of 1862 and 1864 is, that the art of drawing celestial objects is at much too low a pitch to justify accurate deductions as to their physical character. And this, though it looks like the language of disappointment, and is hardly reconcileable with the striking agreement which he often remarks between the drawings of different observers, or the same observer at different times, seems to have been his deliberate impression. He ascribes the variations in part to the differences of presentation and perspective, in part to faulty delineation; and while he admits that atmospheric condensations may have occasioned small apparent changes, he thinks on the whole that they are evidences of the unsteadiness of our air, leaving almost always an uncertainty as to the minuter spots and shadings, and a want of confidence in the correctness of one's own delineation. The discrepancies among his 412 designs are so "enormous" that no one would believe that they were intended for the same body. These differences arose, however, in part from natural causes. Even in the most favourable case, the spots are only seen with any distinctness or in their true form in the centre of the disc; those lying near the limb being greatly foreshortened and not recognisable in their real shape; and this difficulty is very considerably enhanced by the imperfect transparency of the planet's atmosphere and its frequently strongly illuminated precipitations. The inclination of the axis may vary its position at different times about 60° as regards the spectator, and consequently different oppositions bring before him entirely different features in that central position where alone they can be well observed or drawn.

* It is much to be regretted that only a part of the drawings of this great observer have as yet been published in *fac-simile*. Those given in the Monthly Notices (XXV., 225) omit, as Kaiser remarks, some of the most curious presentations of the globe; and the reproduction of others by Proctor does not profess minute accuracy.

And to these sources of difficulty it might, we think, have been added that, in consequence probably of our study of geography from projections of the globe in which the effect of perspective is designedly counteracted as much as possible, we are apt to have a very defective idea of the amount of apparent distortion which it occasions towards the edges of the visible hemisphere. But even when all this has been allowed for, we find, the professor tells us—nor indeed do we need opportunities as extensive as his to convince ourselves of it—that the differences are much too great to be altogether thus explained; and he concludes that the more conspicuous ones are errors in representation. If there is occasional agreement as to the forms, there is still much risk in referring them to the same object, until it has been ascertained by computation that the presentation of the globe towards the spectators was nearly the same. Fortunately, during any given opposition, the position of the planet's axis shifts but little, and in other oppositions the same presentation recurs from time to time; but instead of the correspondence naturally anticipated, the differences are for the most part, as he expresses it, "enormous." And yet amongst them all, coincidences come to the surface, too remarkable to admit the idea of fortuitous resemblance; and we must suppose that many who have taken pencil in hand have not been sufficiently careful as to form and shading, but have followed arbitrary and perhaps very mistaken impressions, from which nothing but absurd and absolutely contradictory inferences of a physical nature could be drawn.

T. W. WEBB

(*To be continued.*)

THE ADMIRALTY CHARTS OF THE PACIFIC, ATLANTIC, AND INDIAN OCEANS *

THESE charts have been compiled by Captains Evans and Hull, of the Hydrographic Departments of the Admiralty, from Maury's pilot charts, Fitzroy's and Fergusson's wind charts, charts issued by foreign Governments, and from the works of Dovè, Neumayer, Buchan, and documents in the Hydrographic Office of the Admiralty. They show for the four seasons the pressure, winds, and temperature over the parts of the globe covered by the sea. January, February, and March are properly grouped together into one season, these being the three coldest months as regards the oceans in the northern, and the three warmest in the southern hemisphere.

The most important piece of new work in these charts is the "isobars," or lines of equal barometrical pressure, which are given for the seasons. These isobars for the sea, taken in connection with Buchan's isobars published in 1868, may be regarded as the first approximation to a complete representation of the earth's atmosphere over both land and sea. We have minutely examined these isobars, comparing them with the large amount of new information collected during the past five years from many places situated on the coasts of the continents, or in islands scattered over the ocean, and can come to only one conclusion, viz., that the greatest care has been taken in their construction. Among the very few cases to which slight exception might be taken is the isobar of 29·7 in. of July, August, and September, drawn to southwards of Japan, which observations do not appear to warrant. It should also be pointed out that a serious omission has been made in not stating how the ship barometric observations were reduced to the mean pressures from which the isobars have been drawn.

We are now in a position to draw one or two general conclusions of great importance regarding the distribution of atmospheric pressure over the ocean. In the ocean, to westwards of each of the continents, there is at all seasons an area, or patch, of high pressure, from 0·10 inch to 0·30 inch higher than is found on the coast westward of which it lies. The distance of the centre of the space of high pressure from the coast varies from 20° to 35° of longitude, the average distance being nearly 30°. The position of the centre of the space varies from about 22° to 35° north or south latitude, or stating it roughly it lies about the zones of the tropics. In these spaces the absolute pressure is greatest during the winter months of the respective hemispheres—a condition of things probably due to the fact that during the winter season of the northern hemisphere the great mass of the earth's atmosphere is disposed about the tropic of Cancer, and during the winter season of the southern hemisphere, about the tropic of Capricorn. The position and shape of the isobars seem to be largely determined by that of the continents adjoining. Thus the rounded form of the southern portion of North America, the bending eastward of the west coast of South America from Payta to Arica, and the form of the north-western part of Africa and its "lie" from S.W. to N.E. are all more or less impressed on the isobars bounding the contiguous spaces of high pressures. These spaces are less prominently marked west of those continents which have the least breadth in lat. 30°; thus the area of high pressure is less marked west of the Cape than it is west of Australia, and still less than to the west of North America. The isobars are much farther apart on the western than on the eastern side of these areas of high pressure; indeed in many cases they are as it were drawn out so as almost to reach the continent lying to westward; and in some cases there is even a tendency towards, or the actual appearance of, secondary areas of high pressure to eastwards of continental masses. This is most distinctly seen to eastward of Australia.

We have dwelt thus particularly on these spaces of high pressures because of their importance in atmospheric physics, but more especially because of their vital connection with prevailing winds and the general circulation of the atmosphere. Out of these high pressures, the wind blows in all directions anti-cyclonically in accordance with the well-known "Buys Ballot's Law of the Winds," of which relation the wind charts before us afford abundant confirmation. Keeping this relation between wind and pressure in view, we have presented in these high pressures the proximate causes of the prevailing winds over the greater portion of the ocean; and through the prevailing winds, the drift currents and other of the surface-currents of the sea; and thereby the anomalous distribution of the temperature of the sea as seen in the Chile, Guinea, and other currents, and the peculiar climates of the coasts past which these currents flow.

The small area of high pressure to the east of Australia may be singled out as perhaps the most interesting of the new facts in the charts. During winter the winds along the east and south of Australia blow inwards upon the interior of that continent, whereas in New Zealand the prevailing winds at the same season are north-westerly and westerly, the directions being thus generally opposite on these two coasts facing each other. The space of high pressure between gives a ready explanation of the direction of these winds, as well as of the heavier rainfall on the west of the South Island of New Zealand as compared with that of the North Island, and of the south-east as compared with the south-west of Victoria.

Like praise cannot be given to the charts of the isothermals of air for January, April, July, and October. In the October chart, the isothermal of 60° cuts the east coast of South America near lat. 27°; now at Monte Video, the mean temperature of October is 61·2°, at Buenos Ayres 61·3°, and at Bahia Blanca, in 38°·4 S. lat. 59°·7; that is, the isothermal of 60° should cut the South American coast 11° of latitude farther to the south. The January isothermal of 60° is drawn passing through New

* "Wind and Current Charts for the Pacific, Atlantic, and Indian Oceans," published at the Admiralty, October 1872, under the superintendence of Rear-Admiral G. H. Richards, C.B., F.R.S., Hydrographer.

Zealand near lat. 40°, and the isothermal of 50° near Dunedin; now the mean temperature of January at Southland situated at the extreme south of New Zealand is 57°·6, and at Duned in (550 ft. high) 57°·5; in other words, the isothermal of 60° and not that of 50° ought to pass near Dunedin. Dr. Hector's meteorological reports during the past seven years place this beyond all doubt, and it is unfortunate that the summer climate of this important colony of Great Britain should have been so misrepresented as to appear to be colder than that of Iceland, and altogether insufficient for the ripening of wheat, barley, and other cereals. The July isothermal of 90° is represented as having its eastern extension at the entrance to the Persian Gulf in 57° E. long. Now Murray Thomson's and Blandford's meteorological reports show that the isothermal of 90° extends eastward to about 77° E. long, so as to embrace the Punjaub and the upper tributaries of the Ganges to the west, being thus 20° farther east than is represented on the chart.

The truth is, that, excepting for the months of January and July, there have been no isothermal charts of the months for the whole globe yet published which do not contain many gross errors similar to those we have pointed out. The time is surely not far off when a committee of the British Association, or some competent authority, will take up this subject, and give us a set of new isothermal lines laid down from all data which the great expansion meteorology has received of late years has made available.

The two charts showing the isothermals of the sea for the extreme months, February and August, and the chart showing the surface currents of the ocean, are very valuable. A supplementary chart showing the currents south and east of Asia during the monsoon season is also given. We should suggest for the second edition of the Charts, that charts of the surface currents for both February and August should be given for the whole globe, it being only thus that these important aids to navigation can be adequately presented.

It was pointed out in NATURE some years ago that the prevailing winds and surface currents of the Atlantic are all but absolutely coincident. These Charts enable us now to extend the remark to the prevailing winds and surface currents over all the oceans. Keeping out of view the deep-water currents of the sea to which Carpenter has given so much attention, it is now placed beyond all doubt that it is to the winds we must look as the prime movers of oceanic currents.

MR. GARROD'S NEW CLASSIFICATION OF BIRDS

AT the scientific meeting of the Zoological Society, on Tuesday, February 3, Mr. A. H. Garrod introduced a new Classification of Birds, based mainly on the disposition of their muscles and other soft parts. The following is an abstract of his paper:—

The osteology of birds, judging from the unsatisfactory state of their classification in the present day, is not sufficient in itself as a basis for distinguishing the mutual relations of the different families and genera; and as the peculiarities in the soft parts are very constant, they deserve more consideration than they have hitherto received. The researches of Hunter, Nitzsch, Macgillivray, Owen, and others, have brought to light many facts in visceral anatomy and pterylosis, all of which are of great value in classification. Sundevall is the only ornithologist who seems to have made any generalisations respecting myology, and these have an important bearing on the subject.

My method of work, Mr. Garrod went on to say, has been the following:—After having carefully dissected a few birds that are known to be but distantly related, a comparison of the notes on the individuals examined showed that there were important myological differences between them. Further dissection of species related more or less intimately, indicated broadly the relative value of the peculiarities that were found, when taken in connection with the most approved classification of the present day; and as observations became more numerous the relative importance of the facts observed was more easy to estimate. The muscles which have, on account of their marked tendency to vary in the class Aves, attracted the most of my attention, are all situated in the thigh, and they are five in number: (1) the *femoro-caudal*, which runs from the linea aspera of the femur, near its head, to the sides of the tail vertebræ; (2) the *accessory femoro-caudal*, which runs parallel to the last, and behind it, from below the femur-head to the ischium; (3) the *semitendinosus*, which crosses the first-named muscle superficially, and arises from the lower part of the ischium, to be inserted into the inner side of the tibia-head; (4) the *accessory semitendinosus*, which arises from the distal end of the linea aspera, and joins the fibres of its larger namesake obliquely just before their insertion; (5) the *ambiens*, that peculiar slender muscle which arises from just above the acetabulum, and after running obliquely through the ligamentum patellæ, joins the tendon of the flexor perforatus digitorum. My observations on these five muscles have been made on more than 500 species of birds, including more than 600 specimens, and the results are recorded in a tabular form, in a paper now in course of publication in this Society's Proceedings. For the present, no more attention need be paid to these muscles themselves, but only their presence or absence considered; therefore, to simplify description, a myological formula will be employed which indicates all the facts required in a very precise manner. Calling the first four of the above-mentioned muscles, A B X and Y, respectively, and omitting from the formula thus based, the symbol or symbols which represent any that are deficient, it is clear that a bird, like the common fowl for example, which possesses them all, would be represented by ABXY; and the eagle, in which the femoro-caudal is alone present, by A; whilst the sparrow, which only wants the accessory femoro-caudal, must have the formula A X Y; and the duck, which only lacks the accessory semitendinosus, is represented by A B X. By this means it is possible to make important statements respecting the myology of any bird in a very concise form, which gives great facility towards the comparison of different species. It must here be mentioned that individuals of a species and species of a genus do not vary among themselves in the muscles under consideration. The following table gives the myological formula of the different families of birds, as far as my dissections enable me to go, the only important types omitted being Eurypyga, Psophia, Todus, and Bucco. They are arranged in an order to be subsequently explained, and the presence or absence of the ambiens-muscle is indicated by + or — after each formula:—

TABLE I.

Struthionidæ B X Y +	I.
Casuariidæ { A B X Y — B X Y —	*Picidæ* { *A X Y* — *A X* —
Tinamidæ A B X Y +	
Palamedeidæ A B X Y +	*Ramphastidæ A X Y* —
Gallinæ { A B X Y +	*Capitonidæ A X Y* —
(excl. Turnix) B X Y +	*Upupidæ A X Y* —
Rallidæ A B X Y +	*Bucerotidæ A X Y* —
Otididæ B X Y +	*Alcedinidæ A X* —
(Incl. Cariama and Serpentarius.)	
Phœnicopteridæ B X Y +	
Musophagidæ A B X Y +	II.
Centropinæ A B X Y +	
Cuculinæ A X Y +	*Passeres* { *A X Y* —
Psittaci A X Y ±	*A X* —
Anatidæ A B X +	*Trogonidæ A X* —

Spheniscidæ A B X +	*Meropidæ A X Y —*
Colymbidæ A B X +	*Galbulidæ* { *A X Y —* / *A X —*
Podicipidæ B X —	
Procellariidæ { A B X Y + / A B X + / A X +	*Caprimulgidæ A X Y —*
	Steatornithidæ X Y —
	Coraciidæ A X Y —
Ciconiidæ A X Y +	*Momotidæ A X Y —*
Cathartidæ { A X Y + / X Y +	
Ardeidæ { A X Y — / X Y —	III.
Phalacrocoridæ A X +	*Cypselidæ A —*
Phaethontidæ A X Y +	*Trochilidæ A —*
Fregatidæ A +	
Falconidæ A +	
Strigidæ A —	
Gruidæ A B X Y +	
Charadriidæ { A B X Y + / B X Y +	
Laridæ A X Y +	
Alcidæ A B X —	
Columbæ A B X Y ±	

On looking at the formulæ in the above table it will be seen that there is a tendency to similarity in those that are placed in juxtaposition; and further, that the presence or absence of the ambiens muscle, indicated by the signs + and —, is more constant than the other characters. Thus, among the *Cuculidæ*, the *Picidæ* and *Ardeidæ*, the ambiens does not vary whilst one or other of the rest is inconstant. There are more reasons than the above for assigning primary importance to the ambiens muscle, which depend on the nature of the tip of the oil-gland and the cæca of the intestine. For, with but few exceptions, those birds which possess the ambiens muscle have cæca to the colon and a tuft of feathers on the oil-gland, whilst those in which the ambiens muscle is absent, have either cæca and a nude oil-gland, or a tufted oil-gland and no cæca. The true relationship of the exceptions is, however, indicated by other collateral characters, the most important of which is the presence or absence of the accessory femoro-caudal (B); that muscle being never found in those birds in which the ambiens is always absent, so that any bird with it developed, is certainly related to those in which the ambiens is present. These facts lead me to propose the division of the class Aves into two primary sub-classes,—the *Homalogonati*,* in which the ambiens is present, and the *Anomalogonati*† in which it is always absent. The former of these are printed in the above table in Roman letters, the latter in italics.

It may be asked, why, on the above principles, are the Ardeidæ and the Strigidæ placed with the Homalogonatous birds, especially as the latter have a nude oil-gland? The position of the latter of these two families is no doubt uncertain, but the sum of characters is in favour of the places assigned to it.

Next, respecting the most important sub-divisions of the Homalogonatous, and the Anomalogonatous birds. Taking the latter first, because they are fewer in number, and more clearly separable, they are found to fall naturally into three well-defined orders:—(1) those in which the oil-gland is nude and the cæca of the intestine present; (2) those in which the oil-gland is tufted and the cæca are absent; and (3) those in which the oil gland is nude and the cæca are absent. These three sections of the Anomalogonatous birds are indicated in Table I. by the corresponding numbers, the Picidæ heading the first, the Passeres the second, and the third comprising the Macrochires only. To most ornithologists the not unreasonableness of this arrangement will be fairly apparent.

* With the knee normal; that is, with the ambiens crossing it.
† With the knee abnormal; that is, with the ambiens deficient.

TABLE II.

Class AVES
Sub-class HOMALOGONATI
Order I. *GALLIFORMES*
Cohort (α) STRUTHIONES
Family 1. *Struthionidæ*
Sub-fam. 1. Struthioninæ
„ 2. Rheinæ
„ 2. *Casuariidæ*
„ 3. *Apterygidæ*
„ 4. *Tinamidæ*
„ (β) GALLINACEÆ
Family 1. *Palamedeidæ*
„ 2. *Gallinæ*
„ 3. *Rallidæ*
„ 4. *Otididæ*
Sub-fam. 1. Otidinæ
„ 2. Phœnicopterinæ
„ 5. *Musophagidæ*
„ 6. *Cuculidæ*
Sub-fam. 1. Centropinæ
„ 2. Cuculinæ
„ (γ) PSITTACI (†)
Order II. *ANSERIFORMES*
Cohort (α) ANSERES
Family 1. *Anatidæ*
„ 2. *Spheniscidæ*
„ 3. *Colymbidæ*
„ 4. *Podicipidæ*
„ (β) NASUTÆ
Family 1. *Procellariidæ*
„ 2. *Fulmaridæ*
Sub-fam. 1. Fulmarinæ
„ 2. Bulweriinæ
Order III. *CICONIIFORMES*
Cohort (α) PELARGI
„ (β) CATHARTEÆ
„ (γ) HERODIÆ
„ (δ) STEGANOPODES
Family 1. *Phæthontidæ*
„ 2. *Pelecanidæ*
„ 3. *Phalacrocoridæ*
„ 4. *Fregatidæ*
„ (γ) ACCIPITRES
Family 1. *Falconidæ*
„ 2. *Strigidæ*
Order IV. *CHARADRIIFORMES*
Cohort (α) COLUMBÆ
„ (β) LIMICOLÆ
Family 1. *Charadriidæ*
„ 2. *Gruidæ*
„ 3. *Lariæ*
„ 4. *Alcidæ*
Sub-class ANOMALOGONATI
Order 1. *PICIFORMES*
Family 1. *Picariæ*
Sub-fam. 1. Picidæ
„ 2. Ramphastidæ
„ 3. Capitonidæ
„ 2. *Upupidæ*
„ 3. *Bucerotidæ*
„ 4. *Alcediniдæ*

Order II. *PASSERIFORMES*

Family 1. *Passeres*
" 2. *Bucconidæ* (?)
" 3. *Trogonidæ*
" 4. *Meropidæ*
" 5. *Galbulidæ*
" 6. *Caprimulgidæ*
" 7. *Steatornithidæ*
" 8. *Coraciidæ*
Sub-fam. 1. Coraciinæ
" 1. Momotinæ
" 3. Todinæ (?)

Order III. *CYPSELIFORMES*

Family 1. *Macrochires*
Sub-fam. 1. Cypselinæ
" 2. Trochilinæ

The Homalogonatous birds must be divided upon a different basis, and their myological formulæ here come into service. Before going further it is necessary to show that the habits of the species are not the cause of their myological peculiarities in most cases, though probably in some they do affect them. The Heron and the Swallow have the same formula, and yet how different their habits? the same may be said of the Owls and the Swifts; the Kaleege and the Flamingo. The Auk and Guillemot, however, are most probably but distantly related to the Ducks and Penguins if the peculiarity in the nasal bones has the importance that I assign to it; nevertheless, the muscles of their legs agree more with them, than with the other Schizorhinal birds. By a glance at Table II., the manner in which the Homalogonati may be best subdivided according to the facts that I have been able to bring forward, may be obtained. Commencing with the orders, the *Galliformes* include all those birds related to the Fowls; and notwithstanding the high opinions to the contrary, I cannot feel justified in separating the Struthious birds away from this group. It is not difficult, after having seen the formula of the Musophagidæ and Cuculidæ (Table I.), to recognise that these families have nothing to do with the Anomalogonatous birds, although they are peculiar in the former having no cæca, and the latter a nude oil-gland. The Psittaci also cannot be placed anywhere else.

The *Anseriformes* all agree, with the exception of the Storm-Petrels, which are also otherwise difficult to place, in wanting the accessory semitendinosus (Y), and in having the great pectoral muscle very elongate. The whole family of petrels are exceptions in this point also, and may have to be put in the next order, amongst the Ciconiiformes.

The *Ciconiiformes* include amongst them the Accipitres, but myology is in no point more clear than with regard to the unnaturalness of that family as at present defined. Every Eagle, Hawk, true Vulture, and Owl, has for formula A. The Secretary Bird, which is generally placed with them, is represented by B X Y; from which it is seen to be as different from them as it can possibly be. This shows that the position of *Serpentarius* must be changed; that it is not a raptorial bird at all; and that, as in formula and general appearance it resembles *Cariama*, it must be placed near it and the Bustards. Similar arguments indicate that the Cathartidæ are not true Accipitrine birds, but must form an independent family, though still in the same order as the Falcons.

The *Charadriiformes* all possess the peculiar nasal arrangement which I have termed Schizorhinal. The *Turnicidæ* and *Parridæ* are included with the *Limicolæ*, and the *Pteroclidæ* with the *Columbæ*.

The justification of many of the smaller divisions of the above orders will be seen by comparing the myological formulæ, and by a review of the osteological, pterylographical, and visceral arrangement of each.

In any attempt at classification on new facts, it must be remembered that there must be great inequality in the importance of the results arrived at in each order as freshly defined. In one family there may be a uniformity in a particular structure which is greater than could possibly have been expected; whilst in another the previously constant character may be one of the most uncertain. For instance, the left carotid artery is alone present in all the Passerine birds that have ever been examined: but amongst the Bustards the Great Bustard has two, Denham's only the right, and *Tetrax* only the left. Therefore it is not to be wondered at that myology is equally uncertain in its indications sometimes, though on other occasions its teaching is most decided. In the above attempt at a new arrangement, it has been my endeavour to bring forward the results of observations made during a considerable time, with the facts obtained from previous work always kept prominently in the foreground.

NOTES

In a Congregation held at Oxford on Feb. 10, Prof. H. Smith introduced a statute providing that the certificate of the examiners appointed under the authority of the Delegates of the Examination of Schools, when given in Greek, Latin, and Elementary Mathematics, be accepted in lieu of Responsions. He represented that in Mathematics the standard would be higher than in Responsions; in Greek and Latin it would be equal, owing to the requirement of translation of "unseen pieces." The candidate would also have to pass in some other subject. It was therefore inconceivable that the idle should select the Schools Examination as the easier. The standard would be kept up by the employment of the same class of examiners as in other University examination. The preamble of the statute was accepted.

Dr H. Alleyne Nicholson, Professor of Natural History in University College, Toronto, has been appointed to the Professorship of Zoology in the Royal College of Science, Dublin, vacant by the resignation of Dr. Traquair. Prof. Nicholson is known as the author of many papers on the Graptolites, and as a writer of several text-books of zoology.

The Smith's Mathematical Prizes have been adjudged to Mr. Walter W. R. Ball, second wrangler, 1874, and Mr. George Stuart, B.A., Emmanuel College, Cambridge, bracketed fourth wrangler, 1874.

A meeting of those who have signified their interest in the formation of the new Physical Society will be held on the 14th inst., at 3 o'clock P.M., in the Physical Laboratory, South Kensington.

A general meeting of the Provisional Committee for the establishment of the Scientific Societies Club was held on Jan. 29 at the Westminster Palace Hotel, when an organising committee was appointed with a view to the early opening of the club. The number of "original members" is nearly complete, 231 gentlemen having given in their names. Among the Provisional Committee we notice the names of Dr. Gladstone, Prof. Lawson, and Prof. Morris, and others known to Science.

At the meeting of the Paris Academy of Sciences on Feb. 2 the place of Correspondent of the Astronomical Section, left vacant by the election of Sir George Airy to a Foreign Associateship, was filled up. M. Tisserand obtained 25 votes and M. Stéphan 23. The former was therefore elected. At the same meeting the Academy, sitting in secret committee, received the report of the committee appointed to select candidates for the Chair of Embryology at the College of France. M. Balbiani was placed first, M. Gerbe second. The election was announced for the 9th inst.

WE have just received from Mr. Gerard Krefft the cast of a fossil specimen of extreme interest. It is that of one of the teeth of an extinct species of *Ceratodus* found with the usual *Diprotodon* remains in the alluvial deposits of the Darling Downs district of Queensland. This able naturalist has named the fish indicated by this fossil in honour of the present Colonial Secretary of Queensland, *Ceratodus palmeri*. It is larger than the corresponding tooth—the left upper dental plate—of *C. forsteri*, the enamel being rather coarser and the surface more undulated than that of Forster's fish. In the specimen under consideration, three of the prongs are perfect, being three-fourths of an inch in width. Mr. Krefft mentions that the existing fish is called "Jeevine," and not "Barramundi;" also that it never goes ashore, and is not caught, as supposed by some, with hooks baited with frogs.

THE *Academy* has been favoured by Dr. Kirk with the following private telegram, which he received from Brigadier-General Schneider, C.B., Her Britannic Majesty's political Resident at Aden, with reference to the news of the death of Livingstone. Dr. Kirk considered that the details given in the telegram as published concerning Livingstone's death and the embalming of his body presented so many doubtful points which required clearing up, that he was anxious to ascertain whether Cameron had convinced himself of the accuracy of these reports by personal examination of the messengers who, it is said, preceded Livingstone's dead body to Unyanyembe, and among whom was Chumah, his servant; or whether the reports had come to his ear, before Chumah himself reached Unyanyembe, in the usual untrustworthy and exaggerated native manner. He therefore telegraphed to General Schneider; but, as will be seen by the reply from General Schneider, it cannot be ascertained at present whether Cameron actually saw Chumah. The evil tidings may have preceded him by some days; and there is nothing for it but to wait the receipt of Cameron's written advice:—"General Schneider to Dr. Kirk.—Aden February 2, 5.15 P.M.—Captain Prideaux merely says Chumah went ahead and gave intelligence to Cameron."

THERE has been instituted by the French Government, under the Minister of Public Instruction, a Commission of Scientific and Literary Voyages and Missions. The object of the Commission, we learn from *Les Mondes*, is (1) to discover what are the most useful scientific and literary enterprises; (2) to examine the projected voyages and missions proposed to the Minister; (3) to study the programmes of these missions, to give detailed instructions to those who undertake them, and to carry on correspondence, if necessary, during the voyage; (4) to examine, on their return, the works on which the voyagers have reported, and prepare their publication in a record of Missions, when that is founded; (5) to name to the Minister such voyagers as may be worthy of honourable reward after the completion of their enterprise; (6) to appeal to the various administrations to concentrate on certain enterprises all the resources at the disposal of the state. The Under-Secretary of State is President of the Commission, and M. Beulé Vice-President; while, among the members are, MM. Felix Ravaisson, Conservator of the Louvre Museum, Leon Renier, Chevreul, Milne-Edwards, D'Avezac, President of the French Geographical Society.

THE *Paris Journal* gives a curious account of an hotel situated in the *Rue des Petites Ecuries*, which has a *clientèle* of living phenomena. It is an hotel of the lowest order, which was fitted up by a French barman for housing extraordinary creatures. The *homme chien* and his son Fedor lived there for some time. The giant of Folies Bergeres (8 ft.) dwelt there. He was an intimate friend of a dwarf whom he carried in his arms every evening, when taking his daily promenade after dark. There are also a good many acrobats and lion-tamers admitted into the house. Mdlle. Christine, the double sisters, were not a lodger; they had an agent of their own, an Englishman. Most of these curious specimens of humanity are placed under the direction of the hotel-keeper, who procures engagements for them at certain prices, according to their *demerits*, and directs them either to some of the minor theatres, concert-halls, or to the booths erected at suburban fairs. A *Table d'hote* of the Petites Ecuries Hotel, where all these strange creatures come together, is the most extraordinary sight in the whole town.

THE sale of several works on the book-stalls at railway-stations has been prohibited by the Minister of the Interior. Amongst these we notice "Les Ballons du Siege," by M. W. de Fonvielle, who, as it is known, escaped from Paris in a balloon during the investment of Paris, and delivered lectures in London. M. W. de Fonvielle, who was just returning from London when the prohibition was issued, has written to the minister in order to ascertain the real facts of that extraordinary decision.

DR. A. ERNST prints (unfortunately in Spanish) under the title "La fécula y las plantas farináceas del nuevo mundo," a list of 100 plants of the New World which yield starch, with detailed accounts of the more important ones.

IN the discussion which followed, Sir Bartle Frere's address, at the opening of the African Section of the Society of Arts, Mr. Hyde Clarke read a letter from Lieut. Maurice, Private Secretary to Sir Garnet Wolseley, dated "Head Quarters, Yancoomassie," from which we take the following extract; it may prove of some interest to students of the Science of language:—"A somewhat curious piece of word-coining, which has fallen under our notice here, may interest you in connection with the broader aspects of the subject of which you write. The Ashantees having experience of our rockets only as they come to them in destructive form at the end of their journey, call them by the sound they make, 'Schou-schou,' or something of the kind. The Fantees, on the other hand, adopt bodily into their Language our own names for those things which they have not seen before. Thus to the Houssa or the Fantee, in speaking to one another, our rockets are named rockets, while their enemies call them schou-schou. It is possible that as war has not been in savage times an uncommon condition of mankind, analogous causes for different names having been adopted by different nations may have been not unfrequent in the past."

THE Council of the Statistical Society have founded a bronze medal, under the title of "The Howard Medal," to be presented to the author of the best essay on some subject in "Social Statistics" a preference being given to those topics which Howard himself investigated, and illustrated by his labours and writings. The title of the Essay to which the Medal will be awarded in November 1874, is as follows:—"The state of Prisons, and the condition and treatment of Prisoners, in the Prisons of England and Wales, during the last half of the eighteenth century, as set forth in Howard's "State of Prisons," and work on 'Lazarettos.'" The Essays must be sent to the Assistant Secretary of the Society on or before September 30. The competition is open to any competitor, providing the Essay be written in the English language.

WE called attention last week to the course taken by the Perthshire Society of Natural Science, in reference to the present election of Members of Parliament. The Society sent questions to the candidates for the City and County of Perth, relating to the appointment of a responsible Minister of Education, to State help for Science, and to the promotion of scientific exploration expeditions, such as that of an Arctic expedition. The Liberal candidates sent no reply; the Conservative candidates sent favourable answers. The following is the reply of Sir William Stirling Maxwell, the Conservative candidate for the County of Perth:—

"In reply to your letter, I beg to say that I have long been of opinion that the Existing Education Department, and all our Public and Literary Institutions should be placed under the general supervision of a responsible Minister. In Parliament I was generally inclined to favour the expenditure of money for scientific objects when the Government thought proper to sanction them; and an Arctic expedition, and various researches, unremunerative in a pecuniary sense, might fairly fall into the list of such objects."

IN June last year Prof. O. C. Marsh, the discoverer of *Dinoceras and Brontotherium*, started on a five months' geological expedition to the Rocky Mountain regions and the Pacific coast, to study, as he had done on previous occasions, the Cretaceous and Tertiary formations, which are there so rich in vertebrate remains. From Fort McPherson, Nebraska, they proceeded to Niobrara under the escort of two companies of United States cavalry, which were indispensable on account of the hostile position of the Indian tribes. Among the other places visited were Fort Bridger, Wyoming; Idaho and Oregon; Colorado and Kansas. The expedition was very successful, and the collections procured were large, containing many new forms. It is much to be regretted that no English geologists have accompanied Prof. Marsh, as most of the fossils peculiar to the regions he is exploring, are quite unknown in this country, except from descriptions.

THERE will be held at Christ Church, Oxford, on Saturday February 28, an election to a Junior Studentship in Physical Science, tenable for five years from the day of election. It will be of the annual value either (1) of 100*l*. (inclusive of an allowance for room rent), if the Governing Body shall so determine; or (2) of 85*l*. (also inclusive of an allowance for room rent), which sum may be raised to the larger sum above-named after the completion of one year's residence, if the Governing Body shall so determine. Candidates must call on the Dean on Wednesday, February 18, at 1.30 P.M. The examination will follow at 2 P.M. Candidates must not have exceeded the age of 20 on the 1st of January last, and must produce certificates both of the day of their birth, and of good character. Papers will be set in Chemistry, Physics, and Biology; but candidates will not be expected to offer themselves for examination in all these subjects.

PROF. COPE has recently explored the beds of the late tertiary formation, called Pliocene, as it occurs in north-east Colorado. He discovered twenty-one species of vertebrata, mostly mammals, of which ten were new to science. Four are *carnivora*, six horses, four camels, two rhinoceroses, one a mastodon, &c. The most important anatomical results attained are that all the horses of the formation belong to the three-toed type, and that the camels possess a full series of upper incisor teeth. The discovery of a mastodon, of the *M. ohioticus* type, constitutes an important addition to the fauna. One of the horses is distinguished by its large head and slender legs, much longer than in the common horse. A full account of these results will shortly appear in the report of Dr. Hayden's Geological Survey of Colorado.

THE additions to the Zoological Society's Gardens during the past week include a Suricate (*Suricata zenic*) from S. Africa and a West African Python (*Python sebæ*), presented by Mr. J. H. Coonley; a Feline Douracouli (*Nyctipithecus felinus*) from Brazil, presented by Mr. G. Hollis; a common Kingfisher (*Alcedo ispida*), British, presented by Mr. A. Yates; a Collared Fruit Bat (*Cynonycteris collaris*), an Axis Deer (*Cervus axis*), and a Molucca Deer (*C. moluccensis*), born in the Gardens; two De Fillippi's Meadow Starlings (*Sturnella de filippi*) from Rio de la Plata, received in exchange.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, Jan. 22.—"On the Physiological Action of the poison of *Naia tripudians* and other Indian Venomous Snakes," II., by Drs. Brunton and Fayrer.

The results of these investigations show that the poison of the cobra is similar in its action to that of Ophiophagus, Bungarus, and other Colubrine snakes, whilst that of Daboia is similar to the virus of Echis, the Trimeresuri, and other viperine snakes, the chief difference between them being the greater tendency in the viperine poison to cause hœmorrhage or more severe local symptoms. The blood of animals killed by the viperine snakes generally remains fluid after death, whilst that of animals killed by colubrine snakes form a firm coagulum.

The conditions caused by the action of the poison are illustrated by the symptoms manifested by man and the lower animals. The Cobra, Ophiophagus Hydrophidæ, and Bungarus are all very deadly. The Viperine Daboia, and Echis are scarcely less so, whilst the Indian Crotalidæ, such as the Trimeresuri, are much less so. A series of experiments is detailed which illustrate the physiological action of the virus on the nervous system, the muscles, the blood, the respiration, the circulation, and the function of excretion, and also the mode in which death is produced.

The fatal action is shown to be due (1) to arrest of the respiration by paralysis of the muscular apparatus, by which that function is carried on. (2) Or by rapid arrest of the heart's action, in cases where the poison has found direct entry by a vein, *e.g.* the ju ular. In such, death is almost instantaneous, and the heart is found to have ceased to beat when in systole. The physiological import of this is very interesting and important, and it was demonstrated by Dr. Brunton, who explained its probable mode of action in certain ganglionic centres in the heart; a subject which gave rise to some discussion; (3) or death may be due to a combination of arrest of respiration and of the heart's action; (4) or it may be due where the quantity of poison is small, or its quality less active, to secondary causes of the nature of other septicæmia, a purely pathological question not discussed.

The mode in which paralysis of respiration (the ordinary form of death) is induced, has been most thoroughly investigated, and it may be said that the question is now settled.

The virus absorbed into the blood either by inoculation into the areolar tissue, or by application to a mucous membrane, affects the cerebro-spinal nerve-centres, the nerves and their peripheral distribution, more especially of the motor nerves. The sensory nerves are less and later affected, and the intelligence generally latest of all, and slightly. The complete loss of it, and the convulsions which precede death, is mainly caused by the circulation of venous blood, the result of the impeded respiration.

Muscular force and co-ordination are gradually lost; paralysis and asphyxia being the evidence thereof. In ordinary cases, the heart goes on beating vigorously long after apparent death, and with artificial respiration, may be kept up for many hours.

The investigations recorded, were made with cobra and daboia poison, sent to England from Bengal in the dried state, a condition in which it resembles gum arabic, and its activity is great. The animals experimented on were dogs, cats, rabbits, guinea-pigs, fowls, pigeons, small birds, frogs. Its action on all these, and the mode in which functions and tissues are affected, are recorded in detail, as well as the extent to which the action of the poison is modified when introduced through different channels.

It has now been clearly shown that the poison acts, when introduced into the stomach, or when applied to a mucous or serous membrane. The idea that it was only effective when injected directly into the blood, is erroneous. It is, no doubt, more certainly and rapidly fatal when it enters the blood direct.

It is also shown that it may be eliminated by the excreting organs, and that there is, therefore, reason to hope that life may be saved if it can be artificially sustained long enough to admit of complete elimination being accomplished, as in the case of curare poisoning; but from the more complex action of the cobra poison this remains a subject of doubt.

By artificial respiration the circulation has been maintained, both here and in India, by Dr. Ewart and Mr. Richards, for many hours; and in one case, after complete paralysis had occurred, symptoms of reaction and elimination were obtained; but no

complete recovery has yet occurred. The doubt still remains whether the nervous system that has sustained so much damage, is capable of ever resuming its functions, even though elimination be complete.

The so-called antidotes appear to be inert; all that have been submitted to trial, including the intra-venous injection of ammonia, have failed to have any satisfactory effect. Artificial respiration has certainly prolonged life, and partial recovery has followed, but no life has actually been saved by it.

The microscopic appearances of the blood are described, but no very remarkable change was observed beyond crenation of the corpuscles or diminished aggregation into rouleaux. Chemical examination of the blood and its gases is still needed and further analysis of the poison is desirable.

It is shown that the activity of the poison is scarcely impaired by drying, excepting perhaps so far as regards its *local* action.

Dilution with water, glycerine, liq. ammoniæ, and liq. potassæ did not destroy its activity, nor did coagulation by boiling in the ordinary way. The boiling for half-an-hour under a temperature of 102° C. seemed to destroy the activity of one specimen which was injected into a bird.

The poison acts on all life, on the lower and higher vertebrata, the invertebrata, and even on vegetable life; for it retards, although it may not arrest the germination of seeds. But it acts most vigorously on the warm-blooded animals.

The most remarkable fact connected with it is that it has little or no effect on poisonous snakes. They can neither poison themselves nor their congeners; or if at all, very slightly so, whilst the poison acts rapidly and fatally on innocent snakes, lizards, fish, and mollusca.

With reference to the means of preventing death, it may be said that those that mechanically prevent the entry of the poison into the circulation by means of the ligature, excision, or cautery are the most reliable, but that they are only so when applied immediately.

No means that offer any hope of benefit should be neglected, and it is possible that stimulants such as alcohol and ammonia may be useful; and in some cases, where the poisoning has been severe but not fatal, do good and even determine recovery where death would have otherwise resulted. The so-called antidotes, however, beyond any actions of this kind that they may possess, are apparently quite inert.

Transfusion of blood is alluded to, but the experiments hitherto proposed have not met with success. A more perfect way of accomplishing it may be more successful.

Zoological Society, Feb. 3.—Dr. E. Hamilton, vice-president, in the chair. The secretary read a report on the additions that had been made to the society's menagerie during the month of January, 1874, amongst which were specially noticed a female Water-Deer (*Hydropotes inermis*), a pair of Pink-headed Ducks (*Anas caryophyllacea*), and a Dusky Monkey (*Semnopithecus obscurus*), acquired by purchase, and two Vulturine Guinea-fowls (*Numida vulturina*), presented by Dr. J. Kirk.—An extract was read from a letter addressed to the secretary by Mr. Luigi M. L. Albertis, containing an account of a new species of kangaroo, of which he had lately obtained a living specimen from New Guinea, and which he had proposed to call *Halmaturus luctuosus*.—Dr. Cobbold communicated the second part of a series of papers entitled "Notes on the Entozoa;" being observations based on the examination of rare or otherwise valuable specimens contributed at intervals by Messrs. Charles Darwin, Robert Swinhoe, Charles W. Devis, the late Dr. W. C. Pechey, Dr. Murie, and others.—Mr. Garrod read a paper in which he proposed a new classification of birds, details of which will be found in another page.

Chemical Society, Feb. 5.—Prof. Odling, F.R.S., president, in the chair.—The secretary read a preliminary notice on the action of benzyl chloride on the camphor of the Lauraceæ (*Laurus camphora*), by Dr. D. Tommasi.—Dr. C. R. A. Wright had a paper on the Isomeric Terpenes and their derivatives: Part III. On the essential oils of wormwood and citronelle; being a detailed account of his experiments on these substances, a preliminary notice of which was communicated to the society some time since.—The other communications were a preliminary notice on the perbromates, by M. M. Pattison Muir, F.R.S.E.; and on the coals from Cape Breton, their cokes and ashes, with some comparative analyses, by Henry How, D.C.L. The latter paper giving the amount of coke produced by slow and quick coking, from the main seam coal of Sydney mine, Nova Scotia, and the Lingan coal, also analyses of the ashes left by these coals.

Royal Microscopical Society, Feb. 4.—Anniversary meeting.—Chas. Brooke, F.R.S., president, in the chair. The report of the council and the treasurer's statement of accounts were submitted and adopted, and the officers and council for the ensuing year were elected. The president delivered an address, and concluded with obituary notice of Fellows deceased since the last annual meeting. The following gentlemen were elected as officers and council. President—Chas. Brooke, F.R.S. Vice-Presidents—Dr. Braithwaite, F.L.S.; J. Millar, F.L.S.; W. Kitchen Parker, F.R.S.; F. H. Wenham, C.E. Treasurer—J. Ware Stephenson, F.R.A.S. Secretaries—H. J. Slack, F.G.S.; C. Stewart F.L.S. Council—J. Bell, F.C.S.; F. Crisp, B.A.; Dr. W. J. Gray; J. E. Ingpen; S. J. McIntire, H. Lee, F.L.S.; W. T. Loy; Dr. H. Lawson; H. Perigal, F.R.A.S.; A. Sanders; C. Tyler, F.L.S.; T. C. White. Assistant Secretary—Walter W. Reeves.

Royal Horticultural Society, Jan. 21.—Scientific Committee.—A. Smee, F.R.S., in the chair.—The Rev. M. J. Berkeley sent portions of holly stems pierced by the larva of the wood leopard moth (*Zeuzera Æsculi*).—Prof. Thiselton Dyer exhibited a small branch of *Vitis gongylodes* from the Victoria House at Kew. The end appeared to have been broken off, and the adjacent internodes had (apparently in consequence) swollen into a mass like a small cucurbitaceous fruit.—Prof. Lawson remarked that an Indian vine (*Vitis quadrangularis*) ordinarily had the internodes swollen, though not to anything like the same extent.—A conversation then arose as to the production of aërial roots by vines.—Mr. Worthington Smith, F.L.S., detailed the results of a series of experiments made with the object of ascertaining how far perfectly sound potatoes can be contaminated by contact with infected ones.—Mr. Andrew Murray, F.L.S., made some remarks on interesting plants suitable for horticulture which he had met with in the Rocky Mountains.

General Meeting.—Mr. W. A. Lindsay, secretary, in the chair.—Prof. Thiselton Dyer made some remarks on a parasitic fungus, which was proving exceedingly destructive to hollyhocks. It has been identified by Berkeley in this country, and subsequently by Durieu de Maisonneuve, in France as *Puccinia Malvacearum* of Montagne; it was first described from specimens collected in Chili by Bertero.

EDINBURGH

Geological Society, Dec. 18, 1873.—On some points in the connection between Metamorphism and Volcanic action, by Prof. Geikie, president. After adverting to his previously published views regarding the connection between the protrusion of granite and ordinary volcanic rocks, the author proceeded to point out that the facts were probably capable of a wider interpretation. The metamorphism of large areas was well known to be intimately related to the contortion and plication of rocks, highly metamorphosed regions being those where the rocks had undergone the most intense pressure and crumpling. Heat would necessarily be evolved in the process of compression, and might have been in some parts sufficient actually to fuse the rocks. Such fused portions were probably recognisable in the masses of granite, syenite, porphyry, and other so-called igneous rocks so common in metamorphosed regions. These views were shared by many able geologists of the present day. The author, referring to the recent memoir of Mr. Mallet, pointed out that such conditions as those indicated by the facts of metamorphism were eminently suggestive of the probability that volcanic action had accompanied metamorphism. The extensive crumpling of the rocks of a region indicates a weak part of the crust of the earth through which the internal heat would for a time be more easily transmitted to the surface, while the effect of that crumpling would be greatly to increase the store of heat out of which volcanic energy arises. Hence both by the access given along the line of weakness to the internal heated mass of the earth, and by the increased temperature due to the contortion, water finding its way downward from the surface would encounter conditions eminently favourable for the production of volcanoes. If this speculation has any ground of truth, we should expect to find some evidence of the association of volcanic masses with wide tracts of metamorphism. Without travelling beyond our own country, we seem to have corroboration of it all along the flanks of the highly-contorted, and, over the Highlands, intensely-metamorphosed Silurian hills. The author then gave some details as to the probable thickness of rock under which the present metamorphosed rocks of the Highlands lay at the

time of their metamorphism, and showed that it was probably comparatively small. They were in great measure, if not entirely, metamorphosed before the time of the Lower Old Red sandstone. But the process of metamorphism was no doubt a very prolonged one, and we should therefore be prepared to find proofs of its progress at widely separated periods. It is now well known that low down in the Old Red sandstone of the Midland Valley of Scotland enormous sheets of felspathic lavas and tuffs occur, forming such chains of hills as the Saidlaws, Ochils, and Pentlands. No earlier traces of volcanic action have yet been met with in Scotland, but these masses prove that when that action began it was developed upon an enormous scale. The author believed the inference might with much probability be drawn that this vast effusion of volcanic material was a consequence, or it might even be to some extent an accompaniment, of the crumpling and metamorphism of the older Silurian rocks. He drew attention to the way in which these volcanic rocks bordered the Silurian areas on both sides of the broad lowland valley, and to the numerous remarkable bosses of granite, syenite, and porphyry by which the Silurian tracts were pierced. That many of these bosses were formed by the actual fusion of the stratified rocks themselves seemed to him highly probable. But he held also that some of them marked the lower parts of the actual orifices out of which the volcanic materials of the Old Red sandstone had issued. He alluded especially to the singular rounded or dome-shaped hills of granite, felstone, and quartz-porphyry by which the Silurian uplands of the southern counties are dotted, and which, from their general form and their relations to the surrounding stratified rocks recall some of the characters of true volcanic "necks." The sheets of lava and tuff have been preserved in the broad lowland valley owing to faulting and subsidence, while they have been removed from the surrounding hills by denudation, so as to uncover the roots of the pipes or funnels from which they were emitted. After the enormous masses of volcanic materials erupted during the period of the Lower Old Red sandstone, the underground forces gradually declined in vigour, and as the author had shown, became reduced in Permian times to the production of a few small cones scattered over the midland valley, and down the valley of the Nith. The remainder of the paper was devoted to the Tertiary volcanic rocks of the western Highlands. The author showed that in Skye, Raasay, and Mull, masses of granite and quartz-porphyry were associated with the volcanic rocks in such a way as to suggest a community of origin. Even at a distance from the main mass of the basalt plateaux, granite occurred which was almost certainly of Tertiary date. The picturesque granite of Arran, for example, which had long been known to be at least post-carboniferous, he now firmly believed to be of the same age as the terraced hills of Skye and Mull, that is, younger in date than the soft clays on which London is built, and it appeared to be associated with actual *coulées* which had, in some cases, suffered an enormous denudation like that of the Scur of Eigg. He had not yet been able to show that the renewed and prodigious outburst of volcanic action in Tertiary times had been associated with the metamorphism of any wide region, and perhaps no data are obtainable to throw light upon this question. But the extravasation of granite rocks at several places seemed to indicate that metamorphism had taken place, and at least showed, as Mr. Jukes long ago pointed out, that molten granite might be associated with true volcanic action, though it did not reach the surface as granite.—On fossil cones from the Airdrie black-band ironstone, by G. A. Panton.—Notes on the geology of India, by Andrew Taylor.

MANCHESTER

Literary and Philosophical Society, Jan. 27.—R. Angus Smith, F.R.S., vice-president, in the chair.—"On a Source of Error in Mercurial Thermometers," by Thomas M. Morgan, Student in the Laboratory of Owens College. While engaged in distillation, the thermometer, which was placed in a Wurtz tube so that the column of mercury was entirely surrounded by the vapour of the distilling liquid, was found after some days to indicate three degrees too little—a discrepancy caused by volatilisation from the surface of the column of mercury and condensation on the upper part of the tube. By causing the mercury to flow to the end of the tube and back, the condensed portion was gathered up and the correct temperature indicated. It has since been observed that after each day of distillation, with liquids boiling between 60° and 100° C., a quantity of mercury equal to 1° or 1°·5 volatilises.—"Notes on fossil Lithothamnia (so-called Nulliporæ)," by Arthur Wm. Waters, F.G.S. These attain their greatest development in the Leithakalk, a miocene formation which is principally, in some cases almost entirely, composed of these algæ. But they are in no way confined to the Leithakalk, being also very abundant in the eocene, especially the upper division; the so-called granit-marmor, or Bavarian marble, a nummulitic formation, is very largely composed of this concretionary-looking body. In North Italy it abounds in the eocene formations which are so largely developed in the Veronese and Vicentin. In many places the formation is some hundred feet, much more than half composed of the Lithothamnium. It occurs abundantly in Hungary and Switzerland. The so-called pisolithic limestone of Paris is according to Gümbel about eight-tenths stone algæ; also M. Mario, Astrup; the pleiocene of Castel Arquato; and in fact it seems to be found in most of the tertiaries on the Continent; it is further found in the chalk at Maestricht, and in the jurassic sponge beds at Schwabenbergs. The object of this paper is to draw attention to the great masses of these bodies and the importance of always noticing their occurrence in geological formations, since it should be a very material help in regard to the climate, and the conditions of the coasts and currents, besides being of great stratigraphical assistance; nor is it of less importance to note carefully the growth of recent ones, for only through a knowledge of the present can we interpret the past.

PARIS

Academy of Sciences, Jan. 26.—M. Bertrand in the chair.—The following papers were read:—Note on magnetism, in answer to M. Gaugain, by M. J. Jamin.—Direct demonstration of the equation $\int \frac{dQ}{T} = 0$ by M. A. Ledieu. This was a continuation of the paper read at the last session of the Academy by the same author.—Note on the Rhone irrigation canal, by M. A. Dumont.—Several papers on the action of water on lead, were received.—Organogenesis compared with androgenesis (*l'androcée*), by M. Ad. Chatin. This part of the paper dealt with the *Saxifrages* and *Crassulaceæ*.—On the lateral solfataras of the Chili volcanoes, and on certain new minerals, by M. L. Domeyko.—On the history of the question as to the passage of birds through the air, by M. A. Penaud.—On the shocks of earthquake at Nice, by M. Prost.—Determination of the pluckerian numbers of envelopes, by M. H. G. Zeuthen.—On the apparent orbit and period of revolution of the double star ζ Herculis, by M. Flammarion.—On the variable state of voltaic currents, by M. P. Blazerna. This was an answer to M. Cazin's recent remarks on the subject.—On a new saccharometer and a new method of obtaining an absolutely monochromatic sodium flame, by M. Laurent. The latter object is attained by interposing a cleavage plate of a crystal of potassic dichromate between the polariser and the flame. This absorbs nearly everything but the yellow light of the flame.—Researches on the flow of liquids through capillary tubes, by M. A. Guerout.—On a new laboratory balance, by M. Deleuil.—On ethylic oxalurate and oxamethane cyanurate, by M. E. Grimaux.—On the grafting of dental follicles and of their constituent organs, separately by M. Legros and Magitot.—Remarks on M. Martin's paper on the comparison of the anterior member of the "*Montotremès*," with those of birds and reptiles, by M. E. Alix.—Note on the ammoniacal fermentation of urine, by M. A. Lailler.—On the pretended emission of ozone by plants, by M. J. Bellucci. The author had made a number of comparative experiments on this subject. He found the colouration of the test paper to be due to the combined action of light and moisture.

CONTENTS

THURSDAY, FEBRUARY 19, 1874

PHYSIOLOGY AT CAMBRIDGE

WE are not of those who believe that the *quality* of the scientific work produced by any country as a whole, is dependent to any great extent on the facilities afforded for special study, though the *amount* yielded in any special direction varies directly as the opportunities and encouragement which are offered. All experience goes to show that the ability of the individual is a constant quantity, and that whatever direction his mind takes, as the result of the circumstances in which he is situated, he is sure to rise to a certain standard of excellence in the quality of his productions, and no higher; in other words, the same facts put before two men of different mental powers will be employed in producing results of different quality, dependent on those powers. The backward state of physiology, and it may be said, of biology generally in comparison with the more exact sciences, has recently become so conspicuous, that attempts are being made by many of the leading scientific men to attract into these comparatively untrodden paths some of those able minds which would otherwise have devoted their best energies to the mastery and further elucidation of points in a subject such as mathematics, which may be almost said to have reached the limit of human mental power, as far as the methods at present at its disposal are concerned. In biology and physiology, however, the case is very different; their students may be said to be suffering from a glut of facts and disconnected minor theories, which want the assistance of some master minds to weed and connect them, so that the road may be made more easy for other less gifted workers. That such is the case is rendered evident by the undecided and tentative way in which most biological problems are on all sides discussed. Opinions the most opposite are held on fundamental points by partisans of different schools, and discussion becomes more a question of which side can be most subtle in its language or most dogmatic in its statements, rather than which is the true exponent of the subject under consideration. In such cases the precise statement of the problem by a master-mind would set the question at rest once and for all.

There are, however, many difficulties in the way of getting men suitable for this higher work, and for more than one reason. One of these is that there are very few who can be made to undertake the thorough training in more than a single subject, that is necessary for it. A student of ability at the University of Cambridge, for instance, takes up mathematics, and too soon finds that he has every reason to expect considerable pecuniary reward if he devotes the whole of his period of studentship to working for his tripos; he cannot but devote the whole of his time to the single subject, for otherwise those of equal powers who did so would beat him in the race and prevent his appearing in the tripos list in that position which insures him a fellowship, and therefore a competency. He keeps to his subject and reaps the reward; but by that time other duties, generally of a social nature, together with the narrowing effect of his one-sided education, have removed all his inclination to strike out a fresh line of thought, and he commences the routine of life, acquiring by every-day experience those facts which so many others of equal ability have learned before, and which he cannot therefore turn to any good account. The great defect of the Cambridge mathematical tripos is that it is too ultimate, and too complete in itself. The day on which the list comes out is that on which most think that mathematics has done as much good to them as it can do, and on that day most throw over for ever that genuine method of working which has occupied so much of their time and thought during the three or more previous years, never to return to it.

Things being so, all must have felt intense satisfaction at the establishment at last of laboratories in Cambridge, such as that for Practical Physiology by Trinity College, under the able superintendence of Dr. Michael Foster, and that for Practical Physics by the Chancellor, under Prof. Clerk-Maxwell, whose return to Cambridge has itself been a great stimulus to the advance of the subject in which he so greatly and so justly shines.

The first instalment of original papers from the former of these newly-founded institutions has recently been published. From the manner in which the researches have been conducted, from the thoroughly scientific and careful method of work adopted, the great discretion and experience of the Professors, as well as the excellent quality of the minds, with the assistance of which he has to deal, are evident. No teacher can help having a feeling of satisfaction at such work as that of Mr. Balfour and Mr. Liversidge, which shows signs of excellent mental training as well as a thorough love of the subject. Dr. Foster's standard is evidently a high one, and from the papers before us it is certain that on future occasions only thorough work, based on well-verified facts, arrived at by the most approved modern methods, and checked by the researches of previous authors, are to be expected from his laboratory.

Besides the papers on the development of the blastoderm and blood-vessels of the chick, and on the amyloid ferment of the pancreas, by the two above-mentioned authors, Dr. Martin gives some short notes on the structure of the olfactory mucous membrane in connection with the observations of Max Schultze and Exner. Mr. Dew-Smith records the results of observations—made with the assistance of that beautiful instrument the pendulum myographion—on double nerve stimulation, or the simultaneous stimulation, by two pairs of electrodes, of a single nerve, with well-marked and very instructive results. Mr. Yule also has a paper on the mechanism of opening and closing the Eustachian tube, in which, besides clearing up some points connected with their physiological function, he throws fresh light on the correct anatomy of their pharyngeal orifices.

In one of the papers, that by Dr. Foster himself, which is referred to by Mr. Lewes in this Journal (NATURE, vol. ix. p. 83), Mr. T. O. Harding, senior wrangler in 1872, is mentioned as one of those who have been working in the laboratory. This is a most promising sign; for, as previously remarked, nothing is more wanted than the assistance of such men, in order to show the bearing and value of the various facts laid stress on by pure physiologists. We hope that

Dr. Foster will be successful in attracting other advanced mathematicians to the study of his subject; and better still, that he will be able to persuade those who are in the beginning of their undergraduate mathematical education to devote some of their spare time—quite a recreation as it would be—to learning the first principles and the methods of physiological research, under his able supervision.

Truly Dr. Foster and Dr. Clerk-Maxwell have a noble work before them, and we may hope that by their example and precept Cambridge may after a lapse of thirty or forty years, in the matter of physical and physiological research, be on a level with a second-rate German University.

ATHENIAN TEXT-BOOKS OF SCIENCE

Εγχειριδιον της Χημειας, κατα τας νεωτατας της επιστημης προοδους. (Υπα Αναστ. Κ Χρηστομαναυ. Εν Αθηναις. 1871.)

Επιστημονικα Παραδοξα. (Υπο Δ. Σ. Στρουμπος. . . . Αθηνησι, 1864.)

Περι Αερος και των Ενεργειων Αυτου. (Υπο Δ. Σ. Στρουμπος, 1869.)

Περι των Γνωσεων και των Δοξασιων των τε ἀρχαιων και των νεωτερων ὡς προς τα φυσικα φαινομενα εν γενει, και των μεθοδων τον ερευναν αυτα. (Υπο Δ. Σ. Στρουμπος, 1858.)

THE University of Athens has existed for no more than thirty-seven years. Two of its four Faculties, —the Faculty of Medicine and the Faculty of Philosophy, require a knowledge of natural philosophy and chemistry. It is difficult to understand how these subjects could have been taught at first, for the students by no means often understand French, and no Greek books on science then existed. No doubt the professors taught as Plato and Aristotle taught; and the note-book of the student had to be his text-book. But matters have changed since then: the demand for text-books in Greek has caused them to appear; slowly indeed, for we have seen but few books on science, but we may hope that the original text-books which are now beginning to appear are the first of a continuous series. Do not let it be imagined that the works whose titles are given above are the only works on science we could find in all Athens. There is a big book on Physics by M. Damaskenos, who has also written on trigonometry and meteorology; there are various memoirs by M. Stroumpos on the refraction of light; on the internal constitution of flame; on the fundamental principles of hydrostatics, &c. The University is tolerably well supplied with physical and chemical apparatus, and in good time, we hope, some good student-work will be done there.

Many of the professors have studied in Paris, and we see evidence in the text-books of French science and of French thought. Prof. Chrestomanos appears, however, in the compilation of his Chemistry, to have consulted most of the recent books and memoirs. We are glad to see Canizzaro often quoted as an authority. The work does not present any specially noteworthy features, but it is sound and eminently clear. The phraseology is at times somewhat strange to a western student; thus we do not employ such words as "Physiography" and "Phutology." . . . After some prefatory remarks concerning the division of the sciences, we have a few pages given to the history of chemistry. The period of Alchemy is wrongly stated to extend from 400 to 1500 A.D. Then Iatrochemistry from 1500 to 1650; Phlogistic chemistry from 1650 to 1783; the new chemistry of Lavoisier and Davy, and so on to the chemistry of Kekulé and Canizzaro. This is followed by a short account of physical chemistry; then an account of crystallography with good figures of crystals. Although many of the names of our elements are derived from the Greek, the table of elements looks rather puzzling: lead is of course *μόλυβδος*, while molybdenum becomes *μολυβδαίνιον*; platinum is *λευκοχρυσος*; tungsten (or Wolfram) is *βολφραμιον*; nitrogen is at the beginning of the alphabetical list; copper near the end. Again, as to compounds the names of the oxides of nitrogen read as *ὑποξείδιον ᾽Αζώτου*; *ὀξείδιον ᾽Αζωτου*; *νιτρῶδες ὀξὺ*; *ὑπονιτρικὸν οξὺ*; *νιτρικον ὀξύ*. The theory of atomicities is well developed: niobium and tantalum are the only pentatomic elements; while molybdenum and tungsten are the only hexads. The peculiar atomicities of nitrogen and iron are not noticed. The building up of compounds on the type respectively of one, two, and three molecules of water is fully discussed (*μόριον* is the term used in place of our low-Latin *molecula*). Full tables of grouped elements appear; and the naming of compounds is considered. After this considerable and important introduction the work begins with hydrogen in the usual manner, and the account of the other element follows in due course.

The "Scientific Paradoxes" of Prof. Stroumpos is a volume of essays on physics and physiology; including magnetism, electricity, illusions, alchemy. Here too we find paradoxes of another kind; would Mr. Glaisher recognise his name as *ὁ Γλαισχερος*, or Mr. Coxwell as *ὁ Κοξουέλλος*? The treatise on the Air, by the same author, is a tolerably complete treatise on pneumatics, illustrated by very crude, but original and sufficient woodcuts. The discourse on the history of Science is very interesting, and full of excerpts from Plato, Aristotle, and other ancient writers. For them we think Prof. Stroumpos has claimed too much; we cannot with any degree of certainty assert that Aristotle discovered that the air possesses weight. His experiment at the outset is altogether faulty, for he tells us that an inflated skin (*ὁ πεφυσημένος ἀσκὸς*) weighs more when filled with air than when empty, that is, not inflated. This of course we know from the law of Archimedes is false; a bladder full of air weighed in air can weigh no more than the uninflated bladder.

These works constitute the commencement of Athenian science. The city, while its art, and literature, and philosophy, have unhappily long passed their culminating point, is more scientific than it has ever been before. Not far from the place in which the Peripatetic made his experiment with a crude statera and an empty wine skin with Theophrastus as demonstrator, Stroumpos now weighs his really vacuous vessel, and Chrestomanos explodes oxygen and hydrogen. Thirty years of science in a remote city, out of the highways of European intelligence, cannot effect much; but we hope in the course of the century original workers will multiply in Athens, and as much will be done to promote chemistry and physics,

as has been done by Dr. Schmidt in the service of astronomy on the Hill of the Nymphs, over against the Acropolis.

G. F. RODWELL

THE ACRIDIDÆ OF NORTH AMERICA

Synopsis of the Acrididæ of North America. By Cyrus Thomas, Ph.D. Published in Vol. v. of Report of the United States Geological Survey of the Territories. Pp. 1-262. (Washington, 1873.)

IN a prefatory note to this volume the United States Geologist, F. V. Hayden, tells us that Prof. Thomas's work on the Acrididæ of North America is published "in the belief that it is a substantial contribution to natural history;" and certainly it is impossible, on a perusal of the work, not to share in this belief; it is, moreover, another proof of the great boon conferred upon natural science by public surveys and Government expeditions. Serious and extended works on natural history (except, perhaps, those relating to some few very popular branches of it) would seldom be produced, or in many cases their materials be collected, if it were not for the assistance of natural history societies, public surveys, and expeditions; organisations of these kinds can afford to disregard the commercial aspect of the question, and are able to bestow upon the public, works which private enterprise would seldom venture upon. Among insects, the Orthoptera (of which order the Acrididæ are a well-defined family group) are certainly not the most popular among entomologists, though, for many reasons, of great interest to others. Few persons but have some cherished association with, for instance, the persistent chirp of the cricket on the hearth, or the shrill stridulations of some of the grasshoppers; there are, again, few more wonderful sights in the insect world than a flight of locusts; and few natural scourges are more terrible than those inflicted by the devastations of these rapacious creatures; the walking-leaf and stick insects (Mantidæ and Phasmidæ) are also very popular objects for sightseers in natural history museums. The lack of general popularity among collectors and students arises probably in great measure from the Orthoptera being commonly less sightly as cabinet objects than some other orders of the Insecta, though perhaps it arises as much or more from the paucity of works combining both a general and special treatment of the whole, or of well-defined groups, of the order under consideration. Dr. Thomas's work is undoubtedly calculated to encourage the study of the large group included under the *Acrididæ*, and to be peculiarly acceptable to American entomologists, for it not only describes a large number of North American species (both known species as well as new ones), but it gives, in an "Introduction," pp. 9-45, a concise view of the general classification of the Orthoptera, with the relation of the Acrididæ to the other sub-ordinal groups, their structure, internal and external, and the distribution of genera and species over North America. This introductory part of the work is illustrated by two remarkably clear and good woodcuts, showing all the different portions of external structure, with the name of each part.

The remarks of Prof. Thomas, in the chapter on Classification, bring strongly before us the difficulties and imperfections involved in a linear arrangement of any portion of the animal kingdom; but if a real genealogical relationship be that which exists between all living creatures, then it is apparent at once how comparatively unimportant is (generally speaking) the mere linear arrangement of the series; it is, indeed, the only possible one on paper, but in reality some of the most important relationships do not run in one unbroken line, but in lines diverging at many different angles, and in many different planes. Dr. Thomas considers the Orthoptera as arising from the *Crustacea*, and, after reviewing the various extant arrangements of their families, divides that under consideration—ACRIDIDÆ (*i.e.* the saltatorial Orthoptera, or Grasshoppers with comparatively short antennæ), into two *sub-families*—ACRIDINÆ and TETTIGINÆ; the former of these is sub-divided into three divisions: — CONOCEPHALIDES, ORTHOCERIDES, and XIPHOCERIDES, forming (in the order in which these are here given) seven groups:—1. PROSCOPINI; 2. TRYXALINI; 3. TRIGONOPTERYGINI; 4. ŒDIPODINI; 3. ACRIDINI; 6. XIPHOCERINI; 7. PHYMATINI (?). The three first of these groups belong to the *Conocephalides*, the two next to the *Orthocerides*, and the two last to the *Xiphocerides*.

The sub-family TETTIGINÆ is undivided, and consists of a single group, TETTIGINI.

A useful and concise Synoptical Table gives the leading characters of the author's sub-families and subordinate groups; and another Synoptical Table of the United States genera (p. 49), as well as an excellent plate containing seventeen figures, will give great assistance to the student of the American species. Pp. 55—245 are wholly occupied by scientific descriptions of species, genera, and other larger groups. This portion of the work is divided into two parts, the first treating of the Acrididæ of the United States (pp. 55—190); the second (pp. 195—245) of those of North America, not found in the United States. The number of genera characterised as North American is 45; that of species 227. In the United States (exclusive of *Tettiginæ*, which contain 3 genera and 12 species) are, at present known, 125 species of 25 genera; of the former, *forty*, and of the latter, *four* are described as new; and six others also are described as not hitherto known to be represented in that more restricted locality. At pp. 3—6 will be found a boon to the American orthopterologist in the shape of a list of those authorities which contain descriptions of the genera and species of Acrididæ belonging to the North American fauna. Another exceedingly useful feature of Dr. Thomas's work is a glossary at the end explaining the technical terms (to the number of upwards of 200) used in the scientific descriptions; the utility of this glossary will, no doubt, be felt far beyond the circle of students and collectors of the Acrididæ.

OUR BOOK SHELF

Daily Bulletin of Weather Reports, Signal Service, United States Army, taken at 7.35 A.M., 4.35 P.M., *and* 11 P.M. *Washington Mean Time, with the Synopses, Probabilities, and Facts for the Month of September* 1872. (Washington, Government Printing Office, 1873.)

THIS is a quarto volume of upwards of 180 pp., containing besides 90 weather-charts—three for each day of the month of September 1872. The volume is published for

the purpose of showing the method of working of this division of the U.S. Signal Service, the "Division of Telegrams and Reports for the benefit of Commerce and Agriculture." The system appears to us to be thorough and careful, and calculated to lead to valuable scientific results in the department of meteorology. For each of the three daily times mentioned in the title, there is first a tabulated meteorological record from 72 stations in the United States and British N. America, showing the state of the barometer, thermometer, humidity, wind, clouds, rainfall, weather. This is followed by a weather-map constructed on the preceding record, on which, by clearly distinguishable marks, the state of the weather at all the stations is shown, whether clear, cloudy, snow, rain, &c., the direction and velocity of the wind, and the average elevation of the locations. Following this is a synopsis of the record, in which the general results of a comparison of the particular observations are briefly stated. This synopsis is succeeded by a statement of "probabilities," which are the deductions made from the conditions exhibited in the chart, considered in their sequence, as to the meteoric changes probably to follow within the twenty-four hours next ensuing. Then come the "facts" by which the "probabilities" may be tested, these facts being a classified statement of the state of the weather at the various stations at the next succeeding time of observation, with "general remarks" showing how far the probabilities have been realised. This is done, as we have said, three times every day of the month for which this Bulletin is published, and the value of the publication to students of meteorology is evident. "As a contribution of data, at least, to meteoric science," the introductory statement justly says, "and a demonstration that it needs only that governments should will and act through proper organisation to make meteoric knowledge of daily and practical use to the people, the publication must have its value." The Government of the United States deserves the highest credit for the wisdom it displays in perceiving what the true interests of the country are, and for its liberality in supporting a scientific department such as the one from which this Bulletin issues, whose business it is, by publishing the result of scientific research, to "benefit commerce and agriculture." By a patient pursuit of the system exhibited in this Bulletin, and by adopting what improvements may from time to time suggest themselves, we have no doubt that results of great value to science will follow.

The Treasury of Botany: a Popular Dictionary of the Vegetable Kingdom, with which is incorporated a Glossary of Botanical Terms. Edited by J. Lindley, M.D., and Thos. Moore; assisted by numerous contributors. New and revised edition, with Supplement. (London: Longmans, Green, and Co., 1874.)

THERE is no more difficult task than that of editing re-issues of scientific works published some years since. The progress of science is so rapid, the number of new facts accumulated year by year so enormous, that the most satisfactory and exhaustive treatise on any subject written by a specialist in that subject, becomes to a certain extent obsolete or imperfect in ten years. And yet, where can our scientific men be found with leisure to write or edit new dictionaries of science every ten years? The re-editing of old dictionaries seems, therefore, the inevitable alternative, though one attended with many disadvantages, which disadvantages are greatly increased when the objectionable plan has been adopted, as in the present case, of stereotyping the plates of the original work. The new facts can then only be placed before the reader in the form of a supplement, which may often seem at variance with the work itself, while errors or imperfect descriptions cannot fail to be reproduced. Lindley and Moore's "Treasury of Botany" was so admirable a work in its day, containing such an enormous mass of information, that a new edition must necessarily be welcome, although botanical science has made such rapid strides since its first publication in 1866; and the welcome will be more hearty when it is found that the new matter has been entrusted to such competent authorities as Dr. Masters, Prof. Thiselton-Dyer, Mr. Britten of the British Museum, Mr. Jackson of the Kew Museum, and the surviving editor. The only fault we have to find with the supplement is that it occupies five times too little space; under 100 pages out of 1,350 is clearly entirely insufficient for even a brief account of the main additions to botanical knowledge made during the last eight years. Had the new contributors been allowed a larger space, the book would have been a far more satisfactory one. It is to be regretted that at a time when so much attention is being paid to vegetable histology, a description of the vegetable cell should be republished without comment, not only so inadequate, but so misleading in our present state of knowledge, as the following:—"Cavities in the interior of a plant; the cells of tissue are those which form the interior of the elementary vesicles;" or that no description whatever should be given of the structure or mode of formation of starch-grains. As a dictionary of botanical nomenclature and classification the work is most ample; and on this ground only the "Treasury of Botany" is one which no botanical student can afford to be without.

A. W. B.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Simultaneous Meteorological Observations

IT is doubtless familiar to most of your readers that at the Meteorological Congress at Vienna a proposal was adopted which was made by the War Department of the United States regarding the institution of a system of simultaneous daily observations all over the globe.

I have recently received the subjoined letter from the chief signal officer at Washington on the subject.

It may be of interest to your readers to know that invitations have been issued by this Office to a large number of observing meteorologists in the United Kingdom, on whose co-operation I considered I might count, and that I have received returns from sixty-one stations for the first fortnight of the year, and from sixty-four for the second, so that we may consider that the plan has met with general acceptance with the public.

I am ready to receive the names of any gentlemen who are willing to assist in the scheme, and who possess properly verified instruments, and shall be very happy to answer inquiries on the subject. ROBERT H. SCOTT, Director

Meteorological Office, London, Feb. 17

"War Department, Washington, D.C.,
"Jan. 20, 1874

"Sir,—At the recent Meteorological Congress at Vienna a proposition was adopted to the effect that it is desirable that, with a view to their exchange, at least one uniform observation of such character as to be suitable for the preparation of synoptic charts be taken and recorded daily and simultaneously at as many stations as practicable throughout the world.

"The United States has an especial interest in reports and exchanges of this character, for the uses of the particular work in which it is engaged. It is hoped that when they are sufficiently extended, satisfactory solutions of many questions from time to time presenting themselves to this Office, and which now cannot be answered, will be arrived at.

"I have the honour, therefore, to request the establishment of a regular exchange between the Meteorological Office of which you are Director, and the Office of the Chief Signal Officer at

Washington, of uniform reports made from simultaneous observations taken daily at as many of the stations under your charge as it may be practicable for you to instruct or request to furnish such reports, or from other stations from which they may be voluntarily tendered, and of similar reports to be taken at the established stations of this Office throughout the United States. The reports to embrace, at least, pressure (reduced), temperature, wind, rain, relative humidity, and clouds, and to be made at 12.43 P.M., Greenwich mean time. The records to be printed or in manuscript, as you prefer, and to be mailed (as many of them as may be ready for exchange on the dates) in packages, on the 15th and last days of each month. Should circumstances render it inconvenient for your Office to furnish such reports without blanks for days on which they will necessarily fail to be taken, the records will be none the less gratefully received. Self-registered records will be very acceptable. In return exchange it is proposed to mail to your Office on the 15th and last days of each month the record of the simultaneous report prepared for that purpose in the form of which the enclosure herewith is a specimen for a single day.

"The data so to be exchanged are intended for any use either Office may wish to make of them.

"As an acknowledgment to those who may, upon your invitation, assist in a work so much wished for on the part of this Office, it is proposed to send to you monthly copies of the 'Official Monthly Weather Review,' with its Maps, for distribution to each of those so assisting, or other papers published by this Office, if so requested.

"In requesting this exchange as a part of a system to which it is hoped a very wide extension can be given, the Chief Signal Officer recurs with pleasure to the prompt encouragement received at your hands at the earlier steps for its adoption, and is gratified to announce that co-operation for similar exchanges of records, commencing on January 1, 1874, has been requested or is in progress with Prof. H. Wild, Director, Imperial Observatory, St. Petersburg; Prof. A. Coumbary, Director, Imperial Observatory, Constantinople, Turkey; Prof. Carl Jelinek, Director, Imperial Observatory, Vienna, Austria; Prof. Quetelet, Director, Meteorological Observatory, Brussels, Belgium; Prof. Buys Ballot, Director, Meteorological Institute of the Netherlands, Utrecht, Holland; and Prof. H. Mohn, Director, Meteorological Institute of Norway, Christiania, Norway. As time and its faculties will permit, this Office will seek additional aid. The advantages to accrue to the service in the United States are certain, and the hope is not unfounded that as the co-operation sought will be world-wide, so also will be the benefits resulting.—I am, &c.,

"ALBERT J. MYER
"R. H. Scott, Esq." "Brigadier-General, U.S.A.

Remuneration of the Contributors to Milne-Edwards' "Mission Scientifique au Mexique"

EN vous remerciant de l'envoi d'un article (vol. ix. p. 260) relatif aux singulières assertions contenus dans une note de M. Gray, je vous demanderai la permission d'ajouter que ni M. Duméril ni aucun des autres naturalistes qui prennent une part, soit directe, soit indirecte à la publication de l'ouvrage sur la Zoologie du Mexique ne recoivent pour ce travail une rémuneration pécuniaire quelconque. C'est gratuitement et dans l'intérêt de la Science seulement qu'ils s'en occupent; par consequent les renseignements fournis à mon estimable ami M. Gray, par je ne sais qui, sont faux.

Recevez, Monsieur, l'assurance de ma consideration tres distingué.

MILNE-EDWARDS

Paris, ce 13 fevr. Membre de l'Institut de France, et Associé Etranger de la Société Royale de Londres

---

Animal Locomotion

IT is not my intention to go through the detailed proofs of the different statements in my review of his work to which Dr. Pettigrew objects, and which his letter of last week in no way falsifies, nor to show how he has quite missed the point of an observation of mine which he condemns as "utter nonsense," but simply to answer the question with which he ends his remarks. At first sight it might seem that the active dilatation of the heart during diastole did depend on an inherent power in the muscular fibres of the ventricles to elongate, but the peculiarities of the coronary circulation are quite sufficient to explain the phenomenon without the introduction of so unnecessary a theory as that of Dr. Pettigrew. For in the heart when removed from the body, as in the living body during diastole, the injection of fluid into the coronary vessels causes the whole heart to open up from the congestion of the ventricular walls, and so produce the active dilatation which is well known to occur. This explanation was proposed by Brücke, and by myself some years later (Journal of Anat. and Phys.)

A. H. GARROD

WHILE admitting that Dr. Pettigrew appears to have made mistakes in his figures, and that he has not explained his views in the clearest manner, nevertheless it appears to me that, on the very important question of whether a bird's wing during onward flight moves downward and forward or downward and backward, he is right in asserting the former to be the fact.

The arguments of Mr. Garrod and Mr. Ward against this view seem to be founded on two assumptions—that the wing during its down-stroke is an inflexible plane, and that during its upward motion the quills open so perfectly that there is neither vertical nor horizontal resistance. But every feather of a wing is highly flexible towards its extremity, so that during the down-stroke the whole posterior margin of the wing must be curved up by the pressure of the air, thus forming a highly effective propelling surface owing to the rapid motion of this part of the wing. During the upward stroke the feathers open freely so as greatly to diminish, though not wholly to prevent, downward reaction; but the broad soft web of each quill will be bent down by the rapid escape of air between the quills, and this will necessarily give a forward motion, probably equal to that attained during the down-stroke, in which the small curved surface has a greater resistance and more rapid motion. If then the up- and the down-stroke both produce onward motion, the resultant of this motion will be in the direction of the mean position of the wings, which we may take to be about that of the body of the bird; but if the down-stroke were directed *backward* and the up-stroke *forward*, the resultant onward motion would be obliquely downward, and this downward angle of motion would tend to be so much increased by the continual gravitation of the body that the surplus vertical reaction of the down-stroke over the up-stroke would not be able to overcome it. A slight upward angle of the mean position of the wing-plane seems therefore to be essential to secure horizontal forward motion as a general resultant of the upward and downward action of the wings under the influence of gravitation; and to Dr. Pettigrew belongs the merit of showing that this is one of the most important characteristics of the flight of birds, and, probably in a still greater degree, of that of insects. A bird's wing is a highly complex apparatus, subject to a variety of flexures and motions in every feather; and it is only by a careful consideration of the action of the resisting medium on these variously curved elastic surfaces, both during the upward and downward motion of the wings, that we can arrive at any definite notion of their supporting and propelling effect. The experiments of Prof. Marey do not seem to contradict the theory of Dr. Pettigrew, as far as I can make out from an abstract of these given in the "Ibis" for 1870, p. 267; though, as his apparatus only gave the motion of the wing relatively to the body of the bird, they are not of very much value in determining the absolute angular position of the wings, which is what we want to arrive at. The highly-inclined position of a hovering bird is more to the point, as any less degree of inclination would lead to onward motion.

ALFRED R. WALLACE

On the Variability of the Node in Organ-pipes

THE variability of the node is an unrecognised phrase. Something similar in kind relating to the node will be remembered as having been mentioned by scientific writers in a cursory manner, then set aside as evidence of too doubtful interpretation to call for more extended comment.

From the time of Savart it has been known that the nodal division of the open organ-pipe does not take place at the exact half of the length, that the half nearest the embouchure is the shorter of these "unequal halves"—a contradictory term apologised for yet sanctioned, I believe, by the late Prof. Donkin.

The displacement of the node is perhaps the most significant fact that in the natural history of organ-pipes presents itself to

the attention of the investigator, be he student or teacher. Why it should have been passed by as though its meaning were not worth wrestling for is incomprehensible. Since Savart wrote no light has been thrown on this singular phenomenon, for the explanation which has been afforded (presently to be quoted), cannot be called in any degree satisfactory. In the illustrations of nodal division given in various scientific works there is a puzzling contrariety hardly to be accounted for except on the supposition that our engravers are as niggardly conservative in design as the buried Egyptians, or that the engravings themselves are the cherished heirlooms of our publishers. In one work a representation of the manometrical nodal division after Kœnig will be given, but *carefully* corrected and revised by the aid of a pair of compasses; in another a beautifully accurate copy of the original, so lopped to suit the size of the page that much mental effort and distortion of reasoning are incumbent on the reader in vain attempts to bring the engraving into harmony with the accompanying text, young eyes are mystified, it needs cold "well-worn eyes" to appreciate these fine economics of the publishing art; in another the manometrical nodal positions will be properly defined and, by some negligent inconsistency, on an opposite page an organ-pipe be depicted, admirably exact to theoretical localisation, in direct contradiction of knowledge. Faults of this kind should not be allowed to pass, they weaken faith in the teacher and are harassing to the inquirer.

Kœnig in his own illustrations represents the displacement of the node as it is indicated under experiment, for this one condition of truth to nature had been too often before him in his manometric flames to allow of his disregarding its faithful portraiture. The difference he shows to exist as to position corresponds very closely with that we arrive at by other means, by calculation of scales and by the practical teachings of experimental study of the relations and arrangements of organ-pipes. Of the cause of the displacement Kœnig offers no elucidation.

The following explanation is quoted from Prof. Airy's treatise on "Sound and Atmospheric Vibrations." In the section on open organ-pipes he says :—

"It was found by Mr. Hopkins that the node next the open mouth of the pipe was somewhat less distant from it than that given by theory, or, which amounts to the same thing, that the place where the air has always the same density as the external air is not exactly at the pipe's mouth but somewhat exterior to it."

The extent of the disparity would be but very imperfectly comprehended under this vague delineation. Other authors have attempted explanation, in substance the same as the above, to account for the disparity; the summary of the whole is, that science brings forward no better plea than the surmise of a probable place, somewhat exterior to the mouth, which the air-wave of the *lower half* of the pipe has to attain before it can be properly said to be completed in length. Truly an illogical conclusion if this line of reasoning is carried out. In common fairness the *upper half* of the pipe may claim to be credited with a reasonable amount of wave-prolongation, seeing that at the higher orifice the internal column of air pulsates the atmosphere with far greater vigour than at the mouth, and consequently that for a similar attainment of density the due addition of wave-length would only serve to increase the disparity in relation to the *half below* the node.

A displacement of some sort thus receives acknowledgment although as yet the variability of the node is unsuspected.

The actual extent of the disparity between the "unequal halves" can be ascertained. It is subject to laws of relation of as definite a character as are found in other dynamical problems when the elements of calculation are delicately defined. An approximate estimate will be sufficient for the present purpose. For avoidance of the inconvenient "unequal halves" it will be permitted me to coin two simple terms as more distinctively representative, and to speak of them as super-nodal and sub-nodal.

If a standard open diapason pipe be made for some designed pitch, whatever that pitch may be, it may safely be predicted that the pipe will stand considerably short of the full theoretical length; æsthetically judged for musical quality, it ought to be about one-eighth less, a difference much affecting the veracity of scientific argument.

Doubtless it would be somewhat a novelty for a scientific lecturer to tell his audience that one-eighth of the whole wave-length was lost by conversion into organ-pipe vibrations, yet, unless he innocently accepts the ironical reply of Galileo on the pump question, that "perhaps Nature is indifferent to a few feet," he is strictly in this dilemma: if the pipe is a natural standard of wave-length, the velocity of sound in air computed on the basis of the pipe's length falls very far short indeed of the philosophical estimate, 1,125 feet per second; on this ruling the latter should be pronounced to be irreconcileably wrong, *or else* the frank admission made that there is no "necessity of relation" that the wave-length in an organ-pipe, giving a defined pitch, and the wave-length in the free air corresponding to that note should be identical.

Taking the several classes of pipes, from the Diapason to the Vox Angelica, ranging from the pipes of the most vigorous to those of the softest intonation, the amount of difference from full measure varies from one-eighth to one-twelfth *less* than that which theory demands. The loss is mainly due to the cause which enforces nodal displacement.

Our immediate inquiry is, what is the extent of displacement of the node, and what its variability? Divide the length of the already reduced pipe into seven equal parts, and the unequal halves will be in the ratio of 4 to 3 Four parts belonging to the super-nodal half, and three parts to the sub-nodal half, subject to a relative variability, according to the position of the pipe in the range of octaves, and subject to a fluctuating variability determined by force of wind, diameter of pipe, character of scale, relative size of mouth, mode of voicing, and other details, changing the proportion, perhaps, to 6 : 5, or even to 7 : 6. Whatever the extent of the variability, change in result rigidly follows change in details, with a calculable value. When, instead of the fundamental note, the pipe vibrates in harmonic nodal divisions, the lowest half-segment takes upon itself almost the whole difference, and not merely a proportional share in comparison with its segmental relation to the whole pipe. A remarkable fact, but one fully accounted for in that which I have termed the aëro-plastic reed theory (NATURE, vol. viii. p. 25) for it is easy to me visibly to demonstrate that the harmonic-independent and the harmonic-concomitant are originated in the pipe by totally different natural processes.

The nodal difference detected by Mr. W. Hopkins was much smaller in extent, but there is an important distinction not to be overlooked: his experiments (recorded in the Transactions of the Cambridge Philosophical Society, vol. 5) were not made with organ-pipes, but with glass tubes supported in position over a glass plate, the plate being set in vibration by friction. He expressly rejected organ-pipes by reason of their intractibility and of the difficulty of obtaining results from them of the nature desired.

In like manner we continually find experimentalists rejecting organ-pipes as insubordinate pupils; they prefer dumb pipes and the artificial speech by tuning-forks, and having obtained such negative evidence, make a clean transfer of their conclusions to all argumentative reasonings and expositions of the nature and functions of the original, living, speaking organ-pipes. The Hon. M. Strutt, in his paper on the Theory of Resonance, printed in Phil. Trans. Nov. 1870, says :—

"Independently of these difficulties, the theory of pipes or other resonators made to speak by a stream of air directed against a sharp edge is not sufficiently understood to make this method of investigation satisfactory. For this reason I have entirely abandoned this method of causing the resonators to speak in my experiments, and have relied on other indications to fix the pitch."

Prof. Airy is as evidently dissatisfied with the state of theory and experiment, using such phrases as these: "the matter, however, demands more complete explanation;" "that obscure subject, the production of musical vibrations in a pipe by a simple blast of air;" "possibly when the mathematical calculus is farther advanced, this may be shown," &c. Beyond the province of mathematical analysis his survey is keen, and with foresight of the results of possible experiments.

At the present date our best authorities are in effect repeating the assertion of Biot that "the particular properties of the vibrations of confined air in tubes are not yet sufficiently explained." The disturbing influence of some unknown agency may be discerned in Dulong's experiments of filling organ-pipes with various gases, and estimating the velocity of sound in these gases by the pitch produced. Similar experiments on this method are referred to by Herschel, and he, noticing how the results gave for hydrogen gas a velocity differing by one-fourth from that which theoretically had been calculated, could only account for it by supposing an impurity in the gas used for the experiments. There is little need to resort to the supposition of

an impurity; it is quite sufficient to know that an agreement in length of organ-pipe and aërial wave-length was assumed which does not exist, and that, moreover, the mechanical nature of the organ-pipe, and its delicate apparatus so wonderfully balanced for the attainment of its ends, had escaped observation. The admirable method of experiment for ascertaining the velocity of sound in gases, devised by M. Kundt, by means of glass tubes and lycopodium seed, is free from the same source of error; and, as might be anticipated, comparison shows a marked difference in estimates. In respect of carbonic acid gas and hydrogen gas, for instance, Dulong differs from Kundt, his estimate in the one case being less by one-fifth of the whole, and the other more by one-fourth; the divergence interprets itself, indicating the relation of their densities to the compelling force, the unseen mechanical action at the mouth of the organ-pipe. This will be clear when the "air-moulded reed" is fully understood in its nature and functions. When the magnetism of the earth is perceived, the dip of the needle to the north or south of the equator in accord with its localisation is explained.

The confession of "obscurity" amounts to a concession that the old theory has been found wanting, that it is inadequate to deal with facts. Whether in dealing with the larger questions here brought into discussion, or with the simpler class, the mere modifications of structure, it is equally incapable. If, for instance, a stopped pipe is pierced through the stopper and a short open pipe inserted, say a third or fourth the diameter and a third or fourth the length, what will be the effect of this on the pitch? The old theory would reply, the added length would cause a flattening of pitch, and then will come a proviso for safety's sake, that if the change converted it into an open organ pipe then the pitch would be raised in accordance with the open length. We go to Nature for her say in the matter, and find that the pitch is raised not flattened, and that the extent is about a quarter of a tone, and that *further lengthening* of the smaller pipe takes back the pitch again just its quarter tone. If another stopped pipe is drilled at the back with a hole of a diameter a third or fourth of that of the pipe, but so that it shall be at a higher level than the lip or edge of the mouth, in effect shortening the air column by admission of external air at a higher point, what will be the result? On the old theory we should expect the pitch to be higher in consequence. Appealing to the ear we know that, on the contrary, it is flattened. These results cease to be anomalies when viewed under the new theory, and indeed they would be predicted with confidence as the necessary outcome of the conditions.

The proposition that in an organ-pipe there is no constant wave-length for an ascertained pitch, will no doubt be discountenanced as novel and revolutionary, but it is true and will have to be acknowledged. A further proposition that in an open organ-pipe there are three different velocities speeding at different rates, concurring in every vibration, and essential to the synchronic time of its note, has a still more aggressive aspect defiant of law. Not so. It is because law—"known law," does not cover the facts, is unstable in its applications, and is deficient in prevision, that there is room for new hypothesis which does not play fast and loose with nature; the utmost exactitude of length in an organ-pipe is as indispensable in this as in the older theory, but the relation is one of proportion to a system, and the least and every variation will make imperative suitable or corresponding modifications in other portions of the structure. Only a whistle, yet with more to marvel at for delicacy of organisation and beauty of adaptation "than is dreamt of in philosophy."

As regards "fixity of wave-length," that characteristic reappears in a new relation, and we shall find that, allowing for retardation by friction, the super-nodal half-wave of the pipe corresponds very closely with length in atmosphere. The cause of the displacement of the node is involved in the physical action taking place at the mouth of organ pipes, the consideration of which is reserved for a further communication.

HERMANN SMITH

Auroral Display

As a few remarks on the aurora of the 4th may be of interest to some of your meteorological readers I append the following notes:—

At 6.15 P.M. on Wednesday, the 4th inst., an aurora commenced in the northern part of the sky which gradually went down towards the south.

7.15.—Semicircle from W. to E., streamers shooting up from it.

7.25.—Light more diffused, a few streamers at N.W.

7.30.—A semicircle of diffused light from W.S.W. to E.

7.35.—Bright line of light from W S.W. to E.; no streamers.

7.40.—A very faint irregular line of light from W.S.W. to E.

7.45.—Diffused light.

7.50.—Same as at 7.45.

7.55.—Streamers shooting down from zenith all round. Very fine.

8.—Bright at N.N.E. Streamers N. and N.N.E. A sharp S.E. breeze.

8.5.—Bright light at N.W. No streamers.

8.10.—Streamers at N.E.

8.15.—Streamers at S.S.E.

9.—No aurora perceptible.

From the above, we note one peculiarity, namely, that the aurora was chiefly in W. + E. or W.S.W. and S.S.E.

WILLIAM HY. WATSON

Braystones, near Whitehaven, Feb. 9

[We have received letters concerning this aurora from several other parts of the country.]

THE PHOTOGRAPHIC SOCIETY

ALTHOUGH we published last week a letter from Mr. Baden Pritchard, Hon. Sec. of the Photographic Society, impugning the justice or accuracy of our strictures on that Society, our esteemed correspondent has not caused us to change our opinion.

We have now before us the Journal of the Society for the past year (a summer vacation of three months excepted), and certainly it furnishes *primâ facie* evidence of the most apathetic and inefficient condition which is consistent with continuous existence. The numbers contain eight pages each, the page little more than half the size of that of NATURE, and in the whole year's proceedings there are twelve pages devoted to science, half of this being a lecture by Prof. Stokes; three or four papers of considerable value on technical points of photographic interest, and much which the charity of any semi-learned society would be largely strained in giving paper and ink to.

There is no mention of scientific or other committees, no provision for them in the laws, no reports of investigations made or to be made, no notice of scientific discovery abroad or recognition of discovery at home. Mr. Pritchard has no need to assure us that the body "does not profess to be a purely scientific one"—the scientific element in it, so far as its own record shows, is purely fortuitous.

But without demanding scientific labours from a body not "purely scientific," we do not even find evidence of common activity in the research of practical problems, and if any of its members are, as Mr. Pritchard suggests, engaged in researches on the process and nature of film best suited for transit of Venus observations, they have not had faith enough in the countenance of their Society to place their labours before it, or ask its assistance in performing them.

Since our article appeared, the revolution alluded to has taken place, and that part of the Society in favour of reform having a majority at the meeting appointed for the discussion of the question, have carried an amendment to the laws providing that henceforward the Society at large shall select its council, and that the majority of the actual council shall not have the power to select for retirement such members as it sees fit and to decide who shall replace them, as has actually been the case hitherto; it has also been decided that the presidency shall rotate. These measures were, as we learn from the photographic papers, strongly opposed by the council, and upon being carried by a majority of 30 to 23 (the council itself voting in the minority) the entire body resigned.

As the meeting at which this stroke of singular policy was made, was that for the election of the new members of council, these were enabled to assume the reins of government and prevent the, otherwise in-

evitable, total dissolution of the Society. And now that the reformers have its affairs in their own hands, it is to be hoped that it will begin a new life of efficiency, and, remembering that it owes the cause of its existence to the labours of scientific men, give its most efficient aid to those scientific researches in which it has become an important element of investigation, as well as to those of a more technical nature which have given photography so great a commercial and industrial value. And on the other hand we bespeak for it the aid and countenance of all scientific men whose researches are in any way dependent on photography, and give it, in its reformation, our best wishes for that complete success and efficiency which will make it as useful to Science as honourable to itself and its members.

NOTES FROM THE "CHALLENGER"

THE following contributions to the literature of the *Challenger* Expedition appear in the *Cape Monthly.* The first contribution consists of a few notes from Commander Maclear, written on the day of the *Challenger's* departure from Simon's Bay, and will give our readers an idea of the work still before the Expedition :—

On leaving Simon's Bay, if the weather permits, dredgings and temperature soundings will be taken on the Agulhas bank; then sail made for Marion Island. This and the Crozetts will be examined ; the last may be occupied by the French as an observing station for the Transit of Venus. Then for Kerguelen Island. It is not likely that the weather will allow a regular series of soundings to be taken as hitherto, but some doubtless will be taken on the passage.

Kerguelen's, or Island of Desolation, will be a fertile field of exploration in every department of science, and as it is to be one of the stations for watching the Transit of Venus, special information will be collected for the use of the astronomers who will go there towards the close of next [this] year. The longitude of the island will be determined by chronometrical measurement from the Cape, and again to Melbourne, and with the great number of chronometers (16) that the *Challenger* has on board, the longitude should be determined very accurately.

After leaving Kerguelen, Macdonald Island will be examined, and search made for a harbour there; and then a stretch will be made to the Ice Barrier. The investigations in the neighbourhood of the ice are very important, but great care will have to be taken not to get entangled in the ice. With steam power, and the clear weather there is likely to be in February, little danger need be apprehended. If the season should be fine, some considerable time will be occupied in this region, but if not, after a short stay, sail will be made for Melbourne, which will probably be reached in the end of March. After a few days there, to obtain the rates of the chronometers, we go on to Sydney to refit and, if necessary, dock. This terminates the second stage of our voyage.

Leaving Sydney about the middle of May 1874, and carrying a line of soundings to New Zealand, we next examine the islands about the Coral Sea and Torres Straits in August 1874: New Caledonia, New Guinea, Arofura Sea, Kaepang in Timor, Java Sea, Macassar, Celebes, and reach Manilla in November. We next look up the doubtful islands of the Western Pacific ; visit New Ireland, the Solomon Islands, and Pellew, and Japan will be reached in March 1875. From Japan we cross to Vancouver's, and then to Valparaiso, examining Eastern Island and Salay group in our course. Leaving Valparaiso in the end of 1875, we go through the Straits of Magellan to Falkland Isles, Rio de Janeiro, Ascension, and England in the middle of 1876.

The other communication, of a different order, comes from a gallant Blue Jacket, who speaks for himself and the *Challengers* and their labours somewhat irreverently thus :—

FROM JACK SKYLIGHT TO HIS OLD SHIPMATE

A Letter without much Rhyme and with a little Reason

We've crossed the Line a many times in craft both great and small,
And of them 'ere fish that's thereabouts I've caught 'em nearly all.
It aint becos I wants to boast I says as "it is so,"
But 'cos I think that wot is wot I'm just the bloke to know.
I'll first acquaint you, topmate, with the nature of my dooty,
And show you what I've larned since last we met, my beauty.
I jined this craft last winter, got rated on her ledger
A swabber, jobber, scrubber, a sounder, and a druger.
I know, old ship, when this you see you'll say I'm flyin' hi,
But it's true as Polly-Arris is above us in the sky.
At sea we sounds—no matter, Bill, if every blessed thread
Aloft or low of canvas before the wind is spread,
In it comes! And down there goes, I've really quite forgotten
How many fathoms (half-inch), Bill, until we touches bottom.
Sometimes the timmey-noggie that holds the weights don't G
And then a fog* arises as is horrible to see.
We flies in all directions, like cats on houses sportin',
The luff cries out, the donkey shies, and makes a dreadful snortin'—
It aint a regular ass, Bill, but one of them inventions
They puts aboard a man-of-war with various intentions,
To wit, it nicks the complement, and gives the honest Jacks
More time to study politics and read their Sunday tracks.
The donkey does the hauling in, which is no doubt a blessin',
For if it had to come by hand, oh! lord, 'twould be distressin'.

We've a many curious ratins, a lot of long shore tallies
For scientifick genelmen, their servants, and their valleys.
Don't yer see these learned bosses have come to search the ocean,
But for what, old son, 'twixt you and I, I'm blow'd if I've a notion.
I've 'eard 'em talk of Artic drift and walleys under water,
And specs next week to find they've nab'd old Davy and his darter.
Of course you know they've got to find the link atween the species,
Some say as there's a coon aboard as liks it all to pieces;
I cannot tell, for well you know it aint the likes o' me
That's got a chance like swells abaft the curus sight to see.
The scientifick swells, old chap, are mad on mud, and great
On getting things like what we used in Chiney for our bait.
You know them squids and stuff we tried for catching them there conger?
Well, it's the same; but then the name is many a fathom longer.
They seems to me to make a deal and show a great surprise
At things we've seen, Bill, many times, when first they meet their eyes.
Perhaps its 'cos the thing's alive their fancies somewhat tickle,
They only having seen them home screwed up in brine or pickle.

I've told yer how we sounded, now I'll tell yer how we druge,
And if my life's a angel's I'll leave yer for to judge.
We hangs the drege at the yard-arm to a sort o' kind of buffer—
At explernation, Bill, yer no I always was a duffer—
It aint a bad doge neither; for when its pulled it streches
And gives a kind of surge when the dredge at summat ketches;
It's like a koncertina, Bill, but where the wind is squoze,
From end to end a set of stays like Inde rubber goes:
A block is tacked at bottom and through it runs the line—
Which is the werry bane of life to this old pal of thine;
I've burnt my hands, I've spiled my close, I torn my underneath,
I bark'd my shins and nik'd my back, and loosened all my teeth—
All through that blessed line, Bill, which, trifling as it seems,
Is wuss nor all the nightmares that ever hunts in dreams.
The care that is required for to keep that line from breakin'
If your stationed near the donkey is a awful undertakin';
The thing flies thro' your fingers, and if stationed near the drum,
Its safe to nab you somehow by a finger or a thumb;
Then there's the pipe and others, Bill, that raise a shout, and call

* Row.

Till you'd almost think they'd been and caught the devil in the trawl;
The trawl's for fancy drugin' and the work's about the same,
The only diff'rance I can see is that wot's in the name.

A scientifick genelman, our Genius on the cruise,
Explained to us the hanimals, their habits, and their use;
I don't tumble to it much; but, Bill, he spun a yarn
About the objeck of the cruise which I was glad to larn.
He said 'twas for the good of man to raise him summat higher,
Since it was proved by some one that a monkey was his sire;
I don't see how it follers—but he sed from wat he found
There was fields of blazing sea weed below upon the ground;
And every little blessed thing we druge out of the sea
Was for the good of all mankind, including u and me.
He likewise said, and bid us all partikilarly remark,
That at the bottom also 'twas most exceedin' dark,
Cause from twenty million fathoms once we got a curus prize
(He didn't want 'em in the dark) a fish with many eyes.
He told us that we'd all be dooks when this 'ere cruise is done;
I think he was mistaken, or he meant he would be one.

Thare goes the pipe, my hearty; so I'll no more at present write
But ax you to believe yours most faithful

JACK SKYLIGHT

THE COMMON FROG*

X.

The Nervous System of the Frog.

THE nervous system consists of the brain, spinal marrow, and nerves.

The whole consists of a soft, white substance, ultimately composed of minute threads, termed *nerve-fibres*, and minute round bodies called "ganglionic corpuscles."

The brain is contained in the cavity of the skull, and consists of a rounded mass made up of corpuscles and fibres, and itself contains a cavity which is a remnant of the original canal formed by the upgrowth and overclosure of the walls of the primitive groove of the embryo.

The spinal marrow (as has been said earlier), traverses the canal formed by the successive neural arches of the vertebræ being directly continuous with the brain which it, as it were, continues on down the back. Like the brain, it is largely composed of corpuscles, as well as fibres, and itself contains a longitudinal cavity (continuous with that in the brain), which is also the ultimate condition of the canal formed from the primitive embryonic groove.

The nerves generally (which are made up of fibres) proceed forth from the brain and spinal marrow, which therefore are called the *central*, or (from their position along the dorsal axis of the body), the *axial* portion of the nervous system.

All the nerves which so proceed together constitute what is called the *peripheral*, or (because going to the limbs which are appendages of the trunk), the *appendicular* portion of the nervous system.

From the brain proceed the nerves of special sense: a pair, one on each side, going to the nostrils (1, the *olfactory nerves*), another pair going to the eyes (2, the *optic nerves*), and a third pair going to the ears within the skull (3, the *auditory nerves*). Other nerves go to the tongue and palate, ministering to taste, and again others to the little muscles (orbital muscles), which move the eyeball in various directions, and to different parts of the face.

The nerves which come forth from the spinal marrow are called spinal nerves. They proceed out in pairs (one on each side), and are distributed to the limbs and trunk.

Each nerve consists of fibres, of the sorts proceeding respectively from the ventral (in man anterior), and the dorsal (in man posterior) aspects of the spinal marrow. But these two kinds of fibres are distributed side by side in the ramifications and distributions of each nerve.

* Continued from p. 266.

The fibres which come ultimately from the dorsal aspect of the spinal marrow are those which carry inwards the effect of a stimulus applied towards their ultimate termination, and are therefore called *afferent*, or *sensory*.

The fibres which come ultimately from the ventral aspect of the spinal marrow, are those which carry an influence outwards, and produce a contraction in the muscles, and are therefore called *efferent* or *motor*.

It is the nervous system of the Frog, rather than any other set of its organs, which has especially excited interest and attention. It is especially to the relations *inter se*, of the parts of this system that inquiry has been directed. The relations, that is, of its central or axial portion (the brain and spinal column) to its peripheral or appendicular portion (the nerves of the body and limbs).

In the ever memorable year 1789, Galvani accidentally discovered in the separated legs of certain Frogs, prepared for broth, those motions produced by irritation of the exposed great nerve of the thigh, now so familiar to most. This action was long called galvanism, after this observer, not, however, that he was absolutely the first to notice a fact of which he was but a re-discoverer—Swammerdam as long ago as 1658 having observed such motions.

They are generally considered as demonstrating the purely "reflex action" of the nervous system—the responsive action, that is, upon muscles, of nervous centres acted on by external stimuli without the intervention of sensation.

It is affirmed that not only will a decapitated frog endeavour to remove an irritating instrument by means of its hind legs and feet; but that if a caustic fluid be applied to a spot easily reached by one foot, the decapitated frog will apply that foot to the spot. More than this, if that foot be cut off it will move the stump as before, seeking to reach the spot, and failing so to do, will then apply the other foot to the irritated locality.

These, and such experiments, are of course conclusive, if the common assumption be conceded that the brain is the indispensable nervous instrument of sensation.

It may be, however, that the faculty of sensation may be subserved by the spinal cord without the brain, and if so, all these much vaunted experiments are valueless as regards the proof of pure reflex action, not but that they are of extreme interest, as showing what may be done in lower animals without the intervention of any brain action whatever.

Mr. G. H. Lewes has long contended against the attribution of sensation to the brain exclusively, and Dr. Bastian has recently supported and enforced similar views.

The latter remarks in his "Beginnings of Life,"—"instead of accepting the popular view, that the brain is the organ of mind, I believe it would be nearer the truth to look upon the whole nervous system as the organ of mind."

Dr. Bastian here uses the word "mind," not as denoting a rational intellect but as a generic term equivalent to psychical activity.

It may be remarked in passing that these views of Messrs. Lewes and Bastian closely approximate, as far as they go, to that most rational belief that the soul of every creature is whole and entire in every atom of its bodily structure so long as the latter preserves its integrity and vital activity.

The brain of the frog consists of the same essential parts as does the brain of all the vertebrate animals, including man. In the form and in the proportions of those parts, however, it differs extremely from the higher animals (and above all from man) and resembles the lower forms—the brain of the frog (and of Batrachians generally) offering a much closer resemblance to that of a lizard than to that of a mammal.

The brain of man consists of the following fundamental parts:

1. A pair (one on each side) of small rounded bodies, each connected, by a long stalk, with the mass of the brain,

and each shaped somewhat like a life preserver. These are the "*olfactory* lobes," and from the swollen head of each proceed the delicate nerves of smell.

2. An enormous pair of folded masses which form the great bulk of the human brain and are called the *cerebral lobes* or hemispheres. These are so large and preponderant in man, as to hide every other part of the human brain when that organ is viewed from above.

3. A relatively very small portion, but one easily recog-

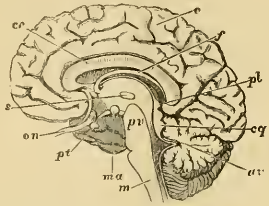


FIG. 69.—The Brain as seen when a Vertical Longitudinal Section has been made through its middle. *Av*, arbor vitæ of the cerebellum; *c*, cerebrum; *cc*, corpus callosum; *cq*, corpora quadrigemina; *f* fornix (between the fornix and the corpus callosum is the septum lucidum); *m*, medulla oblongata; *ma*, corpus mammillare; *on*, optic nerve; *pl*, pineal gland; *pt*, pituitary body; *pv*, pons Varolii; *s*, soft, or middle commissure.

nised since it supports two conspicuous little bodies. One of these (Figs. 69, 70, 71, *pl*) is called the *pineal gland*, and projects more or less upwards; the other (Figs. 69, 70, 71, *pt*) projects downwards and is called the *pituitary body*.

4. An also very small portion relatively, is distinguished by bearing certain small prominences (Fig. 69, *cq*, and Fig. 70, *na* and *te*) placed behind the pineal gland, and called *corpora quadrigemina*.

5. A rounded mass of finely folded brain-substance, placed at the lower part of the back of the head beneath the hinder portion of the cerebral hemispheres. This is

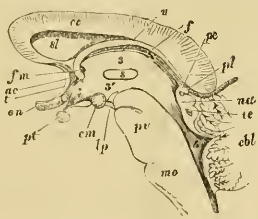


FIG. 70.—Enlarged and Diagrammatic View of a Vertical Section carried through the Corpus Callosum and the parts below. *ac*, anterior commissure; *cc*, corpus callosum; *cbl*, cerebellum; *cm*, corpus mammillare; *f*, fornix; *fm*, foramen of Monro; *i*, infundibulum; *lp*, locus; perforatus medius; *mo*, medulla oblongata; *na*, nates; *on*, optic nerve; *pc*, posterior commissure; *pv*, pons Varolii; *pl*, pineal gland; *pt*, pituitary body; *s*, soft, or middle commissure; *sl*, septum lucidum; *t*, lamina terminalis; *te*, testes; *v*, velum interpositum (between it and the fornix is a space enclosed by the folding over of the cerebrum upon the roof of the third ventricle); 3, upper, and 3', lower part of third ventricle; 4, fourth ventricle—between them is the *iter a tertio ad quartum ventriculum*.

called the *cerebellum*, and when cut through exhibits singular, radiating, tree-like markings, due to the infoldings of the surface of the organ, and called the *arbor vitæ* (Fig. 70, *av*).

6. That part which directly continues the brain into the spinal marrow (Fig. 71, *m*). It is overlapped by the cerebellum, and contains that portion of the remnant of the primitive nervous canal, which is named the *fourth ventricle*. This sixth fundamental part of man's brain is called the *medulla oblongata*.

On turning to the brain of the frog from that of man it is at first sight difficult to find out the resemblances, and to determine which portions of the one answer to definite regions of the other.

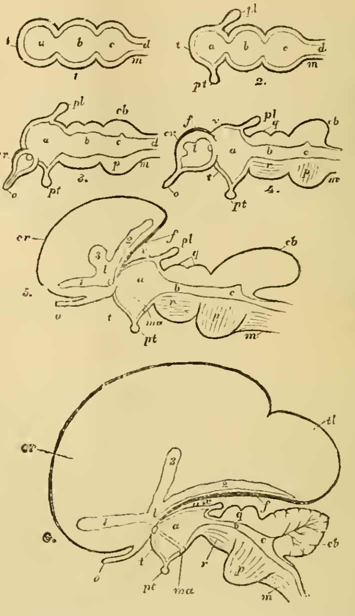


FIG. 71.—Diagram illustrating the progressive Changes that take place during successive stages of the Development of the Brain. 1. The brain in its very early condition, when it consists of three hollow vesicles the cavity of which is continuous with the wide cavity (*d*) of the primitive spinal marrow (*m*). The brain substance forms an envelope of nearly equal thickness throughout. 2. Here the first vesicle or fore-brain has developed the pineal gland (*pl*) above and the pituitary body, (*pt*) below. The wall at the anterior end of the first vesicle (or fore-brain) is the lamina terminalis (*t*). 3. This figure shows the cerebrum (*cr*) budding from the first vesicle, its anterior part (*o*) being prolonged as the olfactory lobe (the so-called olfactory nerve), the cavity of the cerebrum (or incipient lateral ventricle) communicating with that of the olfactory lobe in front and with that of the first cerebral vesicle (third ventricle) behind. The latter communication takes place through the foramen of Monro. The walls of the three primitive vesicles are becoming of unequal thickness, and the cavity (*b*) of the middle vesicle (*iter a tertio ad quartum ventriculum*) is becoming reduced in relative size. 4. The cerebrum is here enlarged, and the inequality in thickness of the wall of the primitive vesicle is increased. The thickened upper part of the wall of the cerebrum is the fornix (*f*). 5. This figure shows the cerebrum still more enlarged, and with a triradiate cavity (*l*, 1, 2, 3). The fornix has now come to look slightly downwards; dotted lines indicate the downward extension of its anterior part, into the corpora mammillaria. 6. Here the cerebrum is still more enlarged and backwardly extended. The fornix is shown bordering the descending cornu and extending into the temporal lobe (*tl*) of the cerebrum, which lobe is destined to descend (when the brain is fully developed) so much more that it comes to advance forwards. The fornix borders the margin of the very thin outer wall of the descending cornu, which when torn forms the fissure of Bichat. The bending back of the cerebrum has now almost enclosed (between the fornix and the velum) the space (*x*) which in Fig. 4 is widely open, making what is morphologically called the outside of the brain come practically to be in its very centre. *a*, fore-brain; *b*, mid-brain; *c*, hind-brain; *cb*, cerebellum; *cr*, cerebrum; *d*, cavity of the medulla; *f*, fornix; *l*, lateral ventricle; *m*, medulla oblongata; *ma*, corpora mammillaria; *o*, olfactory lobe; *p*, pons Varolii; *pl*, pineal gland; *pt*, pituitary body; *q*, corpora quadrigemina; *r*, crura cerebri; *t*, lamina terminalis; *tl*, temporal lobe of the cerebrum; *x*, space, enclosed by the extension backwards of the cerebrum; 1, anterior cornu of lateral ventricle; 2, its middle or descending cornu; 3, its posterior cornu.

In the earliest conditions of the human brain the resemblance is much more marked and obvious; it is later

that the correspondence between the brain of the frog and that of man becomes so disguised through the unequal growth of different portions of the organ in the human brain as it advances in its growth and development. The same six successive portions, however, exist in each.

1. In the frog the olfactory lobes acquire a much larger relative size, and they retain permanently an internal cavity which exists only transitorily in man.

2. The cerebral lobes (or hemispheres) exceed those just noticed but are insignificant indeed, when compared with the corresponding human structures. They may, however, be more insignificant than in the frog, as, for example, in the lamprey, where they are actually smaller than the olfactory lobes. In that the cerebral lobes of the frog each contain a cavity (the lateral ventricles) they have a character which is constant in all animals above fishes, they open by a common aperture (foramen of Monro) into the cavity of the next brain segment behind.

3. This third segment retains a great relative magnitude compared with that of man.

4. The fourth segment, however, consisting of the optic lobes, attains a still further relative development, though consisting only of two bodies instead of four, but these contain a cavity not found in the corpora quadrigemina of the human brain.

5. The fifth segment, the cerebellum, is very small, and

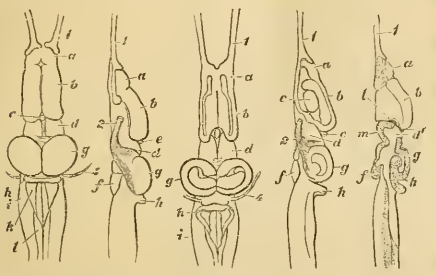


FIG. 72.—Brain of Bull Frog in various views 1, Dorsal view. 2, Lateral view; 3, Transverse horizontal section showing the cavities of the olfactory cerebral and optic lobes. 4, Longitudinal section a little to the left of the median line. 5, Longitudinal section in median line. The corpus striatum, *c*, is here exposed to view and also a body, *g*, within the optic lobes. 5, Longitudinal section in median line. In all five figures:—1, Olfactory nerve; 2, optic nerve; 4, auditory nerve; *a*, olfactory lobe; *b*, cerebral lobe; *c*, corpus striatum; *d*, optic thalamus; *e*, pineal gland; *f*, pituitary body; *g*, optic lobes; *h*, cerebellum.

smaller than the same part in animals both higher and lower in the scale; indeed, in the frog class, this organ may be said to be at its minimum. When cut it exhibits no trace of an *arbor vitæ*.

This fact has a special interest as bearing on alleged functions of this portion of the brain.

It has been asserted by some that the cerebellum ministers to the sexual functions, by others that this part coordinates and directs locomotive movements, and, quite lately, that it is related to movements of the eyes.

The first two of these hypotheses seem to be completely overthrown by our frog. In the first matter there is anything but a deficiency of energy and activity, and as to the second, many reptiles are less active and continuous than the frog in their locomotive efforts. As to the third hypothesis, it should be remembered that the eyes of the Frog are large and very moveable, as also that they require a power of ready adjustment to enable the animal to secure its insect prey.

6. The sixth and last segment of the brain, the medulla oblongata, is also relatively large, and is exposed to view through the rudimentary development of the cerebellum which, as has been said, overlaps it in man.

It has been already said, that in man and the higher animals there are nerves supplying the orbital muscles and different parts of the face.

The eyeball in man is moved by six little muscles, four straight, (the *recti*) and two *oblique*, one being the upper, the other lower, oblique.

Now a nerve called the *third*, because it follows the first two (olfactory and optic) goes from the brain to all the orbital muscles except the upper oblique and the outer rectus.

Another nerve, the *fourth*, proceeds to the upper oblique muscle only.

The *fifth nerve* is a very large one, and supplies the nose, tear-gland, eyelids, upper and lower jaws, tongue and teeth.

The *sixth nerve* is a very small one indeed, being exclusively applied to the outer rectus muscle of the orbit.

The *seventh nerve* is, in part, the auditory nerve in part it sends fibres to the face.

The *eighth nerve* is a very complex structure, and consists of, at least, three nerves united together, all arising from the medulla oblongata. It sends branches to the parts about the throat, as well as to the organ of voice, to the lungs, the stomach and the heart.

The nerves of the frog exhibit certain intermediate conditions like those we have seen to exist in various other parts of its anatomy.

In the higher vertebrate animals, as in Man, the

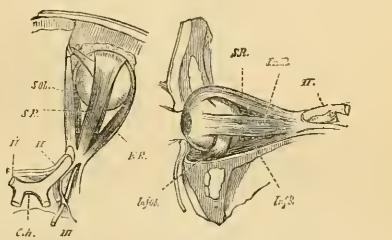


FIG. 73—The Muscles of the Eyeballs, viewed from above and from the outer side. *R.S.*, the superior rectus; *Inf.R.*, the inferior rectus; *E.R.*, the external rectus; *In.R.*, the internal rectus; *S.Ob.*, the superior oblique; *Inf.Ob.*, the inferior oblique; *Ch*, the chiasma of the optic nerves (*II.*); *III.*, the third nerve, which supplies all the muscles except the superior oblique and the external rectus.

muscles which move the eye-ball are supplied by three distinct nerves termed respectively the 3rd, 4th, and 6th. The 5th nerve being a very large and complex one, sending branches to various parts of the head and its organs.

Now in the frog there is no distinct 6th nerve, it being replaced by an extra branch of the 5th nerve. This modification, however, is but one step towards a condition which obtains in the Mud-fish (*Lepidosiren*), when all these three nerves are quite blended with one division (the Ophthalmic) of the fifth nerve.

Again in the higher Vertebrates, as in Man, the 8th nerve is a very large and complex one, and distributed as in him. It is also so distributed in the adult frog.

In the tadpole, however, this nerve shows a very different arrangement. After issuing from the skull this nerve sends a branch down the outer side of each branchial arch and then gives off a very long one, which extends laterally, *i.e.* along the side of the body and tail.

Nothing like this exists in any Beast, Bird or Reptile, but when we come to the class of Fishes we encounter a precisely similar state of things. Here we find the eighth nerve sending a branch to each branchial arch, and giving off a great nerve proceeding along the side of the body and tail, and on that account named the *nervus lateralis*.

ST. GEORGE MIVART

(*To be continued.*)

THE INDUCTION TUBE OF W. SIEMENS

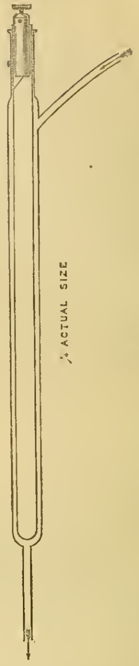
A TRANSLATION from a French periodical, *La Nature*, of an article on "Tubes for silent electrical discharges," appears in NATURE of Jan. 29 (vol. ix. p. 244). After referring to the action of the electric spark upon oxygen gas, the author of the article continues: "For the purpose of more easily obtaining ozone, M. Houzeau has recently constructed an apparatus worked by a Ruhmkorff coil, in which there are no longer sparks, but only dark discharges—*effluvia*—far more efficacious in the production of modified oxygen." Again, it is said, that M. Houzeau "has recently devised an apparatus for the preparation of ozone, which is spreading rapidly among the laboratories, and which has already yielded very remarkable results." A description of the apparatus is then given; further on, it is said, that "M. Houzeau is not the only one who has made use of the tubes whose structure he has made known, but that M. Boillot, a writer, it appears," well known to the readers of the *Moniteur*, "has made some further propositions about them; and lastly, that M. A. Thénard" (whose investigations constitute the main subject of the article) "has brought to bear on the construction of the tubes a further modification which makes them still more efficacious." A description and drawing of the apparatus of M. A. Thénard is given. Those who are unacquainted with the facts of the case will be surprised to learn that the invention thus publicly announced, although, doubtless, in principle deserving of the highest praise, was not made either by M. Houzeau, M. Boillot, or M. A. Thénard, but is simply a somewhat clumsy form of the Induction-tube devised by W. Siemens, which is described in his "Memoir on Electrostatic Induction," contained in *Poggendorff's Annalen*, for 1857 (vol. cii. p. 120).

This Induction-tube is one of the most remarkable, as well as simple instruments, of chemical research which has ever been devised; enabling us, by the action of electricity, to effect changes in the composition of gases which may be compared with the chemical changes effected in liquids by the agency of the voltaic battery. A few words in explanation of the instrument may interest the readers of NATURE.

The simplest form of induction-apparatus consists in two thin glass plates, of which one side is coated with tin-foil, and which are so arranged that the uncovered surfaces are parallel to one another, and separated by a uniform, narrow interval of about one or two millimetres filled, say, with air. If this apparatus be charged with electricity by a sufficiently charged Leyden jar, at the moment of the charge the air between the plates becomes luminous, and the same appearance is presented when the apparatus is discharged. To produce this effect, however, the apparatus must be charged beyond a certain limit, determined, in each case, by the special arrangement of the apparatus and the materials employed in its construction. Now, if the two plates of tin-foil be respectively connected with the terminals of a powerful Ruhmkorff's coil, the apparatus is successively charged with electricity and discharged; these operations being alternately repeated in such rapid succession that the air, in the interval between the plates, appears permanently luminous. We have, moreover, evidence of the occurrence in this interval of chemical changes determined by the electric action, in the odour and characteristic properties of ozone which may be recognised in a current of air or oxygen compelled to pass between the plates. The conclusion drawn by Siemens from this experiment is, that the electric polarisation of the particles of a dielectric cannot be carried beyond a certain point; and that if it be attempted to accumulate electricity in the apparatus beyond this point, the excess of this tension or polarisation appears in the form of the dynamical phenomena occurring between the plates, namely, light, heat, and chemical change. (*Poggendorff's Annalen*, *loc. cit.*, p. 119).

Now it is evident that in this arrangement the two sheets of glass may be replaced by two concentric cylinders of glass, the interior of the inner cylinder and the exterior of the outer cylinder being coated with tin-foil, as in the case of the plates. It is precisely this change which is effected in the induction-tube of Siemens, but with the additional advantage that in the induction-tube a regular flow of the gas to be operated upon may be maintained, that the experiment may be made at any required temperature, and the gaseous products of the experiment collected for examination. The construction of this induction-tube will be readily understood from the annexed drawing (taken from *Pogg. Ann.* loc. cit.), where the ring shows the horizontal section of the tube.

6.a



1/4 ACTUAL SIZE

6 b

2/5 ACTUAL SIZE

If the reader will be at the trouble of comparing the description of the tube of M. Houzeau and the drawing of the tube of M. A. Thénard, with the description and drawing of the induction-tube of Siemens he will be satisfied of the substantial identity, both in principle and construction, of these pretended novelties with that invention. At the same time if the statement of these ridiculous pretensions were limited to those made in the article translated in NATURE, vol. ix. p. 244, they would hardly be worthy of notice, but this is not quite the case. The induction-tube of Siemens under the title of "the tube of M. Houzeau," is being rapidly acclimatised as a French discovery. In the article on ozone contained in a recent number of the "Dictionnaire de Chimie," which bears evidence of being the work of a highly competent writer, where we might expect to find a comprehensive treatment of the subject, a similar lapse occurs. We have there, too, a drawing of the tube of M. Houzeau, which is described as "a happy modification of the tube of M. Babo," but not a word is said about Siemens, the inventor of the tube, whose name is simply dropped. Other similar instances might be brought forward which have afforded an opportunity of rectifying these mistakes, but of which no advantage has been taken. I have therefore ventured to make these remarks, not only I may say in the interest of justice, but also, having myself made many experiments with the induction-tube of Siemens, I have learned, perhaps, more than others to appreciate its value and feel myself under a special debt of gratitude to the inventor.

B. C. BRODIE

RECENT RESEARCHES ON TERMITES AND HONEY-BEES

THE accompanying letter, just received from Fritz Müller, in Southern Brazil, is so interesting that it appears to me well worth publishing in NATURE. His discovery of the two sexually mature forms of Termites,

and of their habits, is now published in Germany; nevertheless few Englishmen will have as yet seen the account.

In the German paper he justly compares, as far as function is concerned, the winged males and females of the one form, and the wingless males and females of the second form, with those plants which produce flowers of two forms, serving different ends, of which so excellent an account has lately appeared in NATURE by his brother, Hermann Müller.

The facts, also, given by Fritz Müller with respect to the stingless bees of Brazil will surprise and interest entomologists. CHARLES DARWIN

Feb. 11

"For some years I have been engaged in studying the natural history of our Termites, of which I have had more than a dozen living species at my disposition. The several species differ much more in their habits and in their anatomy than is generally assumed. In most species there are two sets of neuters, viz., labourers and soldiers; but in some species (*Calotermes* Hg.) the labourers, and in others (*Anoplotermes* F. M.) the soldiers, are wanting. With respect to these neuters I have come to the same conclusion as that arrived at by Mr. Bates, viz. that, differently from what we see in social Hymenoptera, they are not modified imagos (sterile females), but modified larvæ, which undergo no further metamorphosis. This accounts for the fact first observed by Lespès, that both the sexes are represented among the sterile (or so-called neuter) Termites. In some species of *Calotermes* the male soldiers may even externally be distinguished from the female ones. I have been able to confirm, in almost all our species, the fact already observed by Mr. Smeathman a century ago, but doubted by most subsequent writers, that in the company of the queen there lives always a king. The most interesting fact in the natural history of these curious insects is the existence of two forms of sexual individuals, in some (if not in all) of the species. Besides the winged males and females, which are produced in vast numbers, and which, leaving the termitary in large swarms, may intercross with those produced in other communities, there are wingless males and females, which never leave the termitary where they are born, and which replace the winged males or females, whenever a community does not find in due time a true king or queen. Once I found a king (of a species of *Eutermes*) living in company with as many as thirty-one such complemental females, as they may be called, instead of with a single legitimate queen. Termites would, no doubt, save an extraordinary amount of labour if, instead of raising annually myriads of winged males and females, almost all of which (helpless creatures as they are) perish in the time of swarming without being able to find a new home, they raised solely a few wingless males and females, which, free from danger, might remain in their native termitary; and he who does not admit the paramount importance of intercrossing, must of course wonder why this latter manner of reproduction (by wingless individuals) has not long since taken the place through natural selection of the production of winged males and females. But the wingless individuals would of course have to pair always with their near relatives, whilst by the swarming of the winged Termites a chance is given to them for the intercrossing of individuals not nearly related. I sent to Germany, about a year ago, a paper on this subject, but do not know whether it has yet been published.

"From Termites I have lately turned my attention to a still more interesting group of social insects, viz., our stingless honey-bees (Melipona and Trigona). Though a high authority in this matter, Mr. Frederick Smith, has lately affirmed, that "we have now acquired almost a complete history of their economy," I still believe, that almost all remains to be done in this respect. I think that even their affinities are not yet well established, and that they are by no means intermediate between hive- and humble-bees, nor so nearly allied to them, as is now generally admitted. Wasps and hive-bees have no doubt independently acquired their social habits, as well as the habit of constructing combs of hexagonal cells, and so, I think, has Melipona. The genera Apis and Melipona may even have separated from a common progenitor, before wax was used in the construction of the cells; for in hive-bees, as is well known, wax is secreted on the ventral side: in Melipona on the contrary, as I have seen, on the dorsal side of the abdomen; now it is not probable, that the secretion of wax, when once established, should have migrated from the ventral to the dorsal side, or *vice versâ*.

"The queen of the hive-bee fixes her eggs on the bottom of the empty cells; the larvæ are fed by the labourers at first with semi-digested food, and afterwards with a mixture of pollen and honey, and only when the larvæ are full grown, the cells are closed. The Meliponæ and Trigonæ, on the contrary, fill the cells with semi-digested food before the eggs are laid, and they shut the cells immediately after the queen has dropped an egg on the food. With hive-bees the royal cells, in which the future queens have to be raised, differ in their direction from the other cells; this is not the case with Melipona and Trigona, where all the cells are vertical, with their orifices turned upward, forming horizontal (or rarely spirally ascending) combs. You know that honey is stored by our stingless bees in large, oval, irregularly clustered cells; and thus there are many more or less important differences in the structure, as well as in the economy, of Apis and Melipona.

"My brother, who is now examining carefully the external structure of our species, is surprised at the amount of variability, which the several species show in the structure of their hind legs, of their wings, &c., and not less are the differences they exhibit in their habits.

"I have hitherto observed here 14 species of Melipona and Trigona, the smallest of them scarcely exceeding 2 millimetres in length, the largest being about the size of the hive-bee. One of these species lives as a parasite within the nests of some other species. I have now, in my garden, hives of 4 of our species, in which I have observed the construction of the combs, the laying of the eggs, &c., and I hope I shall soon be able to obtain hives of some more species. Some of our species are so elegant and beautiful and so extremely interesting, that they would be a most precious acquisition for zoological gardens or large hot-houses; nor do I think that it would be very difficult to bring them to Europe and there to preserve them in a living state.

"If it be of some interest to you I shall be glad to give you from time to time an account of what I may observe in my Melipona apiary.

"Believe me, dear Sir, &c.,

"FRITZ MÜLLER"

*MARS**

IN the previous article were mentioned some of Professor Kaiser's conclusions. We are induced to add a few further remarks, from their general applicability. The delineation of the heavenly bodies, he says, is always a very difficult task, especially when, as in the case of Mars, we have to deal with features more or less indistinct, delicately and gradually shaded. With the most powerful telescopes the disc is but small; and on it we find a mass of ill-defined and frequently very feeble spots, which require close attention for their disentanglement, and it is hard to obtain a clear conviction as to the outlines and shadings that have to be drawn. The difficulty is much increased by the inces-

* Continued from p. 289.

sant undulations of the air; and in the seldom-recurring moments of stillness so much under good circumstances is visible, that even the best artist cannot draw it all in half an hour, a period during which usually there are but a very few tranquil glimpses, and after which the planet will have materially changed its aspect from rotation. Even were it easier to distinguish what is actually visible, it requires great practice to represent it faithfully; and whoever has had personal experience of the difficulties of such designs will have but a limited confidence in the various portraits or the supposed changes that they represent. As a further illustration of these difficulties he refers to the representations of the Orion nebula by Rosse, Lassell, Secchi, and Liapounov (he could have added Herschel II.); or the portraits given by Bond, and others, of Donati's Comet. He might have cited, had he known of it, Prof. Young's remark as to the solar corona (where, however, these difficulties are heightened by the excitement of the moment), that "the drawings made by persons standing side by side differ to an extent that is sometimes really ludicrous, and has induced more than one astronomer who had not himself seen an eclipse, but judged only from the written accounts and sketches, to declare his belief that this whole outer corona is a mere subjective phenomenon."

The justice of Kaiser's remarks will readily make itself felt, but they do not exhaust the subject; something may perhaps be added as to the "personal equation" of vision. Independently of mechanical defects in the eye, there are inaccuracies of perception; and even if the rays have kept an uninterrupted and undeviating course to the retina, they do not always produce corresponding impressions on the mind. Whatever may be the cause, we frequently meet with defects in the sense of form, or proportion, or inclination, or even the presence of features which are not the immediate objects of attention. Comparisons of size are often very erroneous; craftsmen well know the meaning of "a true eye;" and the expression "I did not see it," is constantly employed with reference to a thousand objects whose representation on the retina is all the while unquestionable. It is in these respects that celestial photography is invaluable as recording everything and putting everything in its proper place; but photography, as Kaiser observes, is inapplicable to the light of Mars. Another point, too, might have admitted of notice. Although we may certainly, with him, be baffled in reconciling Rosse and Lassell, we may bear in mind, as regards the comparison of larger and smaller instruments, Dawes's important remark to the effect that a certain relative proportion of light and power may be essential to the visibility of some classes of difficult objects.

Without subscribing implicitly to the whole of Kaiser's views, some of which admit of doubt—as, for instance, when we contrast his assertion that the spots are never sharply defined, with the clearness and keenness of outline occasionally recorded by Lockyer and others—we may well admit their general accuracy. But we find it more difficult to accompany him in his inferences as to the planet's physical constitution.

The earth-light upon the moon having been found by Schröter more conspicuous when it proceeded from the hemisphere of our globe containing the largest amount of land, Kaiser implies that it has hence been inferred that (as it is difficult for us not to imagine other planets constituted like our own), the brighter and darker portions of Mars are equivalent to land and water. Whether such an opinion may have been arrived at in this circuitous way or not, it seems highly probable without any reference to lunar appearances. The eminently absorptive power of water is well known; even a thickness of seven feet will, it is said, diminish the incident light by one-half; and below 700 feet it is quenched in unbroken darkness; and the quantity of diffused light reflected from its surface would be inconsiderable, while the solar image at the distance of the Earth would be too minute, in all probability, to be visible. This reasoning would seem fairly to hold its ground against that of the Leiden astronomer, who does not believe that seas so looked upon would show such innumerable gradations in tone, or be so invariably ill-defined at their edges, while the same telescope gives perfect sharpness to the polar snows. He goes in fact so far as to say that if we may form any conclusion from their aspect, it is, that they cannot resemble seas such as our own. But as to distinctness of boundary, his experience is not accordant with that of other excellent observers, especially Lockyer, who remarks that "the effect of a cloudless and perfectly pure sky both here and on Mars appears to be, that the dark portions of the planet become darkest and most distinctly visible; the coastlines (if I may so call them) being at such times so hard and sharp that (as has been mentioned by Mr. Lassell) it is quite impossible to represent the outlines faithfully." A more natural inference, it seems to the writer, would be that these fluid masses contain large areas of very slight depth, that the edges are in many places very shelving, and that possibly they may be the more transparent from the absence of salt. Other astronomers, Kaiser tells us, but without mentioning their names, have reversed the idea, and thought the bright parts to be seas, but they do not thus escape his objections on the score of definition, nor account for the dusky tracts which some of the great bright expanses contain. He has perhaps got hold of a more substantial difficulty in the aspect of the north polar region, where the white spot is often encompassed by a widely-extended dark zone with many gradations of tint. The width of this belt, very great when foreshortening is taken into account, is no doubt variable: Beer and Mädler ascribed it to the non-reflective power of the damp surface bared by the rapidly melting snow. On the whole, when Kaiser considers that nothing is established with certainty but the existence of an atmosphere and the connection of the polar spots with the seasons, we hesitate to follow him; and we should prefer the conclusion of Phillips, adopted by Lockyer, that "over a permanent basis of bright and dusky tracts, a variable envelope gathers and fluctuates, partially modifying the aspect of the fundamental features, and even in some degree disguising them under new lights and shades, which present no constancy, a thin vaporous atmosphere probably resting on a surface of land, snow, and water." A more protracted course of observation may possibly modify in some way this result, but so far as past investigations extend, we may say that nothing has been detected inconsistent with it. Could we be actually transported to that far distant surface, we should probably find much to astonish us that we cannot so much as conjecture here; it was a sound remark of Schröter's that unity in variety is the universal character of creation; and the spectroscope of Huggins has already in this instance confirmed it by the detection of absorption-lines the cause of which is utterly unknown. Our future inquiries should be conducted in that impartial spirit which is equally ready to admit the indications of discrepancy and of resemblance, and which is more anxious to ascertain facts than to seek their premature elucidation. We have as yet read but a part of the inscription on that golden shield: some of it has probably been deciphered correctly; how much of the remainder may give way we know not; but the whole, it will never be given to us to understand.

The extensive researches in which Dr. Terby of Louvain has for some time been engaged, and in which he has shown unwearied diligence and perseverance, if embodied, as we trust they will be, in one comprehensive result, will give material assistance in disentangling and concentrating our present scattered and discordant materials, and we may look forward with hope to the very

promising opposition of 1877; when, if the seasons on both planets are as favourable as their mutual proximity, we may reasonably expect some advance to be in store for us. The great object will naturally be the identification of the dark spots, as well as a more careful delineation of their boundaries: attention will doubtless be paid towards obtaining a definitive value for the rotation; but in this direction progress is not very material, as we have already a sufficient approximation. Those who would see an extraordinary instance of the most painstaking and protracted efforts to get rid of a trifling uncertainty may apply themselves to the 23 pages of Kaiser, in which all kinds of varied combinations are tried to reconcile some conflicting decimals of a second, for to these the question is reduced at last. Cassini, as far back as 1666, had fixed the rotation at 24h. 40m. with surprising correctness for his day. Herschel I. brought it to 24h. 39m. 21·67s. but, as Beer and Mädler perceived, the omission of one rotation, and of the effects of phasis and aberration, vitiated the result. They in turn gave 24h. 37m. 23·7s. Kaiser, from many elaborate comparisons, deduced a mean of 22·62s., but Proctor having found a value of 22·735s. the former, who thought the English astronomer's coincidences illusory, went into the whole subject afresh with marvellous minuteness, and got out a final mean of 22·531s., discovering by the way some unexpected inaccuracies, convincing himself that the correctness of the best drawings has been greatly over-rated, and finally, in much mortified perplexity, leaving it to every one to choose his own combination. No computation, he says, can make us sure to the hundredth of a second; and unless observations become very much more precise, it will be several centuries before such a result will be obtained: how much the wiser mankind would be for it, is another question, which we need not discuss here. But there is, perhaps, no great difficulty in divining the cause of the Professor's troubles. Epochs of rotation could only be safely taken from drawings made with that special object, and few such probably exist; the designer usually either contenting himself with a general likeness, or being occupied about details, the study of which would of itself render him less attentive to mere position. In future, these objects might be better separated; and while the artist busies himself with the *minutiæ* of the picture, the rotation-seeker should employ himself exclusively in estimating the co-ordinates of some conspicuous points—a process which admits of a mean taken between many proportional valuations.

Several other desirable matters of inquiry will readily offer themselves. Measures of ellipticity have as yet yielded only contradictory results. The inclination of the axis, last deduced by Oudemans in 1852, may be susceptible of correction; and the excentric position of one or both of the snow-spots, and the unsymmetrical position of the isothermal poles, would be matters of interesting investigation. The amount of the latter deviation, first measured by the elder Herschel, has been given so very differently by different observers, even at the same opposition, that it evidently is open to fresh determination. The well-known colours will of course catch the eye; and attention may be paid to the question whether the green, or as others think blue, tint of the dark parts (which Kaiser saw as grey only) is really, as Herschel II. implies, the mere result of contrast. The effect may be possibly thus heightened; but no one who saw one of the great seas as the writer did with a 9 in. silvered speculum on April 4, 1871, could doubt the independent existence of a beautiful clear blue-grey tint, the more certain as a shading on another part of the disc was of a brownish hue: nor does it seem to have been noticed that no effect of contrast has been traced in the polar snows. The luminous and occasionally coloured patches and segments on the limb should receive attention, and the position of "Dawes' ice-island" be scrutinised; such a brilliant speck I witnessed at the above epoch, but I believe in another situation. Black points should be looked for, as such have been detected by Mitchell and Dawes; and it should be noted at the time of any conspicuous feebleness of the markings, whether the sharpness of the limb indicates the cause to be further distant than our own atmosphere: and in general the "daily—nay, hourly—changes in the detail and in the tones of the different parts of the planet, both light and dark," described by Lockyer, should be carefully watched and recorded;

"In tenui labor;"

nevertheless, none of these little matters will be considered insignificant by those who love to behold in such things the footsteps of Creative and Upholding Power.

T. W. WEBB

NOTES

WE have received some interesting notes of the work done by the eminent Russian explorer, Dr. von Miclucho-Maclay, which we hope to publish next week. Contrary to the advice of everyone, this intrepid traveller and true devotee of Science is determined upon again visiting the east coast of Papua. When his researches here are complete he intends to visit some of the islands of Polynesia and certain parts of the coast of Australia. This, he calculates, will take up five or six years. The Governor of the Dutch East Indies, like a true man of Science, had given Dr. Maclay, for the last six months, roomy and comfortable quarters in his palace at Buitonrovg. It would be well, if all in high position would imitate this kind of "patronage."

THE Meteorological Committee of the Board of Trade have resolved to commence the issue of lithographed copies of the twenty-four hourly tabulated readings, taken at their seven observatories, for every element which is observed continuously, commencing with January 1, 1874. The sheets will be issued quarterly, and the issue will be a limited one. The subscription for a copy is 1*l*. per annum, to cover a portion of the expense of production. The sheets will not be distributed with the publications of the office.

M. L. QUETELET, the founder and director of the Brussels Observatory, died in Brussels on Monday night, aged 77. He leaves a son, M. Ernest Quételet, who inherits the scientific enthusiasm of his father.

THE letter which has been received from Consul Prideaux, and the extract from Cameron's letter published in the *Academy*, adds but little to the details we gave some time ago concerning Livingstone's reported death. Lake Bemba is identified by Consul Prideaux as Lake Bangweolo, and a letter from the Arab Governor of Unyanyembe fixes the spot where the great traveller died at Lobisa. A letter to Dr. Petermann from the German African traveller and Austrian Consul at Zanzibar, Mr. Richard Brenner, merely repeats the statements already known. Dr. Kirk, under date Feb. 12, writes to the *Academy* as follows:—"This morning I have heard indirectly from Zanzibar, and find people there who could judge, still question the truth of the story of Livingstone's death. Like us, they see nothing but native report to base it on." Let us hope that this is the real state of the case. As Zanzibar and Ujiji are at present at peace it is expected that there will be no difficulty in getting the Doctor's valuable journals. It is gratifying to see from Mr. Markham's letter in yesterday's *Times* that through Sir Samuel Baker's determined energy, the route to Zanzibar has been virtually opened up from the north.

THE letter above referred to from Consul Brenner, states that a German botanist, M. Hildebrand, has been preparing, for a year past, to undertake a journey into the interior of the Galla country and Somali Land.

A SHORT course of Lectures on the Growth of Physical Science during the last twenty-five years, is to be given at the request of a number of gentlemen in Edinburgh, in St. George's Hall, by Prof. Tait, of the University of Edinburgh. The first lecture is to be given to-day.

AT the Annual General Meeting of the Glasgow Geological Society, on Thursday last, Sir William Thomson gave an address on "The Influence of Geological Changes on the Earth's Rotation." We hope to be able, very soon to give an abstract of this address.

THE *Times* announces that the following arrangements have been made in consequence of Mr. Henry Cole's retirement last year from the post of Secretary of the Science and Art Department and Director of the South Kensington Museum:—Sir Francis Sandford, Secretary of the Education Department, will also be Secretary of the Science and Art Department; Major Donnelly, R.E., Official Inspector for Science, will be Director of Schools of Science and Art and affiliated institutions; Mr. Norman MacLeod will remain Assistant Secretary of the Science and Art Department; and Mr. Philip Cunliffe Owen, Assistant Director of the South Kensington Museum, will be the Director of that Museum.

PROF. HELMHOLTZ has communicated to the Academy of Sciences of Berlin a paper on "The Direction of Balloons," in which he enters into a number of elaborate calculations. In his calculations he directs attention only to the relation between the force and the weight, and supposes that the means at our disposal will enable us to construct the envelope of the balloon and its motive power. But, Prof. Helmholtz says, "it appears to me that here there exists a great difficulty in the way of execution, for the solid parts of the machine do not preserve the necessary solidity when they are much enlarged, although they continue to be geometrically similar; they then must be made thicker, and consequently heavier. To obtain the same effect with small motors at great speed, there is a loss of work. We can only work economically then with motors of large surface urged by a motion relatively slow. One of the great practical difficulties will then be to obtain the necessary dimensions without overloading the balloon."

PROF. H. A. NEWTON thus criticises the Report of the British Association Committee on Units in the March number of *Silliman's Journal*:—The *dyne* or unit of force which is proposed by the committee is to be a new unit of the same nature as a gram-weight, or the earth's attraction for a gram-mass, and having no commensurable ratio with it. Now our simplest and most useful ideas of force are derived at once from weight. It seems to us that, of necessity, this will always be the case. Probably the learned committee have no expectation that even among scientific men the new units will entirely replace what they call the vulgar ones. If, then, their recommendation is accepted, we shall create for certain departments of mechanical science new units of force and energy which are in no useful ratios to those used in other departments of science, and by people at large. Is there not some way of avoiding this great evil? Societies are formed and sustained whose main and most worthy object is to get rid of such confusions. We think the proposed units should be stoutly challenged to show a necessity for their being. We do need, it may be added, a new *name* for the earth's attraction upon a gram of matter at some fixed place. The words *gram*, *pound*, *ton*, &c., have had to do service in two different senses, that is, as mass, and as force. If any good word could come into use that shall express the earth's attractive force for a gram of matter at some place that may be agreed upon, it would meet a real want.

THE collection of Humming Birds of the late M. Jules Bourcier is to be sold by auction at Paris on March 2. M. Bourcier's collection of these birds was, a few years ago, the best and most complete in existence, embracing numerous types of the species described by the French naturalists, and specimens collected by himself during his residence in Ecuador as French Consul.

MR. A. S. NAPIER, of Owens College, Manchester, who has been elected to a Natural Science Scholarship at Exeter College, Oxford, received the first part of his science training at Rugby. Mr. W. E. Hoyle, of Owens College, has been elected to a Natural Science exhibition in the same College.

THE Japanese Government have, through their Legation in London, appointed Mr. R. Routledge, B. Sc., F.C.S., to the Professorship of Chemistry and Physics in the Imperial College at Yeddo. Mr. Routledge was formerly of the Owens College, Manchester, where he studied Chemistry under Dr. Roscoe, and afterwards took high honours at the University of London.

WE gladly call attention to the action taken by the British Association, "Boulder Committee," under its secretary, the Rev. H. W. Crosskey. A large printed form has been prepared, with a set of well-drawn up questions, and spaces for the answers of those who may be inclined to assist the Committee in their praiseworthy work. Copies of this form may be obtained by applying to Mr. Crosskey, 28, George Road, Birmingham.

A TELEGRAM from Cairo announces that Dr. Beke has succeeded in discovering the true Mount Sinai. It is said to be situated one day's journey west of Akaba, is called by the Arabs the Mountain of Light, and is 5,000 ft. high. On the summit were some sacrificial remains of animals.

MISS FRANCES STRICKLAND, of Appleby-court, Tewkesbury, has offered to found at the University of Cambridge a curatorship of the Ornithological collection formerly belonging to her brother, Mr. H. F. Strickland, F.R.S., and presented to the University in 1867 by his widow. Miss Strickland proposes to endow the office with a permanent stipend of 150*l*. per annum. The principal conditions attached to the gift are that the curator be appointed by the foundress during her lifetime, and afterwards by Mrs. Catherine Strickland, and, on the decease of these two ladies, by the superintendent of the University Museums of Zoology and Comparative Anatomy, but in each case with the consent of the Vice-Chancellor. That the curator is to be subject to the authority of the superintendent of the museums, and that his first duty be the proper custody and efficient preservation of the Strickland collection, making an accurate catalogue of it, so that the collection be of the greatest service to Science. He would be required to reside in the University; and in case of the abolition of the office of superintendent of the museums the curator shall be appointed and removed by the Professor of Zoology and Comparative Anatomy with the consent of the Vice-Chancellor. The Council of the Senate recommend the acceptance of Miss Strickland's liberal offer.

ON this day week there passed from among us a countryman whose power has been but too little appreciated, and far too little recompensed by ourselves or other European nations. Sir Francis Pettit Smith was, to all intents and purposes, the discoverer of the screw-propeller, a method of progression as practically advantageous as it is theoretically perfect; nevertheless, the benefits which he has derived from his indebted countrymen are but a paltry annuity and an equally insignificant decoration. Considering the little encouragement given by our Government for first-class work, it is really a matter of surprise that any should be produced at all.

At the meeting of the Academy of Sciences at Paris, on Feb. 9, the candidates to be recommended to the Minister of Public Instruction for the chair of Comparative Embryogenesis at the College of France, were balloted for. The names of MM. Gerbe, Balbiani, and Dareste, were presented to the meeting, and the result of the voting was to select the two former gentlemen as the Academy's nominees for the post.

Captain S. P. Oliver writes us concerning a meteor-cloud which he observed at Buncrana, Co. Donegal, on Feb. 5, at about 9.10 p.m. local time. He saw what he at first thought to be a comet's tail, viz. a broad band of silvery white and luminous cloud extending in an arc from S.E. by E. to N.W. by W., as near as he could judge, from horizon to horizon, but tapering towards the extremities. The apex of this arc, which was some four or five degrees in width, was as nearly as possible on the meridian at about 80° elevation from the horizon. The band passed within three or four degrees above the upper stars of Orion. Through this luminous cloud the stars shone brightly. The edges appeared well-marked, and there was no appearance of that serpentine track into which meteor-clouds frequently dissolve. Several "shooting-stars" were visible the same evening. One especially he noticed which seemed to come from a radiant point at the S.E. extremity of the above-named cloud.

Messrs. Smith, Elder, and Co. have a new edition of Mr. Charles Darwin's work on the "Structure and Distribution of Coral Reefs" in preparation.

Michelet, the celebrated historian, who died within the last few days at Cannes, aged 76 years, has written a few sensational books on natural history. "L'Oiseau" and "L'Insecte," had an immense circulation, although their real scientific value was very small.

M. Reinwold, one of the largest Parisian scientific publishers, is just publishing a translation of Haeckel's "History of Creation." It is prefaced by M. Charles Martin, one of the most celebrated correspondent members of the French Institute. Consequently Darwinism is not to be considered as having been extinguished in France by the last rejection of Darwin by the Academy. Neither will the success of Haeckel's great work be paralysed by the cry of *no more Germanism* raised in certain quarters.

Capt. Mouchez, who has been appointed the chief astronomer for St. Paul's station on the Venus Transit Expedition, is publishing, at the expense of the French Admiralty, a map of the Algerian coast on the scale of $\frac{1}{120000}$. The survey was executed on a new plan and only lasted 18 months. Although Algeria extends about 750 miles east-west, M. Mouchez has determined all his stations by a series of triangulations executed on shore, independently of the situation of his boats or ships.

For some years past much interest has been excited in the United States in reference to the erection of a large telescope, and possibly a complete astronomical observatory on the high portion of the Rocky Mountains. As preliminary to this, a number of careful examinations have been made of the optical qualities of the atmosphere in various portions of the Western country. Of these special interest attaches to the expedition of Professor Davidson of the Coast Survey, whose report to the California Academy of Sciences, states that the meteorological tables kept at Summit Station, on the Sierra Nevada, 7,042 feet above the sea, during the year ending November 1867, show that out of 358 days and nights only eighty-eight were cloudy, nearly all of these occurring in the winter months, during which the snowfall was about forty-five feet, the winter not being unusually mild. The summer weather is very pleasant, the nights cool, and the atmosphere wonderfully clear. The mountain flanks are covered with verdure during the summer, and there is freedom from great clouds of dust. Prof. Davidson says that, owing to the steadiness of the atmosphere, observations at this elevated point would in one or two nights be of greater value than the results of six months' observations at lower stations. Higher and perhaps more desirable positions exist in the immediate neighbourhood of Summit Station; and the interest excited by Prof. Davidson's report probably has, to a considerable extent, influenced the determination announced in a recent letter of Mr. J. Lick, the well-known millionaire of San Francisco. This gentleman has indicated in a letter to the California Academy of Sciences, and again in a letter to Prof. Joseph Henry, his desire to establish an observatory in the best possible location, and provide it with the largest and finest astronomical instruments. He proposes to this end to set aside one million dollars as a permanent endowment fund. This is a monument and a renown which few are rich and wise enough to achieve for themselves, and it is greatly to be hoped that the founder of the Lick Observatory may live to enjoy the congratulations of his State and country.

Prof. James Orton, of Vassar College, N.Y., has just returned to the United States from South America, where he has been engaged in a second exploration of the Amazons. The general object of his recent travels in South America, was to supplement his expedition in 1867, when he crossed the continent from west to east, *viâ* Quito and the Nipo wilderness. His route in 1873 was up the Amazons from Para to Yurimaguas on the Hoallaga River; thence up to the Paravapura and its tributary, the Cachiyeen to Balsa Puerto; thence over the Icuto Vange on foot to Moyobamba; thence across and among the Andes to Chachapoyas and Cayamarca, crossing the Upper Mavañon, or Balsas, and striking the coast at Pacasmayo; thence to Lima and its immediate region; thence to Mollendo, Areguipa and Puno on the shore of the Lake Titicaca. He was the first traveller to pass from the Pacific to the Lake by the railway just finished by Mr. Meiggs. The prime object of his explorations was to study the physical geography, geology and topography of the Amazons. On these points he obtained a vast amount of new and reliable information. He found that the Upper Amazon (Marañora), has been grossly misrepresented in all the more recent maps of Peru. He made everywhere, but especially in Northern Peru, large collections in natural history, to throw light upon the distribution of animal life. Prof. Orton will condense the results of his expedition in a work on the Physical Geography, Natural History, and Commercial Resources of the Valley of the Amazons.

Fresh advices to January 11, received from the German exploring expedition in the Lybian Desert, under Gerhard Rohlfs, announce that the expedition had reached the important oasis of Dachel, containing 17,000 inhabitants. Valuable geographical discoveries had been made, and six maps of the country had been taken.

The metrical system has just been adopted in Germany for the measurement of distances. The official papers have published the order with decrees that henceforth the kilometre shall replace the Prussian mile.

The additions to the Zoological Society's Gardens during the past week include a pair of Coatis (*Nasua nasica*) from South America, presented by Mr. W. P. Chambers; an Egyptian Fox (*Canis niloticus*) from Port Said, presented by Mr. J. T. Keane; a Bonnet Monkey (*Macacus radiatus*) from India, presented by Mr. R. Wilkinson; a Great Kangaroo (*Macropus giganteus*), born in the Gardens; five Branched Sea Horses (*Hippocampus ramulosus*) from the coast of France, purchased; a Capybara (*Hydrochœrus capybara*) from Rio Negro.

SCIENTIFIC SERIALS

In the *Journal of Botany* for January, there is no paper of special general interest, the illustration being that of a new British moss *Tortula inclinata*. Mr. J. G. Baker describes a number of new or little known capsular gamophyllous Liliaceæ; and Mr. F. E. Kitchener gives an "elementary proof of the rule for detecting spiral arrangement." The first article in the February No. is an illustration of how much yet remains to be done in completing the British flora, being a description with a plate of a British Dock, *Rumex maximus*, discovered by the Hon. J. L. Warren in the neighbourhood of Lewes, where it was recorded many years since, but not having been observed in the meantime, had been generally treated as an error. There is no other paper bearing specially on British Botany, but a very useful account of the Esparto-grass of commerce, by Mr. J. R. Jackson.

Astronomische Nachrichten, No. 1972. The elements of Henry's comet, 1873, by E. Weiss and Aug. Zielinsky, the following elements are given :—

	Weiss. Berlin Time.	Zielinsky. Paris Time.
T =	Oct. 1·80022	Oct. 1·765792
Π =	50° 28′ 18″·5	50° 18′ 42″·96
☊ =	176° 43′ 14″	176° 43′ 21″·88
i =	121° 28′ 58″·8	121° 27′ 48″·19
log q =	9·585297	9·586641

A list of fifteen new nebulæ is given, which M. Stephan observed at Marseilles.

Poggendorff's Annalen der Physik und Chemie, No. 10, 1873.—We may first notice, in this number, some observations relating to phenomena of light.—M. Behrens contributes a paper on the production of coloured light through elective reflection. The reflected and transmitted light of opal and other bodies was examined with a micro-spectroscope; and it is shown that certain substances may have colour without absorbing light, and that the two spectra (from reflection and transmission, respectively) are exactly complementary of each other. This, he says, occurs more frequently than one might suppose.—Dr. Nöggerrath draws attention to the production of light in grinding of hard stones, as witnessed in the agate-works at Oberstein and Idar. In the case of all hard stones (which the workmen press with their hands against large grindstones revolving thrice in a second), a strong red light appears between the object and the grindstone, with a red halo and emission of sparks. Transparent stones, however, are lit up throughout with a beautiful yellowish-red light, like that of glowing iron, so that it seems as if the workman must burn his hands (though the rise of temperature was not above 10° or 12° R.). The author invites research in this direction, for which the works named present good opportunity.—The concluding portion of M. von Bezold's paper on the law of colour mixture and the physiological primary colours, is given; the author is led to some valuable deductions which we cannot here stop to particularise.—M. Valerius, in a note on binocular, as compared with monocular, vision, comes to the conclusion that the proportion of brightness of an object, looked at successively with both eyes, and with one, is nearly independent of the absolute amount of illumination: and with ordinary candle or gas flame, does not exceed 1·15. He afterwards found that his left eye was less sensitive than the right; had he used the latter, the proportion in question would be somewhat less. The measurements were made with Foucault's photometer.—M. Kundt contributes a paper on the vibration of rectangular, and especially of square, *air plates;* meaning, by an air plate, a thin layer of air enclosed between two solid plane plates applied to each other (it may be either in communication with the external air, or closed all round). He makes the vibration-forms visible by means of cork powder; and the present communication chiefly shows that the vibration-numbers observed in the entirely-closed air plates agree with those deduced from theory, to less than 1 per cent.—Dr. Hübener gives an account of researches on transpiration of salt solutions through capillary tubes. The velocity of outflow is found to be inversely as the equivalent weights; which may be explained (the author thinks) by the fact, that in compounds with high equivalent weight the molecules are larger than in those with low. If, then, equal weights of two salts of different equivalent weight be dissolved in a liquid, there will be present in the solution of the heavier salt larger but fewer molecules than in the other solution. Hence, in the solution of the first salt, the molecular surface in contact with the solvent will be less than in the second liquid; and the internal friction will be less; thus (other conditions equal), there will be greater mobility.—A paper by Dr. Dibbits discusses, at some length, the dissociation of ammonium salts in aqueous solution; the results detailed being both qualitative and quantitative.—M. Rammelsberg communicates a second note on natural compounds of tantalum and niobium; and Dr. Bender describes an ingenious method of determining the time of vibration of a material pendulum. The remaining matter does not specially call for notice.

SOCIETIES AND ACADEMIES

Royal Society, Feb. 5,—"On the Anatomy and Habits of the genus *Phronima* (Lattr.)." By Dr. John Denis Macdonald, F.R.S., Staff Surgeon R.N., Assistant Professor of Naval Hygiene, Netley Medical School.

Of all groups of Crustacea the Amphipoda would appear to exhibit the widest range, in the modification of their parts or organs, without obliterating the delicate lines of natural affinity running through them as a whole. This is well exemplified in the interesting paper of Dr. R. Willemoes-Suhm, naturalist to the *Challenger* Exploring Expedition, "On a new Genus of Amphipod Crustaceans" founded by him, and named *Thaumops*. This genus, although exhibiting many characters in common with *Phronima*, presents some striking points of difference traceable in the external jaw-feet, caudal appendages, the position of the generative bone, and certain particulars in its external anatomy.

During the exploratory voyage of H.M.S. *Herald*, in the S.W. Pacific, numerous species which I have always been in the habit of referring to the genus *Phronima*, were taken in the towing-net; and I might remark that the assumed parasitic habit of these creatures was never, at least, a prominent fact to me, they were so often taken either perfectly free, or tenanting a nidamental case. Those who, like Dr. Suhm, are acquainted with deep-sea dredging, are usually cautious how they refer the doubtful products to their proper habitat; whether it be the bottom that has been reached, or some zone of the watery space above. Indeed it is quite possible for the narrow area of the tallow-arming of the deep-sea lead to include fortuitously, and carry down *Phronima* or any other little crustacean naturally living near the surface; and contact with the bottom would finally press it into the tallow, so as to mislead the observer as to its true habitat. Conversely, in bringing up the dredge from a given depth, it may finally carry with it any more superficial objects casually lying in the track which it takes.

The author then describes a species of *Phronima* captured in lat. 30° 16′ S., long. 176° 27′ W.

The evidence of Dr. Willemoes-Suhm supports my own experience that there is no metamorphosis in this group; and as it is very probable that the history of the development of *Thaumops* would resemble that of *Phronima*, the following observations may be of some importance, as carrying the process a little further than it has perhaps yet been traced by him:—

In lat. 21° 0′ S. and long. 17° 45′ W. off the island of Ono, Fiji group, apparently the same species of *Phronima* as that above referred to was taken in the towing-net, but with the addition of a numerous progeny of young in a large gelatinous but tough nidamental case. This interesting nest was shaped like a barrel, but with both ends open, and the external surface was somewhat tuberculated and uneven. The wall of the tube presented numerous round and puckered openings, observing no very definite arrangement, but through which entering currents were observed to pass. These openings in general pierced the tuberculations, though not invariably.

An external membrane, with an internal lining, was distinctly visible, both seeming to be continuous at the rims of the tube. The space between these layers was filled up with a pulpy substance, in which scattered nucleiform bodies were detected with a higher power of the microscope.

In a subsequent commission on the North-American and West-Indian Station in H.M.S. *Icarus*, I have frequently captured "*Phronima* in its bay," as my messmates would say. In order to bring the swimmerets into full play, the animal protrudes its body tail foremost from the case, only calling into use the fine tips of the third and fourth pairs of thoracic limbs to hold fast its charge. When it fully retires into the case, the claws of the two posterior pairs of legs are pressed backwards against the lining membrane, so as still more effectually to secure its hold on the approach of danger.

Royal Society, Feb. 12.—"Note on the Synthesis of Formic Aldehyde," by Sir B. C. Brodie, Bart., F.R.S.

In a former note I communicated to the society the result of an experiment in which a mixture of equal (or nearly equal) volumes of hydrogen and carbonic oxide had been submitted, in the induction-tube, to the electric action. My expectation in making the experiment had been that the synthesis of formic aldehyde would be thus effected according to the equation $CO + H_2 = COH_2$. The only permanent gas, however, other than the gases originally present in the induction-tube, which appeared in the result of the experiment was marsh-gas. When a mixture of hydrogen and carbonic acid gas were similarly operated upon, the same hydrocarbon, together with carbonic oxide, was formed. I have now, however, succeeded, by a modification in the conditions of the latter experiment, in attaining the object which I originally had in view. Evidence of this is afforded by the following analysis:—The gas analysed was the result of submitting to the electric action equal volumes of hydrogen and carbonic acid. After removal from the gas of carbonic acid and carbonic oxide, and also of a trace of oxygen, 191·2 volumes of gas remained, in which were found at the conclusion of the analysis 2·6 volumes of nitrogen. Deducting this amount of nitrogen, 188·6 volumes of gas remain, containing the residual hydrogen in the gas, together with any gases besides carbonic oxide formed in the experiment. This gas was analysed by the addition of oxygen and subsequent detonation by the electric spark, the absorption of the carbonic acid by potash, and the removal of the oxygen over by pyrogallate of potash. The results of the analysis entirely concur with the assumption that the 188·6 volumes of gas were constituted of hydrogen, marsh-gas, and formic aldehyde in the proportions given below.

Hydrogen	183·2
Marsh-gas	0·2
Formic aldehyde	5·2
	188·6

The composition of 100 volumes of the gas being,

Hydrogen	97·14
Marsh-gas	0·10
Formic aldehyde	2·76
	100·00

Another experiment was attended with similar results, only that the proportion of marsh-gas was somewhat greater.

The result of this experiment may be considered to be given in the equation $CO_2 + 2H_2 = COH_2 + H_2O$. I have reason to believe that formic aldehyde is also formed in the reaction of hydrogen and carbonic oxide; and that the marsh-gas found (in both experiments) results from the decomposition of this substance, possibly according to the equation $2COH_2 = CO_2 + CH_4$. I do not now dwell upon this subject, as it is my intention very speedily to lay before the Society, together with other matters, the details of the various experiments which I have made in reference to it.

Geological Society Feb. 4.—His Grace the Duke of Argyll, K.T., F.R.S., president, in the chair.—The following communications were read:—"The Physical History of the Valley of the Rhine," by Prof. A. C. Ramsay, LL.D., V.P.R.S., vice-president. The author first described the general physical characters of the valley of the Rhine, and discussed some of the hypotheses which have been put forward to explain them. His own opinion was that during portions of the Miocene epoch the drainage through the great valley between the Schwarzwald and the Vosges ran from the Devonian hills north of Mainz into the area now occupied by the Miocene rocks of Switzerland. Then after the physical disturbances which closed the Miocene epoch in these regions the direction of the drainage was reversed, so that after passing through the hill-country between the lake of Constance and Basel, the river flowed along an elevated plain formed of Miocene deposits, the remains of which still exist at the sides of the valley between Basel and Mainz. At the same time the Rhine flowed in a minor valley through the upland country formed of Devonian rocks, which now constitute the Taunus, the Hundsruck, and the highland lying towards Bonn, and by the ordinary erosive action of the great river the gorge was gradually formed and deepened to its present level. In proportion as the gorge deepened, the marly flat Miocene strata of the area between Mainz and Basel were also in great part worn away, leaving the existing plain, which presents a deceptive appearance of having once been occupied by a great lake.—"On the Correspondence between some Areas of Apparent Upheaval and the Thickening of Subjacent Beds," by W. Topley, Geological Survey of England. The author referred to many instances in which beds have unequal development, being much thicker in some places than in others; and the main object of his paper was to show that such thickening and thinning of beds has an important effect in producing the apparent dip of overlying beds. The thinning of any one bed may have an appreciable effect in producing or increasing its own apparent dip; but where a whole series of beds thin constantly in one direction, the amount of the dip of one of the higher beds, due to the *sum of the thinnings of the underlying beds*, is often very considerable. It is generally supposed that the dip of any bed is due to great movements of the earth's crust; from the facts mentioned the author argued that our inferences as to such movements will vary according to the beds which happen to be exposed at the surface. It is evident, from the faults intersecting strata, that upheavals and disturbances have taken place; but unless we assume every bed to have been deposited on a perfectly horizontal plane, we cannot infer the amount of such upheaval from the present position of the bed. In all cases we must take into account the actual or possible thinning of underlying beds. The beds which support geological basins frequently thin towards the centres of those basins, thus producing, wholly or in part, the basined form of the strata. It was, however, shown that the beds of the basins themselves frequently thicken towards the centre of the basins.

Anthropological Institute, Feb. 10.—Prof. Busk, F.R.S., president, in the chair.—The second part of the paper "Explorations amongst ancient Burial Grounds, chiefly on the sea-coast valleys of Peru," was read by the author, Mr. Consul Thomas J. Hutchinson. The paper treated of the burial grounds from Lima northwards, as did the former part of the paper on those from Arica to Lima. Mr. Hutchinson described a burial place with the Aymara name of Parárá on the Oroya railroad at a station called Chosica, and at an elevation of only 2,750 feet above the level of the sea, and so named from its grinding stones used for bruising corn, numbers of which lie amongst the cenotaphs. Those were said by Prof. Forbes to be used for cooking purposes, because the Aymaras are stated to have occupied a part of Peru of which the minimum elevation is 10,000 ft., and therefore where the boiling of water is a difficult matter to accomplish. The flattened and elongated skulls mentioned by Dr. Tschudi and Prof. Forbes were touched upon—an illustration of one of these from an elevation of 10,000 ft. above the sea being given. Mr. Hutchinson recommended a further and more extensive exploration of the mounds and Huacas in Peru to illustrate the rich treasures of archæology with which that country abounds.—A joint paper by Mr. Tyrwhitt Drake and Mr. A. W. Franks was read, on skulls and implements from Palestine.

Photographic Society, Feb. 10.—James Glaisher, F.R.S., president, in the chair.—A special general meeting was held to decide whether two new laws, previously proposed, should be adopted, or whether the Council's amendment to appoint a committee to revise the laws generally be accepted. The Council's amendment was lost. The anniversary meeting of the Society was held afterwards, when the balance-sheet, showing an improved financial position, and the report of the Council, were read and adopted. The President and Council, interpreting the rejection of their amendment as a vote of want of confidence, then tendered their resignations, which were accepted.

MANCHESTER

Literary and Philosophical Society, Jan. 19.—Microscopical and Natural History Section.—Mr. Joseph Baxendell, F.R.A.S, vice-president of the Section, in the chair.—Mr. Joseph Sidebotham, F.R.A.S., read a paper no "The similarity of certain Crystallised substances to Vegetable forms." The author called attention to the formation of verdegris on insect pins, in old Entomological collections. This substance makes its appearance where the pins pass through the thorax of the insects, and in length of time grows into a considerable mass of flocculent matter, of a brilliant green colour, and often breaks up the insects and also destroys the pins. It consists mainly of acetate or formiate of copper in combination with fatty or oily matter. On examination of various specimens under the microscope, they were found to present a great variety of forms, filamentous and ribbon-like structure, often resembling various

fungi, in some cases so nearly, that it was difficult to believe that the fibres and fruit-like forms are not really organic bodies. The author expressed his opinion that these bodies were simply crystals, modified in their formation by the oil contained in the insects, with which the crystals are in some way combined. Some of the specimens exhibited were taken from insects collected twenty-five years ago.

LIVERPOOL

Geological Society, Feb. 12.—Mr. T. Mellard Reade, F.G.S. read a paper containing a series of novel investigations on the action of tides on the sea-bottom. Applying a formula used by civil engineers, the result of practical observation in tidal estuaries, to the observed currents at the surface at various points in the St. George's and English Channels, it was proved, by comparison with experiments instituted for ascertaining the moving powers of running water on materials of various specific gravity and bulk, that, conditions being otherwise favourable, tidal currents were capable of destructive erosive action on the sea-bottom. Mr. Reade then entered elaborately into the phenomena of the tides in the Irish Sea, in the English Channel, and surrounding seas, using Captain Beechey's admirable observations for this purpose. Mr. Reade infers from a consideration of a variety of circumstances that the materials of the Irish Sea bottom are principally composed of re-arranged glacial drift, either eroded off the bottom or off the coast by the sea itself, or poured into it by the many rivers in the north-west of England, south of Scotland, and west of Ireland, draining vast basins mostly covered by glacial clays and sands. These materials, notwithstanding the oscillatory character of the tidal streams, have in the main a slow, progressive motion down channel, and out as far into the Atlantic as the little Sole Banks. Clear cases of the erosive action of the water on the bottom were then given. It was shown that there are pits or gullies excavated in the bottom in both the English and Irish channels, and that these depressions have generally their major axes conformable in direction with the set of the stream tide; and that the contour lines of the bottom approximately follow the same direction. The most remarkable of these excavations is the North Channel Gulley, off the coast of Wigtonshire, twenty miles long, one mile wide, and from 400 ft. to 600 ft. deeper than the surrounding bottom, and which the strong tide existing there has either partially or wholly excavated, and now keeps open. In conclusion, Mr. Reade expressed his conviction that the diurnal and semi-diurnal movement of the tides, acting down to the profoundest depths of the ocean, accounts for the preponderance of life in it over that exhibited by the fauna of the Mediterranean.

EDINBURGH

Royal Society, Feb. 16.—Sir William Thomson, president, in the chair.—The president read obituary notices of deceased Fellows of the Society.—The following communications were read:—On the Kinetic Theory of the Dissipation of Energy, by Sir W. Thomson.—On the Electric Conductivity of Iron at a Low Red Heat, by Prof. Tait.—On the Stresses due to Compound Strains, by Prof. C. Niven, communicated by Prof. Tait.

GLASGOW

Geological Society, Jan. 15.—Mr. E. A. Wünsch, vice-president, in the chair.—Mr. R. L. Jack, of H.M. Geological Survey, read a paper on a Boulder-clay, with broken shells, in the lower valley of the River Endrick, near Lochlomond, and its relation to certain other glacial deposits in the same neighbourhood. The author stated that the elevation of Lochlomond above the sea is so trifling that there is no difficulty in classing it with the sea-lochs that indent the western Highlands. A depression of 20 feet, or the removal of the superficial deposits traversed by its short outlet, the Leven, on its way to the Clyde, would restore it to its former condition. He then called attention to a deposit which he had observed in the course of his work on the geological survey near the south-eastern angle of Lochlomond, and whose relation to the already-known members of the glacial series seemed to deserve particular attention. The deposit is a true typical till, in every respect similar to the old boulder-clay or till of the Lowlands of Scotland. In a matrix of stiff unstratified clay, brown in colour, like the subjacent Old Red sandstone rock, are scattered stones of various sizes, blunted, smoothed, and marked with striations in all directions, but most frequently in the direction of their longer axis. It presents, however, one remarkable peculiarity that distinguishes it from the common till—it contains worn and broken fragments of marine shells. Though he had not found any clear instance of an older deposit below this shelly till, he believed its place was above the old boulder-clay, and that it was also the product of land-ice. He believed the till to be the product of land-ice—the *moraine profonde* of a large glacier which filled up the lake, covered the islands, and climbed the rising ground between the Leven and the Endrick to the height of at least 320 feet. This glacier, in all probability, existed during the latter portion of the period which preceded the "great submergence" of the land.—Mr. John Young read a paper on the occurrence of a bed of highly indurated Sandstone, with water-worn quartzite pebbles, interstratified with the trap of the Campsie Hills. The bed is probably of lower carboniferous age, and indicates one of those periods of repose between the great outbursts of igneous rock matter of which the Campsie Fells are principally built up.

PARIS

Academy of Sciences, Feb. 9—M. Bertrand in the chair.—The following papers were read:—On *Balistique intérieure*, by General Morin. This was a paper on the various forces acting on a projectile whilst still in the bore of a gun.—On the devitrification of glass, by M. Eug. Peligot. The author decides that, contrary to the received opinion that this effect is due merely to a crystallisation of the glass, it is due to the formation of a definite silicate having a formula corresponding to that of a pyroxene.—On the action of water on lead, by M. Balard.—New clinical and experimental researches on the movements and repose of the heart, and on the mechanism of the passage of the blood through its cavities when in the normal state, by M. Bouillaud.—On the preservation of vines threatened by *Phylloxera*, by M. de la Vergne.—On the problem of three bodies, by M. E. Mathieu.—On the resistance of glass tubes to rupture, by M. L. Cailletet. The author finds that a tube stands pressure from the outside better than from the inside. The pressures, however, which a tube can stand from the inside are very great. One of 9 mm. internal diameter and 1 mm. thickness, containing 6·9 c.c., was submitted to an outside pressure of 460 atmospheres, without injury, and subsequently to an internal pressure of 104 atmospheres, when it burst.—On the use of a double refracting prism for determining the axes of ellipses, by M. Jannetaz.—On some new bands produced in the absorption spectrum of chlorophyll by reagents containing sulphur, by M. J. Chautard.—On a new process for preserving wood, by M. Hatzfeld.—On the hardness and density of carbon obtained from pure sugar, by M. F. Monier.—On the flight of birds, by M. E. Bertin.—On an electric fire-alarm, by MM. A. Joly, and P. Barbier.—On the measurement of heat, by M. G. West.—On a case of monstrosity, &c., by M. Claudot.—Theorems concerning algebraic equations, by M. F. Lucas.—On the impossibility of certain double equations, by M. A. Genocchi.—On the conditions necessary for a conic with a curve of any order to have a contact of the fifth order, by M. Painvin.—On the chemical characteristics of the uredo of maize, &c., by M. Hartsen.—On the consecutive effects of the removal of the mammæ in certain animals, by M. de Sinéty.

CONTENTS

THURSDAY, FEBRUARY 26, 1874

THE ROTHAMSTED AGRICULTURAL INVESTIGATIONS

IT has become a trite remark, that while both the progress and teaching of Science are fostered in most educated countries by the care of the State, they mainly depend in our own country on the exertions of private individuals; this fact is perhaps, however, more strikingly seen in the case of agriculture than in any other instance. The traveller in Germany will find scattered over the country, some forty Experimental Stations and Agricultural Academies, establishments which are devoted to the investigation and teaching of scientific agriculture and are maintained by their respective States. The German farmer has thus the means of becoming acquainted with the true science of his business, and provision is at the same time made for the investigation of the various problems with which his work abounds. In England the state of things is, alas, wholly different. We have just one college—that at Cirencester, devoted to the teaching of scientific agriculture, and one Experimental Station—that at Rothamsted. There is indeed some experimental work done by local Farmers' Clubs, but this is generally only with the object of comparing the effects of the various manures that are in the market, and with no scientific aim or result. Yet England preeminently needs the help of Science to direct economically her vast system of agriculture. The art of agriculture is here in a higher state of development than on the continent. More capital is here invested in the land; more attention has been paid to tillage, to artificial manures, and to the breeding and feeding of stock. The British farmer succeeds because he is a practical man, and has good common sense, and the enterprising spirit of his race; what might he not do if he thoroughly understood the principles which underlie his art?

If we have but one agricultural station in England we have at least reason to be proud of it. The work done at Mr. Lawes' estate at Rothamsted is not to be equalled by that of any of the foreign stations; indeed, in several departments of investigation it might safely challenge a comparison with their united efforts. This excellence has arisen from the systematic and thorough manner in which the subjects taken up have been treated. We cannot better illustrate this than by referring to the last contribution from Rothamsted, a report by Messrs. Lawes and Gilbert on the growth of barley.*

In one of the experimental fields barley has been grown for twenty years, and the experiment is still progressing. The field is divided into plots of about one-fifth of an acre; some of these have never received any manure during the twenty years; the others receive some one or more of the food constituents which barley requires. Thus one is manured with phosphates, a second with alkalies, a third with ammonia, a fourth with ammonia and phosphates, a fifth with ammonia, phosphates, and alkalies, &c. The same manures are always applied each year to the same plot. At harvest the crops are carefully weighed, and are then analysed in the laboratory under the superintendence of Dr. Gilbert, the amount of dry matter, ash, and nitrogen being determined. The advantages of this systematic mode of experimenting are very great. Carried on in the same manner for so many years, these experiments answer questions relating to the exhaustion of soil, to the permanent effect of manures, to the effect of season upon the produce. With the aid of the laboratory investigations they teach us what proportion of the various ingredients supplied in the manure is recovered in the crop, and how the composition of the plant is affected by the various conditions of the soil. In conjunction with analyses of the soil and of the drainage water, we learn what becomes of the manures applied, how deeply they have penetrated into the soil, what is the loss suffered through drainage, &c. A single field experiment thus thoroughly and patiently carried out touches half the domain of agricultural chemistry, and supplies information of the most solid and valuable kind.

The value of every trustworthy investigation is increased as others are completed which compare with it; the work at Rothamsted thus derives an additional value from its extent. During the last thirty years Messrs. Lawes and Gilbert have investigated in the manner described all the principal farm crops, experimenting both on each singly, and also on their behaviour when grown in rotation. As the results are gradually published, and we are able to compare the behaviour of different crops grown on the same soil, with the same manures, and in the same seasons, the special characteristics of each crop become plainly shown by contrast with its fellows, and we gradually learn the part which each is fitted to play in a scientific system of agriculture.

Nitrogenous manures are of primary importance if luxuriant cereal crops are to be raised, the natural supply of combined nitrogen from the atmosphere being very small, and the crops in question having little power for assimilating the forms of nitrogen chiefly present in the soil. Nitrogenous manures are, moreover, as every farmer knows, very expensive, and it is a matter of great importance to employ them in the most economical manner. Messrs. Lawes and Gilbert, knowing the composition of the manure that has gone on to their fields, and the composition of the crops that have been carted off, can tell exactly what proportion of the nitrogen applied has been assimilated by the plant. They find, on an average of twenty years, that wheat assimilates about 45 per cent. of the nitrogen in a spring dressing of nitrate of sodium, and about 33 per cent. in the case of an autumn dressing of sulphate of ammonium, and only $14\frac{1}{2}$ per cent. of the nitrogen supplied by farmyard manure. With barley, the proportion assimilated is rather greater, being 49 per cent. for a spring dressing of ammonium salts. The question as to what becomes of the large proportion of unused nitrogen is clearly of the highest importance. Analyses of the soils, and of the drainage water, throw much light on the subject. The soils of the wheat field have been analysed down to a depth of 27 inches. A considerable part of the missing nitrogen is found to be actually present in the soil, but since it has scarcely any effect on the crops, it is apparently in some state of combination unsuitable for the plant's use. A still larger portion of the nitro-

* "Report of Experiments on the Growth of Barley for twenty years in succession on the same land," by J. B. Lawes, F.R.S., F.C.S., and J. H. Gilbert, Ph.D., F.R.S., F.C.S.—*Journal of the Royal Agricultural Society*, 1873, 89 and 275.

gen is, however, not to be found in the soil, but the examination of the drainage waters from the different plots exhibits so large a content of nitrates, that calculation leads to the belief that in the case of ammonium salts and nitrate of sodium the loss of nitrogen chiefly takes place in this manner. Chemists knowing that ammonia is readily absorbed and firmly held by soil, had never anticipated that so considerable a loss might occur by drainage. It plainly appears, however, from these results, that ammonia when applied to the soil is quickly converted into nitric acid, and in heavy rains may be easily washed out. During autumn and winter there is little evaporation from the soil, and no consumption of water by a growing crop; as soon therefore as the surface soil is saturated most of the subsequent rain-fall will pass into the subsoil, or find its exit through the drains. The authors calculate that if the drainage water contains 1 part of nitrogen in 100,000, and many of the waters analysed were much richer, there will be a loss of 2·26ths of nitrogen equal to about 23 lbs. of guano for every inch of rain that passes beyond the reach of the roots. It is evident, among other conclusions from these important facts, that ammonia should only be applied to the land in the spring, when the crop is able to make immediate use of it. It may also be found that on gravelly and sandy soils, which have little power of holding water, organic forms of nitrogen, as rape cake and farm-yard manure, may be more certain in their effects than ammonia or nitrates. The organic manures being only slowly rendered soluble in the soil, can suffer comparatively little loss from sudden rain. The subject of the economic application of nitrogen is being further investigated at Rothamsted.

We have no space to do more than allude to the researches which have been conducted at Rothamsted in the department of animal chemistry: the experiments on the fattening of stock, and on the composition of the carcase produced, have been equally important in their results with those field experiments we have referred to. Of the indebtedness of Science to Mr. Lawes' unique and costly experiments we need not speak, the facts are so plain that they speak for themselves. Nor need we state the moral. The addition to the national wealth which has accrued from the discoveries made by Mr. Lawes is already enormous. It must be borne in mind that this benefit has arisen from *accidental* researches, for Mr. Lawes was not compelled to take them up, nor is he bound to continue them. Now if such work is not national work, The Royal Observatory ought to be shut up to-morrow, for the work done there is not one jot or tittle more important.

DR. LIVINGSTONE

THE telegram, dated at Aden on the 23rd of this month, announces that Lieut. Murphy is bringing the body of Dr. Livingstone down to Zanzibar, while Lieut. Cameron has passed onwards to Ujiji to recover Dr. Livingstone's papers and to continue his work. The story of those faithful negroes having carried the body of their beloved chief over hundreds of miles is one of the most romantic in history, and is a fitting close to the noble life of the great explorer. Dean Stanley, we are informed, has proposed that the remains of Livingstone shall find a last resting-place in Westminster Abbey. Yesterday (the 25th) was the last day on which instructions could be sent out by telegram touching the disposal of the body. We cannot believe that the necessary orders have not been despatched; for the wishes of the country are well known, and have been sufficiently expressed. With the body will arrive all Livingstone's faithful followers, who were engaged on the understanding that they were to receive a certain fixed monthly payment. There were Chumah and the two or three other men who had been with him since 1865. There were Jacob Wainwright and the other Nassick boys, and the men sent up to Unyanyembe in the summer of 1872; and there were the men engaged in the interior by Dr. Livingstone himself. A sum of about 1,000*l.* will be required to pay off these loyal and faithful servants of Her Majesty's Consul. Yesterday was the last day on which an order for the payment could be sent out. Has this been done? The people of England have a right to an answer, and an immediate answer, for if the Government hesitates, the country will never allow this disgrace to come upon it.

As soon as the full details arrive by the next mail, it will be fitting that we should give our readers a memoir of the illustrious martyr to Science who has passed away. But now we desire to know—and all England will join with us in the inquiry—whether orders were sent out by telegram on the 25th, respecting the disposal of Dr. Livingstone's body, and the payment of his followers, the devoted servants of Her Majesty's Consul?

Lieut. Cameron, in conducting the search expedition, has suffered terribly from fever and ophthalmia, and has been obliged to incur heavy expenses. But he has displayed the best qualities of an explorer. He is a good manager of natives, an excellent walker, an accurate astronomical observer, a linguist, and a man of indomitable perseverance. He is now pressing forward on a perilous and important duty, and we trust he will carry with him the generous sympathy of the Geographical Society, and of the public generally.

POST-TERTIARY GEOLOGY

The Great Ice-Age and its relation to the Antiquity of Man. By James Geikie. (W. Isbister and Co. 1874.)

I.

EVERY field-geologist, who works in northern latitudes, soon comes to know what is meant by Drift. In his attempts to trace the superposition and run across the country of the solid rocks, he is always sooner or later brought up by coming across masses of stony clay, gravel, and sand, which bury them to greater or less depths, and more or less completely hide them from view. These superficial accumulations lie indifferently on all members of the bedded formations; they occur now in detached patches, and now spread like a pall over vast tracts of country.

In the latter case it is clear that they would soon make their presence felt by the way in which they effectually mask the geological structure of the ground they cover; it was impossible, therefore, that they could be for long ignored altogether, but they seem for a time to have been looked upon as something very inferior in interest and importance to the older and more regular formations, in some

cases, perhaps, as little more than troublesome hindrances to the making of a good geological map. Thus it came about that deposits of this class were lumped together under the comprehensive title of Diluvium or Northern Drift: and that, in the few cases where any geologist thought them worthy of more than a simple recognition, the explanations offered of their origin were crude and unsatisfactory. Some of these explanations we may just glance at. In the days when evolution and continuity were doctrines yet undreamed of, it was imagined that between any two consecutive geological epochs there intervened a period of chaotic turmoil, one result of which was, that a clean sweep was made of the life of the epoch that had just closed, and the ground prepared for the introduction of the life of that which was to follow. Supposing this to have been the general course of past events, some referred diluvial accumulations to the series of convulsions which came in like a great gulf between the age of man and the last of geological eras. It could not be reasonably objected to such an hypothesis that it called to its aid agencies the like of which we had never seen, and the like of which, as far as our knowledge of the economy of nature went, it was most improbable had ever been in operation; there was the ready answer, that during periods which were essentially abnormal, anything was possible. This made such explanations easy to frame and easy to uphold, and they commended themselves readily to the indolence of mind and impatience of accurate thought from which few of us are altogether free. The same may be said of the notion suggested by, but we cannot say based upon, the phenomena of the great ocean wave of earthquakes, "that somehow and somewhere in the far north a series of gigantic waves was mysteriously propagated," which "were supposed to have precipitated themselves madly on over mountain and valley alike, carrying along with them a mighty burden of rocks, stones, and rubbish," and that by this means the piles of diluvium had been heaped up. Again, the name diluvium was founded on the idea that its deposits were the relics of Noah's flood; and the notion that we had in them a proof of the accuracy of the Biblical record was so very welcome, that it was accepted and stuck to in spite of the absence of evidence in its favour, and so contributed, perhaps as much as anything else, to postpone the true solution of the problem.

But by degrees light began to dawn on the subject. Playfair had attempted to turn the attention of geologists to the proper quarter, when he suggested that the most powerful agents which Nature employs for the moving of rocks are the glaciers; but his hint lay for a while unheeded. In 1837, Agassiz arrived at the conclusion that the glaciers of the Alps had been formerly far larger than at present. He had studied the smoothed and furrowed surfaces which occur everywhere below glaciers, and had found that the rocks displayed markings exactly identical with these far beyond the range of the present ice. He explained his views to Buckland, who then saw the meaning of certain surface features which he had observed, but had not previously understood, in the British Islands. The two geologists visited Scotland together in 1840; found over the length and breadth of the land scorings and polishings which ice—and, as far as their knowledge went, nothing but ice—could have made, and came to the conclusion that the whole country had been once swathed in one widespread ice-covering. About the same time Sir Charles Lyell attributed the formation of portions of the Scotch drift to the action of land-ice.

The right clue was now found, and it only remained for others to follow it up. A great step was made by Prof. Ramsay when, some ten years later, he deciphered the story written on the Drift-beds of North Wales, and determined the broad succession of physical changes that had led to their formation. He pointed out that there had been two periods of cold, the first of intense severity, and the second less rigorous, and that between the two there came a milder interval, during which depression brought the sea up the flanks of the mountains to a height of 2,300 feet above its present level.

Still however the importance of the Drift was far from being fully recognised. For many years no notice whatever was taken of it on the maps of the Government Survey; and when at last it met with a tardy recognition, Drift was still for a while Drift "and it was nothing more," a something agriculturally important and therefore not to be passed over by the economic geologist, but hardly a great formation with a story to tell as long, as varied, and as interesting, as any that geology had hitherto revealed to us. It is significant that ever so eminent a pioneer as Prof. Ramsay did not deem these deposits worthy of more than incidental notice in his otherwise exhaustive Memoir on the Geology of North Wales. The Drift in fact was somewhat on the position of a *nouveau riche*, who is trying to work his way into "society," and it had up-hill work before it was admitted into the exclusive circle of the old respectable formations.

But its turn came at last, and amid the band of geologists, who have helped in the work of securing for it the attention to which it is fairly entitled, the brothers Geikie occupy prominent places. The one gave us in 1863 his paper on the phenomena of the Glacial Drift of Scotland, in which he offered a masterly summary of all that was known on the subject up to the date of its publication, and settled for ever the claim of land-ice against ice-bergs to have been the agent that formed the Scotch Till; and now the other comes before us with the goodly volume, whose title stands at the head of this article, and which can be cordially recommended both to the geologist and the general reader. Its account of the labours and conclusions of previous workers is all but exhaustive, but it is far more than a mere *résumé*; a long practical acquaintance with Drift-deposits has enabled the author to add materially to our knowledge of the course of events that accompanied their formation, and in some cases has led him to demur to views hitherto all but universally accepted; and his own contributions and criticisms are as remarkable for the boldness of their originality as for the soundness of the reasoning by which they are upheld. At the same time the explanations are so full, and the method of handling so free from technicality, that with a moderate amount of attention the book may be understood, and its reasoning followed, by those who had previously little or no geological knowledge.

A large part of the work is taken up by a careful and detailed description of the Drift-beds of Scotland, which country the author has chosen as a typical area. A better selection could not have been made, for in no

country perhaps are these deposits so largely developed, and nowhere have they been so elaborately worked out as by the distinguished band of geologists who have made Scotch glacial formations a special study.

The first seven chapters are devoted to a description of the Till, the lowest member of the Scotch Drift; and an explanation of the line of reasoning that has led geologists to acquiesce almost unanimously in the opinion that it was formed on land beneath a sheet of ice, which, during a period of intense cold, overspread the whole country, and pushed its way far out over the shallow bed of the surrounding sea.

So far the author has only been repeating and enforcing the conclusions of his predecessors, but in chaps. 11—14 he enters on ground which is all but his own. It has been long known that layers of well-bedded sand and gravel occur in the heart of the Till, and between it and the older rocks. These deposits however are local and of small extent, or had been detected only in borings or underground workings, and had had comparatively little attention paid to them. Mr. J. Geikie has for the first time pointed out that in spite of their small development they are full of meaning; and that, when this meaning is realised, the fragmentary nature of their occurrence is only what is to be expected, and that the wonder is, not that there is so little of them left, but that any of them should have survived to tell the tale which he has so ably extracted from them. And the story they tell us is this. They are evidently the products of running water, alluvial or lacustrine deposits mostly; now former observers had realised in a vague sort of way that they were a proof of changes of climate, which permitted water to flow over what had been before an ice-bound waste, but we have now clearly brought before us that the abatements of the intense cold, which these beds indicate, were not local and temporary, but wide-spread and of long duration, and that they recurred several times during the period of the first great glaciation. Thus we are led to see that the first subdivision of the great ice-age was not one dreary unbroken lapse of Polar winter, but that it included mild intervals, when the ice shrank back, possibly disappeared altogether, when vegetation reappeared, and when herds of the great mammals returned from the southern retreats into which they had been driven during the most intense phases of the cold. And these facts enable us to realise more vividly the immense lapse of time represented by one division alone of the Glacial Formation. For if "we consider that the succession of changes happened not once only, but again and again, we cannot fail to have some faint appreciation of the lapse of time required for the accumulation of the Till and the Interglacial Deposits." Lastly Mr. Geikie has pointed out that these alternations of intense glaciation and comparative mildness are fully in accordance with the theory so ably expounded by Mr. Croll, that changes in climate are due to the combined effect of the Precession of the Equinoxes and variation in the eccentricity of the earth's orbit, a theory which he has lucidly expounded in chaps. 8—10.

We next come to certain deposits, the meaning of which seems first to have been clearly read by the author of the present work. At last the conditions which gave rise to the Till began to pass away and the climate to improve slowly, and the great glaciers ceased to be confluent; a depression of the land ensued so that the sea followed the retreating margin of the ice; but after a while, perhaps owing to an upward movement, the glaciers terminated on dry land. Mountain peaks now began to rise above the ice, and showered down on to its surface loads of *débris* torn from their exposed faces by frost. As the burden was shot over the ends of the glaciers, it gave rise to huge heaps of morainic rubbish, which at first fell into the sea, and afterwards, as the ice drew back, was shed upon the land. In this way were formed the subdivisions of the glacial formation which the author has distinguished as Boulder Clay and Morainic Rubbish. During this period the author believes that many of the erratic blocks, which form so conspicuous a feature among glacial deposits, were stranded from the ice-sheet as it drew back; and he gives good reasons for preferring this explanation to the older notion, which supposed these travellers to have been dropped from ice-bergs during the submergence which came a little later on.

As the climate gradually improved, the melting of the ice swelled the rivers and gave rise to mighty floods, which thundered down the narrow mountain glens, sweeping before them portions of the Till and Morainic rubbish, and, when they emerged on the open valleys of the lowlands, spread out the worn and rounded materials in broad sheets of gravel. One point here we must pause specially to call attention to. Geologists had long been aware of the disappearance of the great ice-sheet and of a gradual submergence of the land which followed it, but we now learn that the first of these events had made considerable progress, perhaps had been completed, before the second had fairly set in.

The first act of the drama we are looking at may be said to close here; the second opens with the commencement of the submergence just mentioned. The land began to sink and went down till the sea reached to some 1,200 feet, perhaps in some cases to nearly double that amount, above its present level; and as each of the previously formed Drifts, Till, Boulder Clay, Morainic Rubbish, and Gravel, was brought under the action of the waves, they sifted and sorted it, washing out the fine dirt, and rounding and reducing in size the pebbles; and in many cases the clean gravel and sand so formed were piled up along each successive coast line in mounds and long ridges, which still retain the distinctive outline originally impressed on them by wave- and tidal-action. These hummocky piles and ridges are known as Kames or Eskers. That many Kames owe their present shape in the main to the direct action of the sea alone there can scarcely be a doubt; we find them sometimes for instance enclosing hollows *without any outlet*, a little tarn or peat moss occupying in some cases the central depression, and in such a case they must have been piled up by shifting currents, for in no other way could the closed basin in the middle have been produced. But many so-called Kames are only the remnants of large sheets of gravel, the greater parts of which have been carried away by denudation. It would be better perhaps to restrict the term to those mounds which were piled up originally very much as they stand now. Even with this limitation, however, Kames are plentiful enough, and they are found in greatest abun-

dance at the spots where the currents tending to their formation must have prevailed as the land went down; in cols, then straits connecting opposite firths from which tides would flow in on either side; at the openings of mountain valleys, where the stream with its gravel burden was then met by the incoming tide; on low plateaus lying between what were then estuaries, over which opposing currents would sweep each high tide; and in other similar situations.

But were the Kames formed as the land sunk, or during its subsequent emergence? One would be inclined to say during the latter period, for any heaps piled up by the incoming sea would be liable to be swept away when they again became exposed to wave-action as the sea retreated. Nevertheless, Mr. Geikie—and he is supported by other observers in his opinion—holds that it was during the period of depression that kame-building went on, for the following reasons. The material of the Kames is, for the most part, fine and well rounded, and it is a very rare thing to find a large angular boulder in the heart of a Kame; hence it is believed that during the formation of the Kames the climate had so far mended that glaciers no longer existed, and that therefore there were no icebergs to strew the sea-bottom with travelled blocks. Erratics are, however, common perched on the outside of the Kames, and hence it is concluded that at some point in the period of the submergence cold again began to come on, that glaciers reappeared and gave rise to icebergs which bore away these blocks and dropped them where they are now found. That there was a return to cold conditions we know from other evidence, and with the exception of the difficulty just mentioned, which after all is not very serious, for the Kames we have may be only the relics of a body originally much more numerous, the explanation accords well enough with our knowledge of the facts. But the thought crosses the mind that it is not very often that we have an opportunity of seeing into a Kame, or rather, that we see the outside much oftener than the inside, and that this possibly may be the reason why erratics seem to be more plentiful in the one place than the other.

A. H. GREEN

(*To be continued.*)

OUR BOOK SHELF

Mineralogische Mittheilungen, 4th Heft. (Vienna, 1873.)

THE present number of the *Mineralogische Mittheilungen* forms the 4th volume of the series, commenced in 1870. It is published under the auspices of the K. K. Geol. Reichsanstalt, and in connection with their quarterly Jahrbuch, but forms properly in itself an independent journal. It is probably the only periodical devoted exclusively to mineralogy, and thus already occupies an important place among German scientific serials. The list of papers which appear in this number will give a good idea of the position which the journal occupies:—Mineralogical observations in the Argentine Republic, by H. Stelzner (embracing—minerals occurring in the granite quartz masses of Cordoba; minerals associated with the granular limestone; also analyses and special description of Triplite, Jamesonite, Enargite, Linarite, &c.); eruptive rocks of Banat, Hungary, by Niedzwiedzki; crystallised magnesite from the Northern Alps, by J. Rumpf; mineral observations from the Bohemian Forest, by Helmhacker; brief notices of various minerals, Grunochite, an optically uni-axial diamond, native copper, Roselite, &c. The number opens with a short obituary notice of Naumann.

The Mittheilungen are under the charge of Prof. Tschermak, so well known through the scientific world for his many and valuable contributions to mineralogy and lithology.

Prof. Tschermak occupies the position of Director of the Royal Mineralogical Museum of Vienna, a collection which in beauty and completeness is not inferior to that of the British Museum, while it surpasses the latter in the arrangement of the objects exhibited, especially in reference to the good of the general public. The Museum has been much enriched within the last four months by the acquisition of a number of interesting things from the Vienna Exposition. The collections are opened two mornings in the week, for the benefit of the public, opportunities which are well made use of, while the Cabinet is accessible on every week-day to those who are there engaged in regular work. The results accomplished in the Mineralogical School thus formed in connection with Prof. Tschermak and Dr. Schrauf do a considerable part toward supporting the *Mineralogische Mittheilungen.*

The Geological Reichsanstalt, now under the direction of Franz Ritter von Hauer, has carried on its work for twenty-seven years. The results are not only of the greatest importance in developing the resources of the Empire itself, but, as the work engages the best talent, and is consequently carried on according to the highest standard of pure science, the yearly labours are adding vastly to the fund of geological knowledge, and helping to solve many of the difficult problems of the science. The building occupied by the Reichsanstalt contains the various working-rooms, and the extensive collections, complete naturally in all matters pertaining to Austrian Zoology. The immediate results of the survey are first made known in the Evening Sessions, which are held on the first and third Tuesday of each month from November to May. They are attended regularly by some thirty or forty of those interested in such subjects, and form a pleasant opportunity for those of common interests to meet together informally. The stranger is continually impressed with the active spirit, and especially with the community of feeling, among the scientific men of Vienna; the latter has undoubtedy great influence in giving the city the prominent position which it occupies among the different scientific centres.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Zoological Nomenclature

FROM time to time an idea is started that Zoology is breaking down under the weight of its synonymy. With entomologists I have frequently contended that so far from this being the case, there is, on the contrary, an almost marvellous agreement in the generic and specific names used, especially when we consider the extent of the bibliography and the vast number of the species. After reading in NATURE, vol. ix. p. 258, Mr. Wallace's review of Dr. Sharp's pamphlet, I bethought myself of comparing the two best known catalogues of European Coleoptera, viz., Schaum's, published at Berlin, in 1862, and De Marseul's, at Paris, in 1866. Perhaps the results of the examination of the first six families in the two works will suffice. It must be premised that Schaum's is strictly confined to European species, while De Marseul's embraces as well those of the "basin of the Mediterranean in Asia and Africa." As to the genera, in the Cicindelidæ there are two in each. In the Carabidæ, Schaum has 98 genera and de Marseul 118; of the latter four are not adopted by Schaum and the remainder are extra-European. In the Dytiscidæ Schaum has 15 genera, De Marseul 17. In the Gyrinidæ there are two genera in Schaum, and three in De Marseul, the third being

extra-European. Hydrophilidæ not having the same limitation in the two works, I take the Palpicorn families in which that group and the Sphæridiidæ are included. There are 22 genera in each catalogue, but Schaum and De Marseul each ignore a genus adopted by the other, and a third name, Cyllidium, is preferred by the French author to the earlier one of Chætarthria. As to the species, seeing that Schaum has about 1,580 in the families mentioned above, and De Marseul 2,640, it would not be easy to compare them in a definite form; but taking Cicindela, the second genus of the two catalogues, the first having only one species, which is, I conceive, a fair example of the others, if indeed it has not had more than its share of varieties elevated to the rank of species, we find the 26 species in Schaum identical in names with the same species in De Marseul, except two varieties or species, and a synonym given with a ? by Schaum, which is the right name according to De Marseul.

I would venture to suggest that the synonyms which look so formidable to some of our friends, are principally due to the writers of local faunas, or in some cases to specialists, and that such names have, as a rule, never been adopted, and practically offer no hindrance whatever to the naturalist. A species may be described by an author who is ignorant that it has been previously described, but this is an evil which it is sometimes impossible to avoid, as in the case of almost simultaneous publication; but in due time the later name is relegated to the list of synonyms and gives little further trouble. It does not seem to me that any change or additions to the present rules of nomenclature are needed. Naturalists very soon decide on the relative value of names, but always with due regard to the law of priority; it is a misfortune, perhaps, that this law is sometimes pushed too far, as in the case either of forgotten authors, or of doubtful descriptions. The alteration of trivial names from two authors using the same word is a case of very rare occurrence.

FRANCIS P. PASCOE

The so-called "Meteor-cloud" of Feb. 5

YOUR correspondent, Captain S. P. Oliver, appears to have been mistaken as to the character of the phenomenon seen by him on February 5, and noticed in NATURE (vol. ix. p. 313). At the hour he has indicated, the somewhat rare phenomenon an auroral arch was formed, which remained visible for about half an hour, and is doubtless the luminous "meteor cloud" seen by him. The description Captain Oliver has given of it is sufficiently accurate, though he does not mention that it drifted slowly southward, a well-known characteristic of the phenomenon. Its direction was of course at right angles to the magnetic meridian, and its position in the heavens, as seen from this locality, was more northward than that observed by your correspondent. During the whole time that I observed it, the arch crossed some portion of the constellation Ursa Major, the star δ Ursæ Majoris being in its midst when first seen, and the entire arch having retreated southward as far as ζ Ursæ Majoris before it disappeared. It was of uniform breadth and intensity, and spanned the sky from west to east (magnetic), passing not much to the north of the zenith. Although I have been fortunate enough to have seen auroral arches upon several occasions, and once succeeded in obtaining the spectrum, I have never seen a brighter or more complete arch than this one; but what made it quite unique, at least as far as my experience goes, was the fact that the ordinary aurora with a well-defined "dark segment" was visible in the north-north-west at the same time, from which, at an earlier period, brilliant streamers had proceeded. There were therefore two parallel arches of light at an interval of perhaps 50° from one another, which the slow movement of the upper one gradually increased. The night was remarkably clear, and the zodiacal light had been plainly visible earlier in the evening.

JOHN J. PLUMMER

The Observatory, Durham, Feb. 21

Aboriginal Australian Artists

I NOTICED, in one of your latest papers, that some of your readers doubted the ability of Australian, or other low savages, to sketch in the manner of the Vezère people, and I made a copy of a few sketches still found in this neighbourhood engraved on rocks. They consist chiefly of fishes, whales, birds, and a few men; the execution is not so good as when the figures are scratched on blackened bark. I also send you a photograph of a carving in fossil coral from New Guinea. H.M.S. *Basilisk* has not long ago returned from New Guinea, and brought some splendid weapons, &c.; also one of the Papuan pigs, which they brought for our collection. It is the most intelligent pig I have ever seen, follows me like a dog, and goes up to the very top of the Museum building, which is about 80 feet high.

I noticed the, to me, wonderful remark about a scarcity of skeletons of large carnivora in European museums, and I am glad to say that we possess two tigers, two lions, wolf, hyæna, three grey seals, two large sperm whales, 70 and 35 feet in length, many small birds, dugongs, &c. &c. The sum total of our skeletons, all mounted, is more than 150; with few exceptions all articulated on the premises by one man, who has never been out of Sydney in his life. If our Government grant some extra money for cabinets, I think we shall be able to astonish the people on board the *Challenger* when they come here, because half our Australian fossils and minerals cannot be exhibited for want of the necessary cases.

GERARD KREFFT

P.S. The trustees have had so many applications for *Ceratodus* specimens, and they have been so often disappointed when exchanging them with other museums, that they have now determined to sell their duplicates in London to the highest bidders. Five of these fishes, in spirits (males and females) will be despatched to Messrs. P. W. Flower and Sons, and I hope that a good price will be obtained for them. Up to the present time all efforts to obtain more of the *Ceratodus* have been in vain, and I believe that they are not so common as some people think. Mr. George Masters has too much to do here; and besides, we have no funds, travelling being very expensive in the Wide Bay district, otherwise another Expedition would be sent by the Board. Mr. Masters knows *how* to catch them, and I hope that when the *Challenger* arrives he will be able to accompany a party from that ship to Gayndah.

Rainbow and its Reflexion

A FEW weeks ago I had the pleasure of seeing a rainbow and its reflexion, or at least a reflexion of one from the same shower at the same time, in smooth water.

The base of the bow in the cloud seemed but a few hundred yards from me, and the reflexion evidently did not belong to it, as the two bases did not correspond, the reflected bow lying inside the other, the red of the one commencing where the violet rays of the other disappeared.

Balbriggan, Ireland, Feb. 2 GEORGE DAWSON

Remarkable Fossils

THE letter by Mr. T. W. Cowan in NATURE, vol. ix. p. 241, confirms the truth of the statements contained in my "Appeal to our Provincial Scientific Societies" which appeared in NATURE, vol. ix. p. 162. Collections of the kind described by Mr. Cowan are "kicking" about the country in all directions, valued merely as temporary possessions by the owners, few of whom, as far as my experience goes, appear to possess sufficient public spirit or intelligence to realise their public and scientific importance; otherwise these collections would be more frequently localised and preserved for the district museum.

Jan. 31 S. G. P.

Volcanoes and the Earth's Crust

MR. HOWORTH, in NATURE, vol. ix. p. 201, advances the following opinions:—That volcanoes are found neither in regions of elevation nor of subsidence, but on the boundaries between them; that the great continents are on the whole rising, and the beds of the great oceans on the whole sinking; and that the centres of elevation are in the circumpolar regions.

It seems to me that the last two statements cannot be reconciled with each other. The southern hemisphere is for by far the greater part oceanic. According to Mr. Howorth, the ocean-beds are subsiding, and yet the southern circumpolar region contains a focus of elevation. Further: if volcanoes are not found in areas of elevation, and if the circumpolar regions are regions of elevation, what does he make of the volcanoes of Jan Mayen (between Norway and Spitzbergen), and of the Antarctic continent?

Were there any such laws of elevation and subsidence as Mr. Howorth maintains, the respective regions of elevation and of subsidence would have continued the same since the consolidation of the earth: but this is contradicted by the commonest facts of stratification, which show that elevation and subsidence have everywhere alternated with each other.

JOSEPH JOHN MURPHY

Old Forge, Dunmurry, co. Antrim

The Use of Terms in Cryptogamic Botany

As no specialist in Algology has replied to the inquiry of your correspondent "D. R.," in NATURE for January 15, I may be permitted to quote for his information the following from the article "Nucleus," in the "Treasury of Botany" from the pen of the author of the "Introduction to Cryptogamic Botany":—"In Algæ the term is applied to the fructifying mass of the Rhodosperms, whether contained in a single cell or in a compound cyst or conceptacle, the word *nucleoli* being used when there is a group of nuclei." The instance alluded to by your correspondent is, unfortunately, not the only one in which the terminology of cryptogams is in a state of most perplexing confusion.

ALFRED W. BENNETT

A Lecture Experiment

THE condensation of liquid in the form of vapour into minute globules, and the production of a shower of rain, may be very well illustrated for class purposes in the following manner:—

Place about an ounce of Canada balsam in a Florence flask, and let it boil. At the top of the flask clouds of globules of turpentine will be seen hovering about, altering in shape very much like sky-clouds, and the globules are large enough to be visible by the naked eye. If a cold glass rod be gradually introduced into the flask, these clouds may be made to descend in showers. By the adaptation of a lime-light the whole process could be shown on a screen.

LAWSON TAIT

TODHUNTER ON EXPERIMENTAL ILLUSTRATIONS

Segnius irritant animos demissa per aurem,
quam quæ sunt oculis subjecta fidelibus, et quæ
ipse sibi tradit spectator.

THE following is, as nearly as I can recollect, the substance of a few remarks which I felt myself compelled to make to my class in a recent lecture. I had exhibited and described Hope's apparatus for showing the maximum density point of water, and proceeded to say:—

Now that the freezing mixture has been applied, my assistant will from time to time record on the black-board the simultaneous indications of the two thermometers, and will recall our attention to the experiment as the critical period approaches. You must, however, in this form of experiment take for granted his fidelity and accuracy in reading and recording. By means of a somewhat cumbrous application of optical processes, it would be easy to project upon a screen images of the thermometers, in such a way that each of you might see for himself the course of the phenomenon. But the thermo-electric method, whose principle I have already explained to you, is at once far easier of application, and in its indications more directly expressive. This I will show on another occasion. For the present you must rely on the observations to be made for you by my assistant. Yet I have no doubt that all of you will allow that the exhibition of the experiment, even in this imperfect manner, wonderfully assists you in understanding its nature.

This leads me to mention that a very decided opinion against the use of experimental illustration has been recently pronounced by one of the most erudite and voluminous of British mathematicians; my own former tutor, Mr. Todhunter, whose name and many of whose works must be familiar to most of you. Such a man speaks, deservedly with authority, on many points; and therefore his dicta upon a point with which he shows himself to be totally unacquainted are especially dangerous. And I feel that it is my duty to point out to you, and warn you against, errors or absurdities connected with physics, whenever they come from one whose statements are, on other grounds, worthy of attention. I shall not trouble you with the whole passage I refer to in Mr. Todhunter's "Conflict of Studies," but merely read to you a sentence or two of the most astounding part of it. I premise that though he is speaking of the teaching of physical science in schools, his observations apply (if they have any basis whatever) to science-teaching in general.

"It may be said that the fact makes a stronger impression on the boy through the medium of his sight, that he believes it the more confidently. I say that this ought not to be the case. If he does not believe the statements of his tutor—probably a clergyman of mature knowledge, recognised ability, and blameless character—his suspicion is irrational, and manifests a want of the power of appreciating evidence, a want fatal to his success in that branch of science which he is supposed to be cultivating."

Verbal comment on this would be altogether superfluous, and the only practical comment I am disposed now to make is to proceed at once to farther *experimental* illustrations of the subject before us.

P. G. TAIT

POLARISATION OF LIGHT *

V.

THE conversion of plane into circularly polarised light may also be effected by total reflexion. If plane-polarised light traversing glass be incident upon the inner side of the limiting surface at any angle at which total reflexion takes place, it may be considered as resolved into two plane-polarised rays, the vibrations of one being parallel and those of the other perpendicular to the plane of reflexion; and there is reason to believe that in every such case a difference of phase is brought about which for a particular angle in each substance (in St. Gobain glass it is 54° 30′) it has a maximum value of one-eighth of a wave-length. And if the original plane of vibration be inclined at an angle of 45° to that of reflexion the amplitudes of the two vibrations, into which the reflected vibrations are supposed to be resolved, will be equal. A full discussion of the mechanical causes which may be considered to effect this difference of phase would carry us deeper into the more difficult parts of the Wave Theory than would be suitable in this place. But if we accept the fact that the above-mentioned effects result, when polarised light (whose plane of vibration is inclined at 45° to that of reflexion) is reflected at a proper angle; then the following construction will be readily understood. Take a rhomb of glass, *a, b, c, d*, Fig. 14, whose acute angles are 54° 30′; a ray incident perpendicularly to either end will undergo two total internal reflexions at the sides, say at *p* and *s*, and will emerge perpendicularly to the other end. These two reflexions will together produce a retardation, as described above, of one-fourth of a wave-length. And if the ray be originally polarised and its plane of vibration be inclined

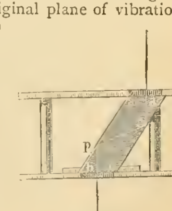


FIG. 14.

* Continued from p. 285.

at an angle of 45° to that of reflexion (that of the paper in the figure) the amplitudes of the two vibrations will be equal; and all the conditions will be fulfilled for the production of circular polarisation. Such an instrument was invented by Fresnel, and is called in consequence Fresnel's rhomb. On account of its length and its displacement of the ray, it is not so convenient as a quarter-undulation plate; but on the other hand it affects rays of all wave-lengths equally, while the quarter-undulation plate can strictly be adapted to rays of only one wave-length.

If either of these instruments be introduced and suitably placed between a selenite plate and the analyser, the chromatic effects will be similar to those due to a plate of quartz cut perpendicularly to the axis.

Another important property of these instruments consists in their effect upon circularly polarised light. Such light may be considered to arise from two plane-polarised rays whose vibrations are perpendicular to one another, and which present a difference of phase equal to a quarter of a wave-length. If, therefore, either a quarter-undulation plate or a Fresnel's rhomb be suitably placed, it will either increase or diminish the difference of phase by a quarter of a wave-length. In the one case the difference of phase will amount to a half wave-length, in the other it will vanish. And in either case the vibration will be converted into a rectilinear one; but the directions of vibration in the two cases will be perpendicular to one another.

Reflexion from a metallic surface may also be employed for converting plane into circular polarisation. If a ray of plane-polarised light fall upon a metallic reflector it is divided into two, whose vibrations are respectively parallel and perpendicular to the reflector; and the latter is retarded behind the former by a difference of phase depending upon the angle of incidence. If the plane of vibration of the incident ray be inclined to the plane of incidence at an angle (nearly 45°) which varies with the metal employed, but which is perfectly definite, the intensities become equal. And further, if the angle of incidence have a particular value dependent upon the nature of the metal (for silver 72°) the retardation will amount to a quarter of a wave-length. And the result will be a circularly polarised ray as in the case of total reflexion.

The apparatus (Fig. 15) best adapted for experiments based upon this principle is a modification of Norremberg's polariscope, suggested by Sir Charles Wheatsone, from whom the following description is quoted:—

"A plate of black glass, G, is fixed at an angle of 3° to the horizon. The film to be examined is to be placed on a diaphram, D, so that the light reflected at the polarising-angle from the glass plate shall pass through it at right angles, and, after reflexion at an angle of 18° from the surface of a polished silver plate S, shall proceed vertically upwards. N is a Nicol's prism, or any other analyser, placed in the path of the second reflexion. The diaphragm is furnished with a ring, moveable in its own plane, by which the crystallised plate to be examined may be placed in any azimuth. C is a small moveable stand, by means of which the film to be examined may be placed in any azimuth and at any inclination; for the usual experiments this is removed.

"If a lamina of quartz cut parallel to the axis, and sufficiently thin to show the colours of polarised light, be placed upon the diaphragm so that its principal section (*i.e.* the section containing the axis) shall be 45° to the *left* of the plane of reflexion, on turning the analyser from left to right, instead of the alternation of two complementary colours at each quadrant, which appear in the ordinary polarising apparatus, the phenomena of successive polarisation, exactly similar to those exhibited in the ordinary apparatus by a plate of quartz cut perpendicularly to the axis, will be exhibited; the colours follow in the order R, O, Y, G, B, P, V, or, in other words, ascend as in the case of a right-handed plate of quartz cut perpendicularly to the axis. If the lamina be now either inverted, or turned in its own plane 90°, so that the principal section shall be 45° to the right of the plane of reflexion, the succession of the colours will be reversed, while the analyser moves in the same direction as before, presenting the same phenomena as a left-handed plate of quartz cut perpendicularly to the axis. Quartz is a positive doubly refracting crystal; and in it consequently the ordinary index of refraction is smaller than the extraordinary index. But if we take lamina of a negative crystal, in which the extraordinary index is the least, as a film of Iceland spar split parallel to one of its natural cleavages, the phenomena are the reverse of those exhibited by quartz: when the principal section is on the *left* of the plane of reflexion the colours descend, and when it is on the *right* of the same plane the colours ascend, the analyser being turned from left to right.

"It has been determined that the ordinary ray, both in positive and negative crystals, is polarised in the principal section,* while the extraordinary ray is polarised in the section perpendicular thereto. It is also established that the index of refraction is inversely as the velocity of transmission. It follows from the above experimental results, therefore, that when the resolved ray whose plane of polarisation is to the left of the plane of reflexion is the quickest, the successive polarisation is right-handed, and when it is the slowest, the successive polarisation is left-handed—in the order R, O, Y, G, B, P, V and in the second case in the reverse order.

"The rule thus determined is equally applicable to laminæ of bi-axal crystals.

"As selenite (sulphate of lime) is an easily procurable crystal and readily cleavable into thin laminæ capable of showing the colours of polarised light, it is most frequently employed in experiments on chromatic polarisation. The laminæ into which this substance most readily splits contain in their planes the two optic axes; polarised light transmitted through such laminæ is resolved in two rectangular directions, which respectively bisect the angles formed by the two optic axes; the line which bisects the smallest angle is called the intermediate section; and the line perpendicular thereto which bisects the supplementary angle is called the supplementary section. These definitions being premised, if a film of selenite is placed on the diaphragm with its intermediate section to the left of the plane of reflexion, the successive polarisation is direct or right-handed; if, on the contrary, it is placed to the right of that plane, the successive polarisation is left-handed. The ray polarised in the intermediate section is therefore the most retarded; and as that section is considered to be equivalent to a single optic axis, the crystal is positive.

"In one kind of mica the optic axes are in a plane perpendicular to the laminæ. They are inclined 22½° on each side the perpendicular within the crystal, but, owing to the refraction, are seen respectively at an angle of 35°·3 therefrom. The principal section is that which contains the two optic axes. If the film is placed on the diaphragm with its principal section inclined 45° to the left of the plane of reflexion, the successive polarisation is right-handed. The ray, therefore, polarised in the section which contains the optic axes is the one transmitted with the greatest velocity.

"Films of uni-axal crystals, whether positive or negative, and of bi-axal crystals, all agree therefore in this respect:—that if the plane of polarisation of the quickest ray is to the left of the plane of reflexion, the successive polarisation is right-handed when the analyser moves from left to right; and if it is to the right of the plane of reflexion, other circumstances remaining the same, the successive polarisation is left-handed.

* The plane of polarisation is, throughout these pages, taken to be perpendicular to that of vibration.

"It must be taken into consideration that the principal section of the film is inverted in the reflected image; so that if the plane of polarisation of the quickest ray in the film is to the left of the plane of reflexion, it is to the right of that plane in the reflected image.

"It may not be uninteresting to state a few obvious consequences of this successive polarisation in doubly refracting laminæ, right-handed and left-handed according to the position of the plane of polarisation of the quickest ray. They are very striking as experimental results, and will serve to impress the facts more vividly on the memory.

"1. A film of uniform thickness being placed on the diaphragm with its principal section 45° on either side the plane of reflexion, when the analyser is at 0° or 90° the colour of the film remains unchanged, whether the film be turned in its own plane 90°, or be turned over so that the back shall become the front surface; but if the analyser be fixed at 45°, 135°, 225°, or 315°, complementary colours will appear when the film is inverted from back to front, or rotated in its own plane either way 90°.

"2. If a uniform film be cut across and the divided portions be again placed together, after inverting one of them, a compound film is formed, which, when placed on the diaphragm, exhibits simultaneously both right-handed and left-handed successive polarisation. When the analyser is at 0° or 90° the colour of the entire film is uniform; as it is turned round the tints of one portion ascend, while those of the other descend; and when the analyser is at 45° or $n90° + 45°$, they exhibit complementary colours.

"3. A film increasing in thickness from one edge to the other is well suited to exhibit at one glance the phenomena due to films of various thicknesses. It is well known that such a film placed between a polariser and an analyser will show, when the two planes are parallel or perpendicular to each other and the principal section of the film is intermediate to these two planes, a series of parallel coloured bands, the order of the colours in each band from the thick towards the thin edge being that of their refrangibilities, or R, O, Y, G, B, P, V. The bands seen when the planes are perpendicular are intermediate in position to those seen when the planes are parallel; on turning round the analyser these two systems of bands alternately appear at each quadrant, while in the intermediate positions they entirely disappear.

"Now let us attend to the appearances of these bands when the wedge-form film is placed on the diaphragm of the instrument, Fig. 15. As the analyser is moved round, the bands advance toward or recede from the thin edge of the wedge without any changes occurring in the colours or intensity of the light, the same tint occupying the same place at every half revolution of the analyser. If the bands advance toward the thin edge of the wedge, the successive polarisation of each point is left-handed; and if they recede from it the succession of colours is right-handed: every circumstance, therefore, that with respect to a uniform film changes right-handed into left-handed successive polarisation, in a wedge of the same substance transforms receding into advancing bands, and *vice versâ*. These phenomena are also beautifully shown by concave or convex films of selenite or rock-crystal, which exhibit concentric rings contracting or expanding in accordance with the conditions previously explained.

"4. Few experiments in physical optics are so beautiful and striking as the elegant pictures formed by cementing laminæ of selenite of different thicknesses (varying from $\frac{1}{2000}$ to $\frac{1}{60}$ of an inch) between two plates of glass. Invisible under ordinary circumstances, they exhibit, when examined in the usual polarising-apparatus, the most brilliant colours, which are complementary to each other in the two rectangular positions of the analyser. Regarded in the instrument, Fig. 13, the appearances are still more beautiful; for, instead of a single transition, each colour in the picture is successively replaced by every other colour. In preparing such pictures it is necessary to pay attention to the direction of the principal section of each lamina when different pieces of the same thickness are to be combined together to form a surface having the same uniform tint; otherwise in the intermediate transitions the colours will be irregularly disposed.

"5. A plate of rock-crystal cut perpendicular to the axis loses its successive polarisation, and behaves exactly as an ordinary crystallised film through which rectilinear polarised light is transmitted.

"By means of the phenomena of successive polarisation it is easy to determine which is the thicker of two films of the same crystalline substance. Place one of the films on the diaphragm E of the instrument (Fig. 15) in the position to show, say, right-handed polarisation, then cross it with the other film; if the former be the thicker, the successive polarisation will be still right-handed; if both be equal, there will be no polarisation; and if the cross film be the thicker, the successive polarisation will be left-handed. In this manner a series of films may be readily arranged in their proper order in the scale of tints.

"In the experiments I have previously described the planes of reflexion of the polarising mirror and of the silver plate were coincident; some of the results obtained when the azimuth of the plane of reflexion of the silver plate is changed are interesting.

"I will confine my attention here to what takes place when the plane of reflexion of the silver plate is 45° from that of the polarising reflector.

"When the principal sections of the film are parallel and perpendicular to the plane of reflexion of the polarising mirror, as the whole of the polarised light passes through one of the sections, no interference can take place, and no colour will be seen, whatever be the position of the analyser.

"When the principal sections of the film are parallel and perpendicular to the plane of reflexion on the silver plate, they are 45° from the plane of reflexion of the polarising mirror.

"The polarised ray is then resolved into two components polarised at right angles to each other; one component is polarised in the plane of reflexion of the silver plate, the other perpendicular thereto; and one is retarded upon the other by a quarter of an undulation.

"When the analyser is at 0° or 90° no colours are seen because there is no interference; but when it is placed at 45° or 135°, interference takes place, and the same colour is seen as if light circularly polarised had been passed through the film. The bisected and inverted film shows simultaneously the two complementary colours.

"But when the film is placed with one of its principal sections $22\frac{1}{2}°$ from the plane of reflexion of the polarising mirror, on turning round the analyser the appearances of successive polarisation are reproduced exactly as when the planes of reflexion of the silver plate and of the polarising mirror coincide. In this case the components of the light oppositely polarised in the two sections are unequal, being as cos $22\frac{1}{2}°$ to sin $22\frac{1}{2}$; these components respectively fall $22\frac{1}{2}°$ from the plane of reflexion of the silver plate and from the perpendicular plane, and are each resolved in the same proportion in these two planes. The weak component of the first, and the strong component of the second, are resolved into the normal plane, while the strong component of the first and the weak component of the second are resolved into the perpendicular plane.

"The apparatus (Fig. 15) affords also the means of obtaining large surfaces of uncoloured or coloured light in every state of polarisation—rectilinear, elliptical, or circular.

"It is for this purpose much more convenient than a Fresnel's rhomb, with which but a very small field of view can be obtained. It must, however, be borne in mind that the circular and elliptical undulations are inverted in the two methods: in the former case they undergo only a single, in the latter case a double reflexion.

"For the experiments which follow, the crystallised plate must be placed on the diaphragm E, between the silver plate and the analyser, instead of, as in the preceding experiments, between the polariser and the silver plate.

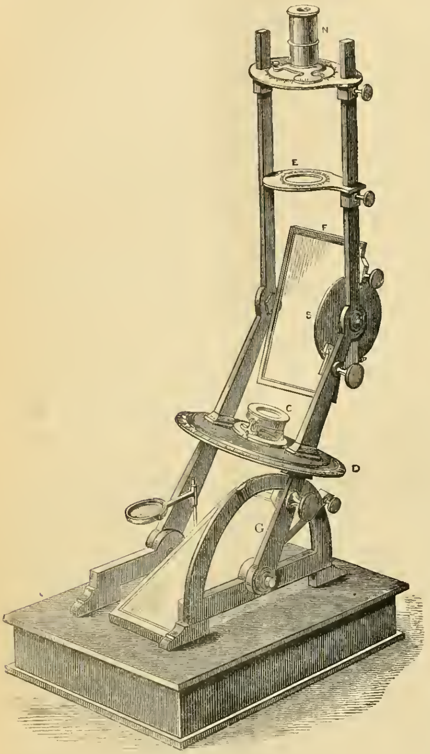


Fig. 15.—Wheatstone's modification of Norremberg's Polariscope.

"By means of a moving ring within the graduated circle D, the silver plate is caused to turn round the reflected ray, so that, while the plane of polarisation of the ray remains always in the plane of reflexion of the glass plate, it may assume every azithumal position with respect to the plane of reflexion of the silver plate. The film to be examined and the analyser move consentaneously with the silver plate, while the polarising mirror remains fixed.

"In the normal position of the instrument the ray polarised by the mirror is reflected unaltered by the silver plate; but when the ring is turned to 45°, 135°, 225°, or 315°, the plane of polarisation of the ray falls 45° on one side of the plane of reflexion of the silver plate, and the ray is resolved into two others, polarised respectively in the plane of reflexion and the perpendicular plane, one of which is retarded on the other by a quarter of an undulation, and consequently gives rise to a circular ray, which is right-handed or left-handed according to whether the ring is turned 45° and 225°, or 135° and 315°. When the ring is turned so as to place the plane of polarisation in any intermediate position between those producing rectilinear and circular light, elliptical light is obtained, on account of the unequal resolution of the ray into its two rectangular components.

"Turning the ring of the graduated diaphragm from left to right, when the crystallised film is between the silver plate and the analyser, occasions the same succession of colours for the same angular rotation as rotating the analyser from right to left when the instrument is in its normal position and the film is between the polariser and the silver plate."

The same principles apply to the case of bi-axal crystals cut parallel to a plane containing the two optic axes. A ray of plane-polarised light transmitted through such a plate is divided into two, whose vibrations respectively bisect the angles formed by the two axes. As mentioned above, the line which bisects the smallest angle is called the intermediate section, and the line perpendicular to it the supplementary section; and the order of the colours depends upon the relative velocity of the two rays. In selenite, the ray whose vibrations lie in the supplementary section is the slowest; in mica it is the swiftest. Hence these two crystals, all other circumstances being alike, give the colours in opposite orders, and may be regarded as positive and negative, like quartz and Iceland spar. And a test similar to that indicated for uni-axal may be applied to bi-axal crystals.

Some interesting and varied experiments may be made by using two circularly polarising instruments, *e.g.*, two quarter undulation plates (say the plates A and B), one between the polariser proper and the crystal (C) under examination, the other between the crystal and the analyser. The light then undergoes the following processes. If the plate A be placed so that its axis is at 45° on one side or other of the original plane of vibration, and the plate B with its axis parallel or perpendicular to that of A, then on turning the analyser we shall have the phenomena of circular polarisation described above. Again, if, the plates A and B retaining the positions before indicated, the crystal C be turned round in its own plane; then, since the light emerging from A and B is circularly polarised, it has lost all trace of direction with reference to the positions of polariser and analyser, and consequently no change will be observed.

Again, if the plates A and B have their axes directed at 45° on either side of the axis of C, and the three plates be turned round as one piece, the colour will remain unchanged, while if the analyser be turned, the colours will follow in the regular order. If the plates A and B have their axes directed at 45° on the same side of the axis of C, and the pieces be turned round bodily as before, the colours change in the same order as above, and go through their cycle once in every right angle of rotation; and if the analyser be turned in the same direction, the colours change, but in the reverse order. The explanation of this is to be found in the fact that when the plates A and B are crossed, the retardation due to A is compensated by that due to B; so that the only effective retardation is that due to the crystal C. But upon the latter depends the rotation of the plane of vibration; if, therefore, the polariser and analyser remain fixed, the colour will remain unaltered. When the plates A and B have their axes parallel, there is no compensation, and the colour will consequently change. It should be added that the rotation of the plane of vibration, and consequently the sequence of colours, does not follow exactly the same law in these cases as in quartz.

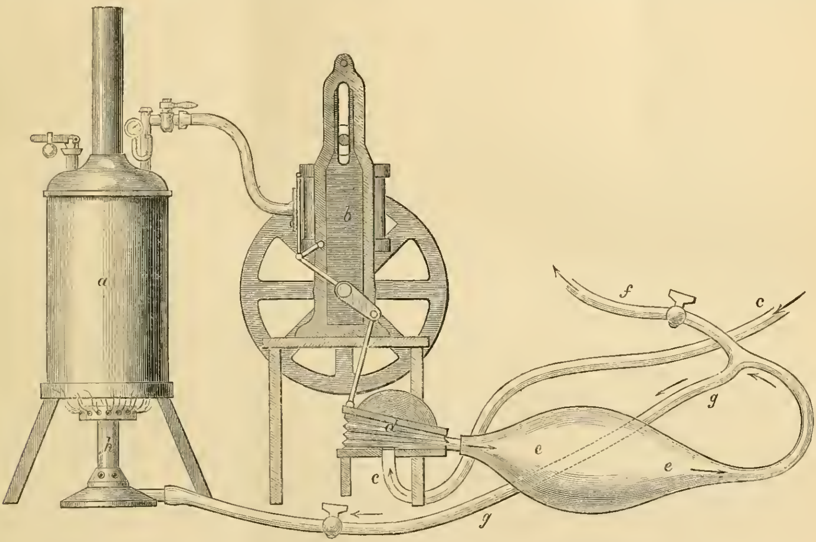
W. Spottiswoode

(*To be continued.*)

THE HEART AND THE SPHYGMOGRAPH*

IN the same way that by the spectroscope much can be learned as to the chemical constitution and the physical changes going on in the sun, so by the sphygmograph applied to the artery at the wrist many of the most important phenomena occurring in the heart can be studied with a facility that cannot be otherwise attained. Till the introduction of the sphygmograph of Marey the pulse was considered to be little more than a simple up and down movement, because the instruments employed to register it, such as those of Herisson, Ludwig, and Vierordt, developed so much momentum that the details of the true trace were disguised. In the instrument as at present employed, the substitution of counterbalancing springs instead of weights has so far improved its efficiency, that the pulse is now known to form a decidedly complicated curve if its movements are allowed to record themselves on a moving paper. The sphygmograph trace, as thus produced, gives indications in two directions; first, as to the action of the valves of the heart; and secondly, as to the manner in which the muscular walls of the ventricles perform their work. It is to the former of these subjects that most physiologists have directed their observations in employing the instrument; but it is to the latter, the more important of the two, that it is my intention to direct attention on the present occasion.

The heart being nothing more than a pump of a peculiar construction, much may be learned by comparing it with other artificially constructed machines for the same purpose. In most such machines the force which keeps the pump at work is constant in power, in other words it does not vary automatically in efficiency with the amount of work that is expected of it. In the locomotive engine, however, there is an arrangement by which the furnace becomes hotter as the speed at which it moves is increased, the waste steam pipe opening into the funnel and so varying the amount of the draught through the boiler tubes. With this arrangement it is nevertheless evident



Automatically Working-engine, when supplied with coal-gas.

that there is a great waste of fuel in the construction of the furnace.

It is quite possible to construct a steam-engine on much more economical principles, and the accompanying figure illustrates the manner in which the small engine on the table is at present working (see Figure). The boiler (*a*) being sufficiently heated, drives the engine (*b*), which performs work by pumping *coal-gas* from the tube *c* through the pump *d*, into the elastic reservoir *e*. From this elastic bag most of the coal-gas escapes, through the tube *f*, into an ordinary gas bag, but a tube (*g*) carries some of it to supply the Bunsen's burner (*h*) which heats the boiler. It is evident that with this arrangement the size of the flame of the Bunsen's burner (*h*), and therefore the pressure of steam in the boiler, which is the same as saying the efficiency of the engine, varies with the amount of work required of that engine; for the greater the pressure in the elastic bag, the harder is it for the engine to perform the work required of it, and the greater is the burner-flame. With a certain proportion between the sizes of the orifices of the taps and the extensibility of the elastic bag and tubes, it would be possible to arrange this engine in such a manner that, within certain limits, the velocity of the fly-wheel would not vary with the pressure in the elastic bag; in other words, with the work to be done. That the heart is a pump constructed on the same principle as this engine is the teaching of the sphygmograph, as far as it is in my power to interpret its curves, the proof resting on the following considerations.

First, the analogy between the anatomical distribution of the arteries and the different parts in connection with the engine is not difficult to trace. The coal-gas corresponds to the blood, the boiler (*a*) together with the engine (*b*) to the muscular tissue of the heart, whose left ventricular

* Abstract of a lecture delivered by Mr. A. H. Garrod at the Royal Institution on the evening of Friday, Feb. 6.

cavity has its analogue in that of the bellows (*d*). The elastic reservoir, together with the tubes, corresponds to the systemic arteries, the gas-bag connected with the tube *f* (the capillaries) to the systemic veins; and the tube *g* to the coronary arteries, which supply the muscular tissue of the heart with nutrient blood, just as it does the boiler by means of the burner *h*. This, however, does not show that the pumping power of the heart varies directly as the blood-pressure; that such is the case depends on the opportunity offered by the sphygmograph-trace for the estimation of the length of the ventricular systole under different circumstances. Each beat or revotion of the heart is divided into two main parts—(1) the period of contraction or systole, and (2) the period of repose or diastole. The former of these occupies the interval between the commencement of the primary rise and that of the dicrotic rise in the sphygmograph trace; the latter from the dicrotic rise to the commencement of the succeeding primary rise. In all good tracings from healthy pulses these two points, the primary and dicrotic rises, are readily found; and their relative lengths can be estimated with great accuracy. A large number of measurements have enabled me to prove that *the relative lengths of the systolic and diastolic portions of the pulse-trace do not vary for any given pulse-rate.* But, as will be granted by most physiologists who have worked at the subject, *the blood-pressure in the arteries is quite independent of the pulse-rate.* Consequently the heart may be doing very different amounts of work without any variation in the pulse-rate, which is the same thing as saying, with the same length of systole; which makes it evident that, as in the above-described engine, *the force of the cardiac muscular contraction varies directly as the blood-pressure*, knowing what we do about the flow of fluids through capillary tubes, and the capacity of the arterial system under different degrees of blood-pressure.

The sphygmograph trace tells us more than this. Though the length of the systolic portion of the beat does not change with any given pulse-rate, nevertheless it does so greatly with different rapidities of pulse; my observations showing that the length of the systole varies as the cube root of the whole beat, being found from the equation $xy' = 47 \cdot \sqrt[3]{x}$ when $x =$ the pulse-rate and $y' =$ the ratio borne by the systole to the whole beat. From this no other inference can be drawn than that the length of the diastole, or period of cardiac rest, during which fresh blood is circulating through the ventricular walls, must modify the contractile force of its muscular substance. The exact extent of this influence can be more readily estimated by a study of the cardiograph trace, which is obtained by applying the sphygmograph to the side of the chest at any spot where the pulsations of the heart are to be felt. It may, from the thus obtained curves, be demonstrated that if not exactly, approximately, at least, *the nutrition of the heart's walls must vary as the square-root of the length of the diastolic period.**

There is much, therefore, as I hope I have been able to show, to be learned respecting the action of the heart from measurement of sphygmograph tracings, and it is scarcely too bold to extend the generalisation to the properties of muscular tissue generally; for the fact that each beat depends entirely for its efficiency on the peculiarities in the blood-pressure and the duration of the previous diastole, removes all complications as to incompleteness of exhaustion, and all doubts as to the exact amount of work done by the muscular fibres themselves of that most perfect of engines, whose extreme perfection enables it to complete in most of us something like 750,000 beats in a week, and nearly thirty thousand million revolutions in a person by the time he is seventy years of age.

* *Journal of Anatomy and Physiology*, May and November, 1873.

*DR. VON MIKLUCHO MACLAY'S RESEARCHES AMONG THE PAPUANS **

WHEN lately at Buitenrovg—the scarcely euphonious equivalent of the "Sans Souci" of a former English Governor of Java—we had the good fortune to make the acquaintance of the owner of a name, whose peculiarity, no less than fame, has rendered it familiar to every biologist.

The friends—and we are sure they must be numerous—of Dr. Miklucho Maclay will regret to hear that he is determined, in spite of an aguish fever which still clings to him, and of, it is feared, some serious implication of the liver, to start again in a few days for the scene of his recent labours—the east coast of New Guinea, where he had previously spent fifteen months in close intercourse with the natives.

On September 19, 1871, the Russian corvette *Vitias* cast anchor in Astrolabe Gulf, and Dr. Maclay landed with two servants, one a Polynesian, the other a Swede. After a hut of very modest dimensions† had been built for him by the ship's carpenter, the *Vitias* weighed anchor on the 26th, and departed.

Dr. Maclay was soon left practically alone, and dependent entirely upon himself, for the Polynesian servant died early in December of a chronic fever which he had when he started, and the Swede soon followed suit, with the exception, that he did not die, but by constant ailing was a source of much encumbrance to his master.

As the natives were very distrustful, scarcely answering any questions, Dr. Maclay did not make much progress with the essential task of learning the language. Not only, however, were they suspicious, but determined to discourage the presence of the stranger by shooting arrows close to his head and neck, and pressing their spears so hard against his teeth, that he was constrained to open his mouth. Finding that he did not only not take the least notice of these annoyances, but that all his actions toward them were good (for, he being a doctor, his utility in the economy of the community was soon discovered), they concluded that he was no ordinary mortal, but that he was the veritable man-in-the-moon ("Kàramtâmo"), and paid him due respect accordingly.

As there were footpaths only in the neighbourhood of the villages, and as these latter were never found at a greater elevation than 1,500 feet, Dr. Maclay had some difficulty in making expeditions without guides, which at first were difficult to procure.

During his stay in New Guinea Dr. Maclay studied the inhabitants of the whole coast of Astrolabe Gulf; the people of the mountains round the gulf, and the dwellers on the islands near Cape Duperré, one of the boundaries of the gulf, who lived a life of such perfect peace that he called the islands "the Archipelago of Contentment." ‡ The inhabitants, too, of Dampier Island (Kar-kar) paid him visits. The inhabitants of "Maclay Coast," by which name Dr. Maclay proposes to call the coast skirting the edge of the Astrolabe Gulf, were of especial interest, as it seems that they have never been in intercourse with any civilised people, for not only were all their tools and weapons made out of stone, wood, or bone, but no trace of any European article could be found among them. These people treasured up, or exchanged as valuable, the smallest trifles which were given them, *e.g.* fragments of broken bottles, with which they shaved themselves, as a substitute for flint, or the sharp edges of grasses.

* "Anthropologische Bemerkungen ueber die Papuas der Maclay Küste in Neu Guinea." Reprint from the *Naturkundig Tijdschrift voor Nederlandsch Indie Deel* xxxiii. *Mijn Verblijf aan de Oostkust van Nieuw Guinea. Ibid.* (Batavia, 1873).

† Only 7 feet broad, and 14 feet long, and divided by a screen of sailcloth into two rooms, one for his servants, the other for himself. The hut was situated on the south coast of Astrolabe Gulf, midway between the two capes, its boundaries.

‡ "Archipel der zufriedenen Menschen."

Dr. Maclay told us of one curious custom which he does not mention in either of the two papers referred to in the note. The Papuans, though they know how to produce fire by rubbing together two pieces of wood, do not do this when they require this agent, but always carry their fire literally about with them, either trailing a lighted stick after them as they walk, or placing the same under their beds when they sleep.

Dr. Maclay, despite much pains, was only able to collect ten skulls, and only two out of these had the lower jaw, for the natives preserve this with great veneration, while the skull itself is thrown into the neighbouring jungle as a thing of no worth. The skull of the Papuans of Maclay coast is "dolicho-cephalic." The superciliary eminences are frequently very strongly developed The maxillary region is prognathous, so that the upper teeth project considerably beyond those of the mandible. The Papuans are of middle stature, the females being considerably smaller than the males, but are strong and well built.

Contrary to what has been written, there is no roughness of skin considerable enough to constitute a race characteristic ; which may be largely accounted for by the custom of smearing the bodies with a kind of earth, and to the frequency of psoriasis ("masso"). The colour of the skin too is in general of a light chocolate brown, and not of a bluish-black colour as has been previously asserted. The inhabitants of New Ireland, an island not far distant, have, on the other hand, a comparatively dark skin. The scars of slight wounds, *e.g.* such as are made with a red-hot coal, are somewhat darker than the surrounding skin, while deep wounds, which are of not infrequent occurrence, leave behind them scars almost white in colour.

After a series of very careful observations, made as well upon shaven as upon well-covered scalps, Dr. Maclay concludes that the hair is not naturally disposed, as has been represented, in tufts or clumps, but grows just as it would upon the head of a European. The length of the hair, too, varies in different individuals, for while one man is fain to cover his bald pate with a cuscus,* another is proud to display a "gatessi," which luxuriantly covers his shoulders.†

The natural colour of the hair is dull black, but this is marked, after the period of childhood, by a black ("kuma") or red ("surru") dye. The hair of children is covered with a wash of ashes and water for protection against lice ; this hardens into a thick crust. In the case of males this is continued till the time of circumcision, after which period much care is bestowed upon the coiffure. The women, oddly enough, expend no pains upon the arrangement of their hair. The eye-brows are generally shaven, and the hairs of the beard are either shaven or plucked out in the young men, but are permitted to grow among adults.

The general hair-growth upon the body seems to be more scanty than it is among the Caucasian races. Though hair is never seen on the back of the hands, it sometimes grows pretty thickly along the line of the vertebral column, and is sometimes so far extended as to cover the whole of the buttocks.

With regard to the physiognomy, the forehead is not high but small, and sometimes retreating ; the nose is broadly flattened out, frequently with dilated nostrils ; the mouth is broad, and has a projecting upper lip ; the chin is retreating, while strongly projecting cheek-bones strikingly contrast with the smallness of the forehead in the temporal region.

The Papuans of Maclay coast bore a hole through the septum of the nostrils, in which a long fragment of stone or piece of shell is worn. The teeth are much worn through the almost exclusive use of a vegetable diet : Dr. Maclay noticed this in his own teeth after a stay of eight months in Papua. The lobules of the ears are pierced at an early age by means of the thorn of a *Dioscorea* and become much elongated by having to support heavy ear-rings.

If the back of a Papuan is seen in profile, there will be noticed a considerable concavity of curve in the lumbar region. This would seem to be a characteristic in which the Papuan differs from the Caucasian race. The Papuans make a greater use of the left hand and arm than of the right, and use the feet to pick up various objects—sometimes very small ones—from the earth. This is done, not by flexion of the toes, but by anadduction of the great toe, which is considerably separated from the rest of the toes. From this use of the,toes, it frequently happens that the two feet are dissimilar in size.

Circumcision is performed at from the ages of 13 to 15 years, and, as Zipporah performed it, with a sharp flint. This custom is general among the Papuans of Maclay coast, and among most of the coast and some of the mountain inhabitants. Those—and among them are the New Irelanders and the inhabitants of one of the Islands of the Archipelago of Contentment—who do not use this rite are looked down upon by their circumcised brethren. The suckling of infants is carried on for a long period, sometimes to the age of four years.

The Papuans are very strict in their sexual relations. The men marry early, soon after circumcision, and have only one wife ; concubinage is almost unknown. The women, probably on account of the hard work in which they are engaged, seldom bear many children.

In spite of the dark colour of their skin, Dr. Maclay was able to recognise a change of colour in the face among the Papuans. He does not, however, state whether blushing follows upon a sense of shame, but only notices that the features are darker when they are overjoyed, or have been making great efforts, *e.g.* in the dance.

The Papuan women, like their European sisters, cultivate the art of which Mr. Turveydrop was the distinguished professor. Readers of the "Arabian Nights may remember how that the seductive wriggling of the sides of one of the damsels "shaped like the letter alif," caused the "world to turn black" before the eye of a susceptible hero, and will therefore fully appreciate the subtle influence of a peculiar and "killing" wriggle which the Papuan maid begins to have at even the tender age of seven years. The half-caste women whom one sees at Batavia seem to have adopted a similar though modified habit.

The favourite position of the Papuan men—as it seems to be among the Malays also—is resting the buttock upon the heels (*das Hocken*), while the whole surface of the soles of the feet is applied to the ground. Dr. Maclay found that he could keep his balance only when the toes alone were in contact with the earth. This position of the Papuan must not only be acquired, but must depend also upon a peculiar relation of proportion in the limbs. Nothing can be said with certainty as to the duration of life among the Papuans. Dr. Maclay never saw an old individual among them.

Dr. Maclay, from the observations which he has at present made, concludes that *the Papuan stock falls into numerous varieties, distinct from one another, which, however, have no sharp lines of demarcation.*

On December 19, 1872, some natives came to Dr. Maclay to inquire the cause of some smoke which had been seen rising from the sea between Vitias and Dampier Islands. This turned out to be the clipper *Izoumroud*, which had been sent out to look for the traveller (whose death, it seems, had been announced in the English journals), at the instance of the Grand Duke Constantine.

Early on the morning of the 24th the *Izoumroud* weighed anchor, and as she steamed away there could

* A small marsupial found in Papua. It is figured in Wallace's "Malay Archipelago."

† The long hair worn at the back of the head is termed "gatessi."

be heard all along the coast the sound of the Bâroem, a great wooden gong, announcing to the islanders the departure of the "man-in-the-moon," who had taken up his abode for more than a year amongst them.

JOHN C. GALTON

MICROSCOPIC EXAMINATIONS OF AIR

A WORK* of the greatest importance on the above subject has just been published in Calcutta by Mr. Douglas Cunningham. The conclusions which he has reached as the result of the experiment are so valuable that we deem it right to give them as great publicity as possible. The following is Mr. Cunningham's description of the aeroscope with which he made his experiments:—

The apparatus employed in obtaining specimens was a slightly modified form of that devised by Dr. Maddox. It consisted of three thin brass tubes, two of which slipped over the third central one and came into contact with the opposite side of a projecting rim on its circumference. This rim was formed by the margin of its diaphragm which divided the centre tube into two chambers. It was of sufficient thickness to allow of a spindle passing up through it. The latter terminated in a pointed extremity, which came in contact with the upper end of the bearing, and provided for the free rotation of the system of tubes. Round the margin of the diaphragm there was a set of perforations, to allow of the passage of air through it, and, on the centre of its anterior surface, there was a square plate of glass with a slightly projecting rim on its lower margin. The anterior of the two lateral tubes was provided with an expanded orifice, and contained a small, finely-pointed funnel in its interior; the pointed extremity opening immediately in front of the centre of the diaphragm-plate. The posterior tube was quite simple, and had a good-sized fish-tail vane fitted into a slit in its extremity.

The following are Mr. Cunningham's conclusions:—

The most important conclusions to be derived from all the preceding experiments regarding the dust contained in the atmosphere in the vicinity of Calcutta appear to be the following:—

1. The aeroscope affords a very convenient method for obtaining specimens really representing the nature of the true atmospheric dust.

2. Specimens of dust washed from exposed surfaces cannot be regarded as fair indices of the constituents of atmospheric dust, since they are liable to contain bodies which may have reached the surface otherwise than by means of the air, as well as others which are the result of local development.

3. Specimens collected by gravitation also fail to indicate the nature and amount of organic cells contained in the atmosphere, as the heavier amorphous and inorganic constituents of the dust are deposited in relative excess due to the method of collection.

4. Dew also fails to afford a good means of investigating the subject, as it is impossible to secure that all the bodies really present in a specimen of it should be collected into a sufficiently small space, and, moreover, because it is liable to accidental contaminations, and also affords a medium in which rapid growth and development are likely to take place.

5. Distinct infusorial animalcules, their germs or ova, are almost entirely absent from atmospheric dust and even from many specimens of dust collected from exposed surfaces.

6. The cercomonads and amœbæ appearing in certain specimens of pure rain-water appear to be zoospores developed from the mycelial filaments arising from common atmospheric spores.

7. Distinct bacteria can hardly ever be detected among the constituents of atmospheric dust, but fine molecules of uncertain nature are almost always present in abundance; they frequently appear in specimens of rain-water collected with all precautions to secure purity, and appear in many cases to arise from the mycelium developed from atmospheric spores.

8. Distinct bacteria are frequently to be found amongst the particles deposited from the moist air of sewers, though almost entirely absent as constituents of common atmospheric dust.

9. The addition of dry dust, which has been exposed to tropical heat, to putrescible fluids is followed by a rapid development of fungi and bacteria, although recognisable specimens of the latter are very rarely to be found in it while dry.

10. Spores and other vegetable cells are constantly present in atmospheric dust, and usually occur in considerable numbers: the majority of them are living and capable of growth and development; the amount of them present in the air appears to be independent of conditions of velocity and direction of wind; and their numbers are not diminished by moisture.

11. No connection can be traced between the numbers of bacteria, spores, &c., present in the air and the occurrence of diarrhœa, dysentery, cholera, ague, or dengue; nor between the presence or abundance of any special form or forms of cells, and the prevalence of any of these diseases.

12. The amount of inorganic and amorphous particles and other *débris* suspended in the atmosphere is directly dependent on conditions of moisture and of velocity of wind.

If these results be compared with those obtained by other observers, and detailed in the first section of this report, it will be seen that they agree very closely with those of M. Robin, only differing from them in indicating the presence of a somewhat larger number of spores than appeared in his observations. They differ almost equally from those arrived at by Pouchet and Ehrenberg. It is somewhat difficult to understand how the former observer so constantly failed to detect the presence of spores in his experiments, but there is an apparent reason for Ehrenberg's observation of the predominance of animal forms in the atmosphere. His conclusions appear to have been almost entirely founded on the results of the examination of specimens of dust not directly obtained from the air, but from surfaces on which it had been previously deposited from the air, such as leaves, tufts of moss, &c. Now, as has already been indicated, it is certainly quite unwarrantable to assume that all organisms found in such specimens existed as such in the air, or were even derived from the air in any way. All such surfaces are more or less liable to contact-inoculation; leaves and moss, for example, are liable to this through the agency of insects or birds. Moreover, with regard to many of the organisms detected in such situations, it must be recollected that there is no reason why they should not have arrived there by means of active progression over the surface. When surfaces are wet with rain, there is no reason why Tardigrades, Rotifers, Anguillulæ, and many infusoria should not travel over them from one point to another. The journey accomplished at any one time may be small, and its progress soon arrested by defective moisture; but, unless they are deprived of vitality in the interval by desiccation, they are ready for a fresh start when favourable conditions are again presented to them.

It is hardly safe to venture on the vexed questions regarding the origin of bacteria, but it may, at all events, be stated that the results of the present experiments are certainly not opposed to the belief in the transmission of these organisms in some way or other by means of the atmosphere; for they were actually observed among the particles in moist air, the addition of dry dust to putre-

* "Microscopic Examinations of Air," by D. Douglas Cunningham, M.B. Surgeon H.M. Indian Medical Service (Calcutta).

scible fluids was followed by their rapid development, and they appeared in specimens of pure rain water.

Although these observations may not appear to encourage the hope of success in discovering the presence of atmospheric particles connected with the origin of disease, it must not be forgotten that they only refer to bodies distinguishable from one another *whilst in the air*, the possibility remaining that many of the finer molecules present in it are really of different natures, and may yet be distinguished from one another by means of their actions or developments. Many interesting questions are suggested in connection with the fact of the presence of such considerable numbers of living cells in the air. What becomes of them when drawn into the respiratory cavities of animals? Is their vitality destroyed, and, if so, how are they got rid of? Are they ever capable of undergoing any development within the organism, and do they then exert any prejudicial influence on the recipient? These and similar questions can only be answered by means of patient and extended experiment, but even such imperfect and superficial observations as the present will, I trust, serve a useful purpose in clearing away a few of the preliminary obstacles from the path of investigation.

NOTES

A SPECIAL General Meeting of the Linnean Society is to be held on Thursday, March 5, at 8 P.M., "to consider alterations in the Bye-laws of the Society;" when it is expected a full explanation will be given of the reasons which induced the Council to make the alterations recently adopted by the Society, which met with such violent opposition from a small section of the Fellows. It is understood that Mr. Bentham, who has occupied the chair of the Linnean Society for the past eleven years, will not offer himself for re-election at the ensuing anniversary. The custom of the Society requires that the next president shall be a Zoologist, but students of both branches of Biology will be glad to learn that Prof. Allman has allowed himself to be nominated. Few naturalists would bring to the office a wider, and none a more sympathetic knowledge.

MR. HIND writes to the *Times* that he has received from Prof. Winnecke, Director of the Observatory at Strasburg, the following position of a comet discovered by him in the Constellation Vulpecula on the morning of Saturday last:—February 20, at $17^h\ 16^m\ 40^s$ mean time—right ascension, $20^h\ 35^m\ 34{\cdot}2^s$; north declination, 26 deg. $0^m\ 46^s$. The diurnal motion in right ascension is 9^m increasing, and in declination 1 deg. 30^m towards the south.

PROF. ASA GRAY has been appointed to fill the Chair in the Board of Regents of the Smithsonian Institution, previously occupied by the late Prof. Agassiz.

THE Rev. Dr. Thomas William Jex-Blake, Principal of Cheltenham College, has been elected Head-Master of Rugby School, in succession to Dr. Hayman.

A BARONETCY has been conferred upon Dr. George Burrows, F.R.S., President of the Royal College of Physicians.

WE would direct the attention of Palæontologists and others who are specially interested in the Cephalopoda, to a paper by M. Munier-Chalmas, in the *Comptes Rendus* for Dec. 29, 1873, which is translated in the current number of the *Annals and Magazine of Natural History*, in which, from a study of their earliest stages, the generally accepted systematic position of the Ammonitites and Goniatites is stated to be inaccurate, they being shown to be dibranciate decapoda allied to Spirula, and not tetrabranchiata at all.

THERE are two islands named St. Paul in the ocean: one close to the Equator was visited lately by the *Challenger;* the other, south of the Cape of Good Hope, is to be visited by a French expedition under Capt. Mouchez, for observing the forthcoming transit of Venus, as we stated in our last number. The identity of name has created a singular confusion. The French administration having decided that no naturalist was needed for St. Paul, the *Challenger* having explored the island a few months since, M. Mouchez had some trouble, it is said, to get the decision reversed by the authorities. Both islands, southern and northern, are almost of the same microscopical size and equally barren. They are of volcanic formation, with no trace of vegetable earth, and consequently of vegetation.

A TELEGRAM from Melbourne, dated February 17, states that Colonel Egerton Warburton has reached Perth, in Western Australia, overland from Adelaide, having thus accomplished the object of the exploring expedition on which he left Tennant's Creek, north of Adelaide, in the centre of Australia, about twelve months ago. Colonel Warburton's explorations embrace a portion of the interior of Western Australia hitherto unknown. The distance traversed is over 1,000 miles of longitude, the expedition having been conducted by means of camels, and was fitted out by the munificent liberality of the Hon. Thomas Elder, M.L.C., and Mr. W. W. Hughes. Another expedition under Mr. Gosse, conducted with horses at the expense of the Government of South Australia, has not been so successful. Mr. Gosse, amid many difficulties caused by want of water and the barren nature of the country through which he passed, managed to reach as far as E. long. 129° 59′ in lat. 26° 32′ S., the total distance traversed irrespective of numerous turnings and windings, being not less than 600 miles. His most notable discovery was made in lat. 25° 21′, long. 131° 14′, being a hill consisting of one solid rock (fine conglomerate) or huge natural monolith two miles long, one wide, and 1,100 feet high, with a spring coming from its centre; Mr. Gosse named it "Ayres Rock." Both expeditions are highly creditable to the enterprise of South Australia, which, as our readers know, has succeeded in carrying a line of telegraphy right across the country, from Port Augusta to Port Darwin.

THE enterprise of the Australian Colonies is producing really valuable scientific results, as will be seen from the following telegram, dated Dec. 22, published in the *Brisbane Courier*, from Mr. G. Elphinstone Dalrymple, commander of the Queensland North-east Exploring Expedition:—"The coasts, harbours, inlets, navigable rivers, and creeks have been examined from latitude 18° 15′ to 15° 15′ S. The Bellenden Kerr mountain range has been successfully ascended, and found to be a complete 'razor back' of granite. Palms were found on the summit; but although the botanical discoveries were interesting, they have not borne out all that was anticipated from them; 144 miles of soundings and 371 compass cross bearings have been taken in 19 navigable rivers and creeks of which the North and South Johnstone, the Mulgrave and Russell, drain the Bellenden Kerr range; the Mossman and Daintree drain the Arthur Palmer range inside the Schnapper Island. This range is nearly as lofty as the Bellenden Kerr, and is 25 miles in length. New rivers have been discovered penetrating a jungle-clad country of thoroughly tropical character, covered with a new rich soil suitable for sugar and other tropical cultivation. The extent of this country is roughly estimated at, in the aggregate, half a million acres, thus at once placing Queensland on a par with other favoured tropical countries. Mr. Hill has collected 3,000 botanical specimens, roots, and blocks of timber; 130 shells of five genera and eight species; 42 specimen bags of soils. Mr. Johnstone has collected 30 specimens of interesting birds, insects, and reptiles; and I have obtained 93 geological specimens."

The French Society of Geography and the Commission delegated by the Syndical Chambers of Commerce of Paris have instituted a "Commission of Commercial Geography." This Commission has for its object—1. To spread in France, either by education or by publications, information relating to commercial geography; 2. To pursue the organisation or development, from an industrial and commercial point of view, of explorations in all quarters of the globe; to take part in researches relative to existing routes or to create new ones; 3. To point out the natural riches and the manufacturing processes which may be utilised by commerce and industry; 4. To inquire into all questions relating not only to the development of French colonisation, but also to the colonial systems of the various civilised nations. The Commission is divided into four sections corresponding to the above, and in the interval between the general meetings these sections hold stated *séances* for discussing questions, their decisions being submitted to the approbation of the Commission.

The Paris Jardin d'Acclimatisation has just received a flock of six magnificent male ostriches and twelve females presented to it by General Lacroix-Vaubors, who holds a high command in Algeria. All attempts to breed these birds have hitherto proved futile, but a new attempt is to be made under the sun of Provence. The six ostriches will not remain long in Paris, and are to leave soon for Hyeres, where the Acclimatisation Society possesses a large estate.

The Meteorological Society of France has decided upon holding its next Biennial Exhibition at the Palais de l'Industrie, Champs Elysées: it is to be an International one. The expenses being paid by the Government, no charge will be made for exhibiting. A special circular will be sent to the English Society this year.

The *New York Tribune* in calling attention to the unauthentic character of a story to the effect that the non-existence of the companion star of Procyon, and of all except two of the satellites of Uranus, had been determined by the new telescope at Washington, announces the first important result obtained from this instrument. The recent observations have resulted in the rediscovery of the two smallest moons of Uranus, which have been not only distinctly seen on several occasions, but have actually been measured by Prof. Newcomb and his assistant, Prof. E. L. Holden. The two larger moons of Uranus, first discovered by Sir Wm. Herschel, are well-known objects, and can be seen under favourable circumstances with any telescope of 12 in. aperture. The two smallest were first discovered by Lassell, about twenty years ago, through the fine instrument attached to his private observatory near Liverpool; but his observations were very unsatisfactory (scarcely, indeed, determining the exact number of moons), and it was not until he renewed his researches at Malta that he obtained any accurate indications. Since that time, and until this re-discovery, no one has seen these satellites, and their detection and accurate observation through the Washington instrument is gratifying evidence of its superior power.

Mrs. Mary Treat publishes in the *American Naturalist* for December 1873 a remarkable contribution to our knowledge of the sensitiveness of the leaves of the sundew, her experiments being chiefly made on the large American species *Drosera filiformis*, the leaves of which capture and kill moths and butterflies two inches across. Her observations are in accordance with those already recorded on English species, that the motion of the glands is excited only by organic substances, or if for a very short time by mineral substances, that the excitement passes off almost immediately. The most astonishing of her observations is, however, that when living flies are pinned at a distance of half an inch from the apex of the leaf, the leaf actually bends towards the insect until the glands reach it and suck its juices. In the *Naturalist* for January is an account of Roth's observations on the irritability of the sundew, made nearly a century ago.

We have before us the first number of what seems to us likely to be a most useful work—"Insects of the Garden; their habits," &c., by Dr. A. S. Packard. The present number contains 32 pp. with woodcuts and a coloured plate, and is published at 25 cents. It forms part of a work called "Half hours with Insects," to be completed in 12 parts.

An advance sheet of the forthcoming number of Petermann's *Mittheilungen* contains an official account of the voyage of Count Wiltschek in the summer of 1872 to Spitzbergen and Novaya Zemlya in the yacht *Isbjörn*, the chief object of which was to plant a provision depôt in the Arctic Sea for the Austro-Hungarian expedition under Weyprecht and Payer in the *Tegethoff*. The account contains some valuable observations on the ocean-currents, temperature, weather, wind, &c., of the region, and the geology of Novaya Zemlya; collections of the fauna and flora of that island were made, and photographic views were taken. Nothing is known at present of the Austro-Hungarian expedition in the *Tegethoff*, though it is probable that she may be wintering somewhere on the coast of Siberia.

The Government of Peru have for some years been expending vast sums of money in exploring the little known portions of Peru which lie to the west of the Andes, and Señor Raimondi, a scientific man of the highest character, has, in the service of the Government, been also exploring the remote valleys between the Cordilleras, and at the head waters of many of the rivers which flow down the northern slopes to the eastern plains, a work in which he has been engaged for twenty years. The announcement is now made that the labours of Señor Raimondi are to be utilised in the publication, by the Government, of a magnificent illustrated work, which is to embrace a narrative of his explorations, and the result of all his researches upon the geography, natural history and climate of Peru.

In a "Note Additionelle," by Mr. Albert Lancaster, of the Belgian Academy, to Mr. W. T. Brigham's memoir on "Volcanic Manifestations in New England, 1638—1870," published by the Boston Society of Natural History, the author records a number of earthquakes omitted in Mr. Brigham's memoir. Taking all the recorded earthquakes in New England during the last three centuries, the author finds that ·2 occurred yearly during the seventeenth century, 1·2 during the eighteenth, and 2·0 during the nineteenth, though on account of the imperfect data of the seventeenth and eighteenth centuries, he thinks that 2·0 per annum may be taken as the average annual number of earthquake phenomena in New England. If the number of earthquakes during the three centuries be examined in reference to the months in which they occurred, it will be found that there are two distinct maxima and minima, both showing an equality almost to a unit; the former fall in February and November, the latter in April and September, and they are to each other as 3·6 : 1. Dividing the number of earthquakes according to the seasons in which they occurred, it is found that eighty-seven occurred in winter, forty-three in spring, forty-three in summer, and ninety-one in autumn. Enough is not yet known of the geological constitution of New England to enable us to explain these remarkable results, though it is hoped that the researches at present carried on by the U.S. geological officials may ere long enable us to do so.

The existence of gigantic Cephalopoda in American waters has long been suspected, and at last a large specimen of a "squid," or sepia, has been captured and preserved. The measurements, as given by the Rev. M. Harvey, of St. John's, Newfoundland, are, length of body, 7 ft.; circumference, 5 ft.;

length of two tentacular arms, 24 ft. each; eight pedal appendages, 6 ft. in length, and 9 in. in circumference nearest the head; the sucking-discs are denticulated, and in some instances measure $1\frac{1}{4}$ in. in diameter. This individual has been preserved, and its measurements are therefore authentic; but still larger specimens are believed to exist, and an account is given of an encounter between some fishermen and a huge creature which, on being struck by them, attacked their boat by twining its arms round the vessel. Two of the arms were cut off by a fisherman, when the squid moved off, ejecting a large quantity of inky fluid to cover its retreat. A portion of one of these arms, measuring 19 ft., has been preserved, but it is said that 6 ft. of it were destroyed, while the fishers estimate that they left 10 ft. more on the body of the squid. This would bring its length to 35 ft. It is to be hoped that more care will in future be taken to prevent the mutilation of specimens; and the capture of the first-mentioned one will, no doubt, excite the fishermen and others to greater care and exertions in looking out for still larger examples. The first squid was caught in Logy Bay, Newfoundland. The encounter with the second took place off Portugal Cove, Conception Bay, about 9 miles from St. John's.

AT a recent meeting of the Essex Institute (Salem, Mass.), Mr. Byron Groce of Peabody read a paper on "The Study of Natural History in Schools," in which he advocated its introduction by substituting it for some of the less useful studies now pursued. He also gave an account of the method he had followed in the High School of Peabody, stating that during the summer he took his school into the woods and fields for a half day each week, taught the scholars to collect specimens and preserve them properly; then had the specimens arranged in the school cabinet, and on unpleasant days in the winter they were used for instruction. In this way a lively interest had been created in the school, and a Natural History Club had been formed among the scholars for the purpose of carrying on the study.

A NEW illustrated weekly newspaper is announced for first appearance on March 7. The title is the *Pictorial World*. We trust the projectors will be wise enough—to take the word in its largest sense—to let its readers know something of what is being done in the world of Science.

WE have received a map (published by the U.S. Geological Survey) of the sources of the Snake River, with its tributaries, together with portions of the head waters of the Madison and Yellowstone, from surveys and observations of the Snake River Expedition, by G. R. Bechler, Chief Topographer, and James Stevenson, Director. The scale is five miles to an inch, and all the remarkable features of the extensive district, which includes the Yellowstone National Park, and the nature and products of the ground, are clearly indicated.

WE have received the third volume, for 1873, and the commencement of the fourth volume of the "Procès-verbaux des Séances de la Société Malacologique de Belgique," showing the activity with which this department of Natural History is pursued in Belgium.

THE additions to the Zoological Society's Gardens during the past week include a Crested Agouti (*Dasyprocta cristata*), from Mexico, presented by Mr. C. H. M. de Lichtacbel; a Pennant's Parakeet (*Platycercus pennanti*), and a Cockateel (*Calopsitta novæ-hollandiæ*), from Australia, presented by Dr. H. Wheeler; a Common Gull (*Larus canus*), British, presented by Mr. W. K. Stanley; a Malayan Hornbill (*Buceros malayanus*), from Malacca, purchased; and a hybrid Pheasant (between *Thaumalia amherstiæ* and *T. picta*), received in exchange.

SCIENTIFIC SERIALS

Justus Liebig's Annalen der Chemie u. Pharmacie, Band 170, Heft 1 und 2. This number contains the following papers:—On the chlorides and oxy-chlorides of sulphur, by A. Michaelis. The author describes the compound SCl_4 and other chlorides, also an oxy-chloride of the formula $S_2O_5Cl_2$. He gives tables and curves showing the dissociation of SCl_4 which is very rapid between $-20°$ when 100 per cent. of that body exists and $+6°\cdot2$ when only 2·43 per cent. exists as SCl_4, the rest consisting of SCl_2 and chlorine. SCl_2 dissociates much less rapidly, 5·44 per cent. existing at a temperature of $+120°$. Researches on the nature and constitution of gallic acid, by H. Schiff. A correction of the formula of carbazolin, by C. Gräbe.—On capronic acid contained in the crude butyric acid of fermentation, by A. Lieben—On the salts of capronic acid derived from fermentation, by F. Kottal.—On a condensation product of oxybenzoic acid, by L. Barth and C. Senhofer. The author's obtained a body of the formula $C_{14}H_8O_4$; two of the hydrogens of this formula are replaceable by metals. The Ba Ca, K and Na salts thus formed are described. On treating the original body with zinc, anthracene was obtained. They propose to call this body Anthraflavon; it is useles as a dye-stuff.—On phenol-trisulphuric acid, by C. Senhofer. The acid is prepared by acting on sulphuric acid with phosphoric anhydride in the presence of phenol; it is a tribasic acid of the formula $C_6H_6S_3O_{10}$ crystallising with $3\frac{1}{2}$ molecules of water. Several of its salts are described.—On orthoxylol prepared from liquid brom-toluol, by P. Jannasch and H. Hübner.—On the action of ozone on carburetted hydrogen, by A. Houzeau and A Renard. This is a translation from a paper in the *Comptes Rendus*, vol. lxxvi., 572.—On dichlorglycide, by A. Claus. This body is prepared by the action of potassic hydrate on trichlorhydrin. On the action of potassic cyanide on dichlorglycide, by the same author.—On œnanthylic acid and normal heptyl alcohol, by Harry Grimshaw and C. Schorlemmer.—On trimethyl acetic acid, by A. Butlerow.—On the dichlor propionic ether from glyceric acid, by Messrs. Werigo and Werner.—Contributions to our knowledge of citric acid; and On baric citraconate, by H. Kämmerer.—On dissociation, by A. Horstmann.—The number concludes with a short reply to Butlerow's paper on trimethyl carbinol, by E. Linnemann.

Bulletin de la Société Imperiale des Naturalistes de Moscou. No. 2. 1873.—This number commences with a paper by Dr. Koch on malformations in the embryos of species of salmon and Coregonus; the various monstrosities being treated under the headings of (1) Dicephaly; (2) Diplomyelia (duplicity of spinal cord, total or partial; (3) Divergences of body from its long axis; (4) Defects in organs of locomotion; (5) Anomalies in the vegetative sphere; (6) Defects in organs of sense. As to the disputed point how double monsters arise, Dr. Koch finds confirmation of I. Müller's view, according to which they are produced through union of two organised embryos arising from an imperfect fission. He also asserts that double monsters, where both bodies are formed alike, never live after leaving the egg, and when the yolk has been absorbed; other monsters may, if the form permits of food being procured. From experiments made on production of monsters, it seemed well established, that unfavourable conditions, such as shaking, were peculiarly apt to cause them; even double formations, but only of a certain kind, viz. *Diplomyelia partialis*, not *D. totalis*. The influence of temperature was also seen in the fact, that, with embryos in these unfavourable conditions, a difference of three degrees R. (above the normal cold temperature), made a difference of twelve days in the time of development, which was to this extent retarded. The paper is accompanied with numerous illustrations.—M. Wolkenstein continues his account of anthropological researches on the ancient cemeteries of Waldai, named "Jalnikis;" giving here detailed measurements of the skeletons found in these peculiar tombs.—M. Becker describes a journey he made in 1872 to several places in the neighbourhood of the Caspian and in South Daghestan; apppending a list of plants and animals found there.—M. Truntschold furnishes some measurements of *Elasmotherium sibericum*; M. Motschoulsky a list of new species of Coleoptera; and there are one or two notes, in Russ, on botanical subjects.

Astronomische Nachrichten, No. 1973. In this number Dr. Stein gives an account of an apparatus for astronomical photography, with which the negatives are taken without the use of a dark room or tent, and if useful in practice, it justly deserves credit. It consists practically of a sort of flat box of glass, one

side of which is the collodionised plate which fits water-tight against the other sides by means of india-rubber packing. There is a tube passing into this box through which first the ordinary silver solution is poured, and then by laying the collodionised plate downwards it is covered by the solution and sensitised; this is then drawn off, and the box, which is contained in a suitable holder, placed on the telescope and exposed by drawing away the non-actinic glass cover in front. After exposure the coloured glass is replaced, the box removed and developed by pouring in the solution in the same manner as the silver, in the meantime watching the plate through the coloured glass; the washing is then proceeded with in the same manner.—Dr. Stein proposes to use this method for photographing the transit of Venus.—Prof. Schmidt contributes a paper on the rotation of Jupiter, in which he discusses all the old observations of Cassini and others. From his list we gain that these observers differed to the amount of 6^m, the minimum being $9^h\ 50^m$, and the maximum $9^h\ 56^m$. From Prof. Schmidt's observations in 1873, he obtains a period of $9^h\ 56^m\ 7{\cdot}2^s$.

Archives des Sciences Physiques et Naturelles, Dec. 15, 1873.—In this number a short opening notice of M. de la Rive is followed by an article by M. Wiedemann, being an extract from his recent work on elliptic polarisation of light, and its relations with the superficial colours of bodies. The author shows that superficial colours change considerably with the nature (indices of refraction) of the substances in contact with which they are produced; and colours the most strongly reflected present generally the most intense elliptic polarisation, provided the reflection occurs in air or in vacuo. The principal angles of incidence undergo the most rapid modifications for wave-lengths corresponding nearly to the bands of absorption. M. Wiedemann's work elucidates the connection between the phenomena of bodies with superficial colours and the principal angles of incidence and relations of amplitude.—Dr. Hermann Müller's recent interesting work on fertilisation of flowers by insects is reviewed in a paper which gives a succinct *résumé* of the principal results.—M. Plantamour furnishes an account of the proceedings of the Meteorological Congress held at Vienna in 1873, and the circumstances which led to it.—There is also a note on the early development of Geryonides, by M. Fol; and this is followed by the usual scientific summary.

Ocean Highways, February.—About one-third of this number is occupied by a paper by Captain R. F. Burton, describing "Two Trips on the Gold Coast," the first being to the Beauleh Gardens and Agimanti Hills, and the second along the shore to the Volta River. The paper, which is written in Captain Burton's characteristic and attractive style, and illustrated by two maps, is full of information, and will no doubt prove interesting to many at the present time. An article on the Bengal Famine recounts the principal Indian famines from 1661 to the present time, and shows how much could be done to foresee and obviate the consequences of famine by a more scientific investigation of the laws which regulate meteorological phenomena. The article is accompanied by a map showing the extent of the famine districts. In a short article on "Wyche's Land," called by the Germans after King Karl of Wurtemburg, it is shown satisfactorily, we think, that the honour of the discovery, by right, belongs to Edge's expedition in 1617, and that the name then imposed should remain unchanged. Some interesting details are given of Richard Wyche or Wiche, the London merchant, who did much to encourage early discovery. Other articles are on "European Emigration to the Argentine Republic," and on the "Provindah Trade," or trade of the Lohani merchants, who are the channels of communication between India and Central Asia.

SOCIETIES AND ACADEMIES

Royal Society, Feb. 12.—"On the Division of Sound by a layer of flame or heated gas, into a reflected and a transmitted portion," by John Cottrell, Assistant in the Physical Laboratory of the Royal Institution; communicated by Prof. Tyndall, F.R.S.

A vibrating bell contained in a padded box was directed so as to propagate a sound-wave through a tin tube and its action rendered manifest by its causing a sensitive flame placed at a distance in the direction of the sound-wave to become violently agitated.

The invisible heated layer immediately above the luminous portion of an ignited coal-gas flame issuing from an ordinary bat's-wing burner was allowed to stream upwards across the end of the tin tube, from which the sound-wave issues. A portion of the sound-wave, issuing from the latter, was reflected at the limiting surfaces of the heated layer; and a part being transmitted through it, was now only competent to slightly agitate the sensitive flame.

The heated layer was then placed at such an angle that the reflected portion of the sound-wave was sent through a second tin tube (of the same dimensions as the above), and its action rendered visible by its causing a second sensitive flame placed at the end of the tube to become violently affected. This action continued so long as the heated layer intervened; but upon its withdrawal the first-mentioned sensitive flame, receiving the whole of the direct pulse, became again violently agitated, and at the same moment the second sensitive flame, ceasing to be affected, resumed its former tranquillity.

Feb. 19.—"On the Number of Figures in the Period of the Reciprocal of every Prime Number below 17,000," by William Shanks, Houghton-le-Spring, Durham.

"On an Instrument for the Composition of the Harmonic Curves," by E. A. Donkin, Fellow of Exeter College, Oxford.

"On the Absorption of Carbonic Acid by Saline Solutions," by J. Y. Buchanan, chemist on board H.M.S. *Challenger*.

Linnean Society, Feb. 19.—J. Gwyn Jeffreys in the chair. —The chairman announced that a Special General Meeting of the Society would be held on Thursday, March 5, at 8 P.M., to consider alterations in the Bye-laws of the Society." The following papers were read:—Systematic list of the Spiders at present known to inhabit Great Britain and Ireland, by the Rev. O. P. Cambridge.—Some observations on the vegetable productions and rural economy of the province of Baghdad, by Surgeon-major W. H. Colvill.—Note on the Bracts of Crucifers, by Dr. M. T. Masters.

Zoological Society, Feb. 17.—George Busk, F.R.S. vice-president, in the chair. Mr. Busk exhibited some skulls of the tiger and leopard from China, procured by Mr. R. Swinhoe, and showed that those from the northern and southern provinces did not appear to be specifically distinct.—A communication was read from Mr. L. Taczanowski, Conservator of the Museum of Warsaw, containing the descriptions of twenty-four new birds, obtained by Mr. Constantine Jelski in Central Peru. Amongst these was a new Cotingine form, proposed to be called *Dolyornis sclateri*, and four new humming-birds named respectively *Metallura hedvigæ*, *Helianthea dichroura*, *Eriocnemis sapphiropygia* and *Lampraster branickii*.—A communication was read from Sir Victor Brooke, Bart., describing a new species of Gazelle, founded on two specimens living in the Society's Menagerie, which he proposed to call *Gazella muscatensis*.—A communication was read from Dr. T. Schomburgh, Director of the Botanic Gardens, Adelaide, containing an account of the habits of the Australian Coote (*Fulica australis*) as observed in the Gardens under his charge.—Mr. E. Ward exhibited the head of a supposed new species of Wild Sheep, from Ladak, which he proposed to name *Ovis brookei*, after Sir Victor Brooke.—Dr. J. E. Gray, F.R.S., communicated some notes on the Crocodile of Madagascar, which he proposed to distinguish from *Crocodilus vulgaris* of Continental Africa, and to call *Crocodilus madagascariensis*.—A communication was read from Mr. W. N. Lockington, of Humboldt County, California, containing some notes on the mammals and birds met with in that part of the State of California.

Mathematical Society, Feb. 12.—Dr. Hirst, F.R.S., president, in the chair.—Prof. Clifford gave in some detail a statement of the views advanced in his paper on the foundations of dynamics.—A discussion ensued, in which Messrs. Wilkinson, Moulton, Cayley, Roberts, and G. H. Lewes took part.—Mr. Clifford having answered questions and replied to objections, proceeded next to give an account of a paper on the free motion of a solid in elliptic space.—Owing to the lateness of the hour a paper by Mr. C. J. Monro, entitled "Note on the Inversion of Bernoulli's Theorem in Probabilities," was taken as read. Under the name of Bernoulli's Theorem are comprehended two theorems which, with a little licence, we may distinguish as the deductive and the inductive. The deductive theorem assumes the constant probability p of a given result on a single trial, and determines the probability P that on m trials the result will be produced from $mp - l$ to $mp + l$ times, or from $x - l$ to $x + l$, if x is the greatest integer in $mp + p$. The inductive theorem

assumes that the given result is produced mp times on m trials, which give a constant facility for its production (that is, are made under definable circumstances, which, if defined, would give a constant probability for the same), and determines P′, the probability that this facility lies between $p \pm \frac{l}{m}$. In the deductive theorem it is supposed that $\frac{1}{m}$ may be neglected; and in the inductive $\frac{1}{\sqrt{m}}$. (The author here refers to Mr. Todhunter's "History," p. 555, and to Mr. De Morgan's treatise in the "Enc. Metr.," § 77.) The object of the paper was to show, first that there is an oversight in Laplace's statement of the inversion (see Todhr., § 997), the correction of which removes the inconsistency of the results; and secondly, that upon the hypothesis of equally probable values within equal ranges, the inversion is so far legitimate that either theorem may be inferred from the other with little calculation, and in particular without the approximate evaluation of a general integral, and accordingly that the two solutions are identical in principle.

Chemical Society, Feb. 19.—Prof. Odling, F.R.S., president, in the chair.—Mr. James Bell delivered his lecture "On the Detection and Estimation of Adulteration in Articles of Food and Drink." The lecturer, after some preliminary remarks on the fiscal regulations with regard to adulteration, began with a description of the microscopic appearance of the various kinds of starch, as many of them, from their cheapness, are largely employed for the purposes of adulteration; he then considered the characters of pure coffee and of the various substances used to adulterate it, pointing out the most convenient methods for their detection. Tea, pepper, and mustard, were afterwards treated of in the same way. Owing to want of time, Mr. Bell was unable to complete the lecture, so that the adulteration of cocoa, tobacco, and beer was not touched upon. This admirable and instructive lecture was copiously illustrated by the most beautifully executed drawings of the structure of the various substances as exhibited under the microscope. After the lecture many of the Fellows availed themselves of the opportunity afforded them of looking over the extensive collection of microscopic preparations connected with the subject.

Entomological Society, Feb. 2.—Mr. J. W. Dunning, vice-president, in the chair.—Mr. Müller exhibited a blind Myriapod and others found in a limestone cave in the Jurassian Mountains; he believed them to be the first found in the caves of Switzerland.—Mr. Kirby exhibited *Lycæna phœbe* from Australia, which had been described by the Rev. R. P. Murray.—Specimens were exhibited of *Monohammus leuconotus*, a Longicorn beetle which was very destructive to the coffee plantations in Natal. The only remedy that appeared to have been tried was the application of Stockholm tar to the roots of the trees; but handpicking was suggested on the first appearance of the insect in the imago state. This was the practice usually adopted on the continent of Europe with regard to *Melolontha*. Also it was desirable to protect the insectivorous birds, which were frequently shot for the sake of their plumage.—Mr. Butler forwarded some corrections of the synonymy with regard to *Apatura herse* and *A. lycaon* of Scudder and Riley, which were equivalent to *A. clyton* and *A. celtis*, Boisduval; whereas *A. herse* and *A. lycaon*, Fabricius, were sexes of one species = *A. alicia*, Edwards.—A paper was communicated by Mr. Herbert Druce, entitled "Descriptions of fifteen species of Diurnal Lepidoptera, chiefly from South America."

Meteorological Society, February 18.—The papers read were:—"General Remarks on the West Indian Cyclones, particularly those from the 9th to the 21st Sept., 1872," by Mr. F. H. Jahncke, harbour-master of St. Thomas; "New Forms of Alcohol Thermometers," and "An Improved Vacuum Solar Radiation Thermometer," both by Mr. James J. Hicks; and "Note on a Waterspout which burst on the Mountain of Ben Resipol, in Argyleshire, in August, 1873," by Mr. Robert H. Scott, F.R.S. A very interesting discussion followed the reading of each paper. That upon Mr. Jahncke's led to expressions of opinion on the origin, form, tracks, and general characteristics of West Indian Hurricanes, and of the best means of improving and increasing the records of weather phenomena in those parts. The special feature in Mr. Hicks's second paper was the application of an electric current as a test for the perfection of the vacuum, which principle was very beautifully illustrated by experiments.

EDINBURGH

Scottish Meteorological Society, Jan. 29.—Mr. M. Home, of Wedderburn, in the chair.—From the report of the council it appears that two new stations, viz., Broadlands, Peebleshire, and Ochtertyre, Crieff, have been added to the society's stations, and that Kettisis and Cairndow have ceased to be stations. Thus the number of stations in connection with the society is the same as at last meeting, viz., 92 in Scotland, 5 in England, 4 on the Continent, 2 in Iceland, 1 in Faro, and 1 in South America. Observations have also been begun to be made for the society at Melstad, in the north of Iceland, and at Fairlie Plains, Paroo River, near the northern watershed of the River Darling, Australia. The council had had offers of many more stations, some in most eligible districts; but the establishment of these would have entailed additional expenditure which the society's funds would not justify. Teachers of several schools had also made known their wish to observe for the society, provided they were furnished with instruments, at the same time proposing to introduce into their schools some instruction in meteorology. The council, however, had been obliged to decline these applications for want of funds. The membership of the society is at present 560. In room of the three members of council who retired, Prof. Alexander Dickson, Dr. J. Robson Scott, and Mr. George Hope, of Broadlands, were elected.—An application has been made to the council by Mr. Colin McVean on behalf of the Government of Japan for advice regarding the establishment of a system of meteorological observations in Japan. In answer to this application, the council has forwarded a memorandum regarding suitable instruments, their position, hours of observation, the establishment of a central observatory, inspection of stations, publications, and special observations of storms.—Mr. Buchan submitted a second report of the committee appointed to carry out the Marquis of Tweeddale's proposal to investigate the relations of the herring-fisheries to meteorology. The committee had, with the assistance of the Hon. Bouverie F. Primrose, of the Fishery Board, obtained complete returns of the daily catch of herrings and state of the weather from all the fishing districts of Scotland during the past season. Thirty-five weather maps at 9 P.M., specially constructed with reference to this question, and showing the number of boats out fishing in each district each day and the average catch of each boat, were shown to the meeting. Some interesting relations between the catches of the different districts and the prevailing weather were pointed out; and as these were in general accordance with the results stated in the first report, presented in July last, it is highly probable that when the statistics of three or four years' fishings similar to the very satisfactory returns of the past year have been collected, valuable conclusions will be arrived at.—Mr. Thomas Stevenson, in bringing before the meeting a proposed inquiry regarding storms, remarked that the barometric gradients hitherto ascertained having been deduced from readings at stations many miles apart, necessarily could not give more than a rough approximative gradient. What is wanted in order to get a formula for computing the velocity of the wind due to a given gradient is, as he (Mr. Stevenson) suggested in NATURE, vol. ix. p. 103, to have a string of stations at short distances apart. It is now proposed to establish such storm stations, arranged in lines radiating from Edinburgh for a distance of about twenty miles, and it is believed that in addition to the existing stations of the Scottish Society many farmers and others possess good barometers, which could be compared with the society's standard. It is proposed that observations of the instruments and of the weather should be limited to the periods during which storms last, and a special schedule for the observations had been prepared.—Mr. Buchan gave an account of the proceedings of the Meteorological Congress held at Vienna in September last, to which he and Mr. Scott, of the Meteorological Office, London, had been sent as delegates from the British Government.

Geological Society, Feb. 12.—A paper was read by Mr. John Horne, of the Geological Survey of Scotland, on "The Geology of the Isle of Man." The chief points of interest in the paper were the correlation of the red sandstones and Breccias with the Lower Carboniferous series of Scotland, and the proofs adduced that the volcanic rocks were probably on the same horizon as the upper limestone shales of England. Detailed evidence was given to show that the Isle was glaciated by a confluent ice-sheet from the north-west of England, south of Scotland, and the north-east of Ireland. The two submarine

hollows lying between the Portpatrick coast and the north-east of Ireland, and between Anglesea and the coast south of Dublin, were attributed to the increased erosive action of the ice-sheets due to the narrowness of the channel at these points.—Mr. Andrew Taylor gave a description of the course of the River Almond, near Edinburgh, and stated that that river followed, at various places, which he specified, lines of "faults."

MANCHESTER

Literary and Philosophical Society, Feb. 3—*Physical and Mathematical Section*.—Alfred Brothers, F.R.A.S., President of the Section, in the chair.—"On the Theory of the Tides," by David Winstanley.

Feb. 10.—R. A. Smith, F.R.S., V.P., in the chair.—"The Northern Range of the Basques," by W. Boyd Dawkins, F.R.S. The northern extension of the Basque race from their present boundary, in ancient times, is demonstrated by the convergent testimony of history, ethnology, and the researches into caves and tombs. In the Iberian peninsula the Basque populations (Vascones) of the west are defined from the Celtic of the east by the Celtiberi inhabiting modern Castille. In Cæsar's time, the Aquitani were surrounded on every side, except the south, by the Celtæ, extending as far north as the Seine, as far to the east as Switzerland and the plains of Lombardy, and southwards, through the valley of the Rhone and the region of the Volscæ, over the Eastern Pyrenees into Spain. The district round the Phocæan colony of Marseilles was inhabited by Ligurian tribes, who held the region between the river Po and the Gulf of Genoa, as far as the western boundary of Etruria, and who probably extended to the west along the coast of Southern Gaul as far as the Pyrenees. The ancient population of Sardinia is stated by Pausanias to be of Libyan extraction, while that of Corsica is described by Seneca as Ligurian and Iberian. The Basques, or Ligurians, are the oldest inhabitants, in their respective districts, known to the historian; while the Celts appear as invaders. We may be tolerably certain that the Basques held France and Spain before the invasion of the Celts, and that the non-Aryan peoples were cut asunder, and certain parts of them left—Ligurians, Sikani, and in part Sardinians and Corsicans—as ethnological islands, marking, so to speak, an ancient Basque non-Aryan continent which had been submerged by the Celtic populations advancing steadily westwards. The Celtic and Belgic invasion of Gaul repeated itself, as might be expected, in Britain. Just as the Celts pushed back the Iberian population of Gaul as far south as Aquitania, and swept round it into Spain, so they crossed over the Channel and overran the greater portion of Britain, until the Silures, identified by Tacitus with the Iberians, were left only in those fastnesses that formed subsequently a bulwark for the Brit-Welsh against the English invaders. The Basque non-Aryan blood is still to be traced in the dark-haired, black-eyed, small, oval-featured peoples in our own country in the region of the Silures, where the hills have afforded shelter to the Basque populations from the invaders. The small swarthy Welshman of Denbighshire is, in every respect, except dress and language, identical with the Basque peasant of the Western Pyrenees, at Bagnéres de Bigorre. The small dark-haired people of Ireland, and especially those to the west of the Shannon, according to Dr. Thurnam and Professor Huxley, are also of Iberian derivation, and, singularly enough, there is a legendary connection between that island and Spain. The human remains from the chambered tombs as well as the river-beds prove that the non-Aryan population spread over the whole of Ireland as well as the whole of Britain. The evidence offered by an appeal to history and ethnology, as to the former northern extent of the Basque peoples, is confirmed by an examination of the human remains in the Neolithic caves and tombs, scattered throughout the area under consideration. The discoveries in the caves of Gibraltar and of the Spanish mainland prove that a small long-headed race, with delicate features and orthognathic profile identical with the Basques who buried their dead in the modern cemetery of Guipuscoa, ranged throughout the Peninsula, using with indifference caves and chambered tumuli for their tombs. And on the same grounds their former range through France, Britain, and Ireland is demonstrated, and as far to the east as Belgium. At the present time the Basque blood asserts itself in the physique of certain isolated populations, and within the historic period is demonstrated to have been more strongly defined, and to have occupied larger areas, and lastly in the prehistoric period to have formed one continuous race from the Pillars of Hercules, as far north as Scotland, and as far to the east as Belgium.

NEW HAVEN, U.S.

Connecticut Academy, Dec. 17, 1873.—Prof. Lyman, president, in the chair.—Prof. Marsh, of Yale College, gave an account of the explorations of his party in the Rocky Mountains and on the Pacific Coast during the past season. The first explorations this year were made in the Pliocene deposits near the Niobrara River. Owing to hostile Indians, the explorations of the party here were attended with much difficulty and danger, but were on the whole quite successful. Many new animals were discovered, and ample material secured for a full investigation of those previously known from that region. A second expedition was made in August from Fort Bridger, Wyoming, and large collections of Eocene fossil vertebrates were obtained, especially of the *Dinocerata*, *Quadrumana*, and *Chiroptera*, which had first been brought to light by the researches of the party in previous years. A third trip was made in September to the tertiary beds of Idaho and Oregon, where some interesting discoveries were made.

PARIS

Academy of Sciences, Feb. 16.—M. Bertrand in the chair.—The following papers were read:—On the acid waters which flow from the volcanoes of the Cordilleras, by M. Boussingault.—On a mechanical equation corresponding to the equation $\int \frac{dQ}{T} = 0$, by M. R. Clausius. This was a paper relating to those of M. A. Ledieu on the same subject which have recently been read.—Report on a memoir, by M. Marey, on the point of action of a wing on the air, M. Tresca, reporter.—Experiments to determine whether all the vascular nerves have their focus of origin and their vaso-motor centre in the rachidian bulb, by M. A. Vulpian.—New topographical chart of Mont Blanc on a scale of $\frac{1}{40,000}$, by M. E. Viollet-Leduc.—M. Ad. Chatin advanced his paper On androgenesis compared with organogenesis another stage.—On the action of soft waters on metallic lead, by MM. Mayençon and Bergeret. Electrolysis was used by the authors to detect the lead, as they considered sulphuretted hydrogen not sufficiently delicate. They found galena slightly soluble in water by long boiling.—On the preservation of wood by means of cupric sulphate, by M. Boucherie.—Facts illustrating the history of yeast, by M. P. Schutzenberger.—On a transformation of Taylor's formula, by M. Jourgon.—On a method of determining vapour densities, by M. Croullebois. This method is a modification of that which depends on observing the tension of the vapour in a barometer tube.—Observations on the efflorescence of the two hydrates of sodic sulphates, by Dr. L. C. de Coppet. This was an answer to a late paper by M. Gernez.—On the "antifermentescible" and antiputrid properties of solutions of chloral hydrate, by MM. Dujardin-Beaumetz and Hirne.—On the method of respiration in certain fish having a labyrinthiform pharynx, by M. Carbonnier.—On the fossils brought from Cape Verde Islands by M. de Cessac, by M. P. Fischer.—On the movements of the chlorophyll in the *Selaginaceæ*, by M. Ed. Prillieux.—On the relations between thermo-electric properties and crystalline form, by M. C. Friedel.—On a method of quickly re-forming vineyards threatened by phylloxera by the introduction of American vines, by M. H. Bouschet.—On anesthesia produced by the injection of chloral, by M. Oré.

CONTENTS

THURSDAY, MARCH 5, 1874

PROFESSOR HUXLEY AT ABERDEEN

THE Address just given by the Lord Rector of Aberdeen University, and published *in extenso* in the March number of the *Contemporary Review*, is second in importance to none of the similar utterances which have been heard of late years. It bears in every line the stamp of a master mind. The many topics touched on, the apparent diversity of which has alarmed the shallow critic of the *Times*, are all grouped round one central idea—the advancement of Science; and there is not only a splendid unity throughout the Address, and no "uncertain sound," which, coming as it does from a Royal Commissioner charged with a special survey of our scientific needs, as well as a Lord Rector, may well fill us with confidence for his advocacy, even if one despairs of much improvement being effected in the lifetime of the present generation. It is indeed to be feared, as Mr. Huxley himself anticipates, that on many points he will be "The Rector who was always beaten;" if so, it is none the less certain that his defeats will become "victories in the hands of his successors."

It is especially fitting that the Address, dealing, as it did by its title, with "Universities: Actual and Ideal," should have been delivered in connection with one of the Scotch Universities, which, in regard to scientific research and teaching, rank higher than the older English Universities, given up in the main to "elementary teaching of youths under twenty," as the ideal University must take rank above them. We cannot too much thank Prof. Huxley for bringing out this point sharply, and quoting Mr. Mark Pattison to intensify it, all the more because the *Times* has taken hold of another sentence of the address, to point out the importance of a "pause" in the Reforms at Oxford and Cambridge, as if things were moving too fast! Surely the older English Universities may at least approach the level of the Scotch Universities, to say nothing of the French and German ones, in the matter of the higher teaching and of research before this "pause" is insisted on?

And, more than this, we conceive it to be possible that the present Government may not treat the Report of the Commission appointed to inquire into the Revenues of the Colleges at Oxford and Cambridge as mere waste paper. It has frequently been roundly asserted that the political distinctions between Liberals and Conservatives by no means represent the line of demarcation between those most and least anxious for University reforms. However this may be, it is well known that one of the most enlightened and far-seeing among University reformers, so far as the highest functions of a University are concerned, is a member of the present Government. Let us hope, therefore, that the magnitude of the pause may have been exaggerated; that the Heads after all may not oversleep themselves, that the last of Endowment may be even as the first, Endowment being, according to Professor Huxley, a foreign element,

"Which silently dropped into the soil of Universities like the grain of mustard-seed in the parable; and, like that grain, grew into a tree in whose branches a whole aviary of fowls took shelter. . . . . It differed from the preceding, in its original design to serve as a prop to the young plant, not to be a parasite upon it. The charitable and the humane, blessed with wealth, were very early penetrated by the misery of the poor student. And the wise saw that intellectual ability is not so common or so unimportant a gift that it should be allowed to run to waste upon mere handicrafts and chares. The man who was a blessing to his contemporaries, but who so often has been converted into a curse, by the blind adherence of his posterity to the letter, rather than to the spirit, of his wishes—I mean the 'pious founder'—gave money and lands, that the student who was rich in brain and poor in all else might be taken from the plough or from the stithy, and enabled to devote himself to the higher service of mankind; and built colleges and halls in which he might be not only housed and fed, but taught.

"The colleges were very generally placed in strict subordination to the University by their founders; but, in many cases, their endowment, consisting of land, has undergone an 'unearned increment,' which has given these societies a continually increasing weight and importance as against the unendowed, or fixedly endowed, University. In Pharaoh's dream the seven lean kine ate up the seven fat ones. In the reality of historical fact, the fat Colleges have eaten up the lean Universities."

We have already, in NATURE, referred to Prof. Huxley's suggested reforms in respect to the Medical Curriculum, and we may therefore pass lightly over this part of his Address, expressing a hope, however, that his reference to this subject at length may be indicative that it will be considered by the Commission of which he is so distinguished a member.

The Lord Rector points out that while he would drop Zoology and Botany in the Medical Curriculum, he would make them part of the Arts Curriculum; and after remarking that the Faculties of Theology, Law, and Medicine are technical schools, intended to equip men who have received general culture with the special knowledge which is needed for the proper performance of the duties of clergymen, lawyers, and medical practitioners, he adds,—

"I have no sort of doubt that, in view of the relation of Physical Science to the practical life of the present day, it has the same right as Theology, Law, and Medicine, to a Faculty of its own in which men shall be trained to be professional men of science. It may be doubted whether Universities are the places for technical schools of Engineering, or Applied Chemistry, or Agriculture. But there can surely be little question that instruction in the branches of Science which lie at the foundation of these Arts, of a far more advanced and special character than could, with any propriety, be included in the ordinary Arts Curriculum, ought to be obtainable by means of a duly organised Faculty of Science in every University.

"The establishment of such a Faculty would have the additional advantage of providing, in some measure, for one of the greatest wants of our time and country. I mean the proper support and encouragement of original research."

This at once brings us to what we consider by far the most important part of the Address, the Lord Rector's opinions on the endowment of unremunerative research:—

"The other day, an emphatic friend of mine committed himself to the opinion that, in England, it is better for a man's worldly prospects to be a drunkard,

than to be smitten with the divine dipsomania of the original investigator. I am inclined to think he was not far wrong. And, be it observed, that the question is not, whether such a man shall be able to make as much out of his abilities as his brother, of like ability, who goes into Law, or Engineering, or Commerce; it is not a question of 'maintaining a due number of saddle horses,' as George Eliot somewhere puts it—it is a question of living or starving.

"If a student of my own subject shows power and originality, I dare not advise him to adopt a scientific career; for, supposing he is able to maintain himself until he has attained distinction, I cannot give him the assurance that any amount of proficiency in the Biological Sciences will be convertible into, even the most modest, bread and cheese. And I believe that the case is as bad, or perhaps worse, with other branches of Science. In this respect Britain, whose immense wealth and prosperity hang upon the thread of Applied Science, is far behind France, and infinitely behind Germany.

"And the worst of it is, that it is very difficult to see one's way to any immediate remedy for this state of affairs which shall be free from a tendency to become worse than the disease.

"Great schemes for the Endowment of Research have been proposed. It has been suggested, that Laboratories for all branches of Physical Science, provided with every apparatus needed by the investigator, shall be established by the State; and shall be accessible, under due conditions and regulations, to all properly qualified persons. I see no objection to the principle of such a proposal. If it be legitimate to spend great sums of money on public Libraries and public Collections of Painting and Sculpture, in aid of the man of letters, or the Artist, or for the mere sake of affording pleasure to the general public, I apprehend that it cannot be illegitimate to do as much for the promotion of scientific investigation. To take the lowest ground, as a mere investment of money, the latter is likely to be much more immediately profitable. To my mind, the difficulty in the way of such schemes is not theoretical, but practical. Given the laboratories, how are the investigators to be maintained? What career is open to those who have been thus encouraged to leave bread-winning pursuits? If they are to be provided for by endowment, we come back to the College Fellowship system, the results of which, for Literature, have not been so brilliant that one would wish to see it extended to Science; unless some much better securities than at present exist can be taken that it will foster real work. You know that among the Bees, it depends on the kind of cell in which the egg is deposited, and the quantity and quality of food which is supplied to the grub, whether it shall turn out a busy little worker or a big idle queen. And, in the human hive, the cells of the endowed larvæ are always tending to enlarge, and their food to improve, until we get queens, beautiful to behold, but which gather no honey and build no comb.

"I do not say that these difficulties may not be overcome, but their gravity is not to be lightly estimated."

It is pointed out that the creation of Faculties of Science will, to a certain extent, remedy the present lamentable condition of things to which we have so often called attention.

"It is possible to place the scientific inquirer in a position in which he shall have ample leisure and opportunity for original work, and yet shall give a fair and tangible equivalent for those privileges. The establishment of a Faculty of Science in every University implies that of a corresponding number of Professorial chairs, the incumbents of which need not be so burdened with teaching as to deprive them of ample leisure for original work. I do not think that it is any impediment to an original investigator to have to devote a moderate portion of his time to lecturing, or superintending practical instruction. On the contrary, I think it may be, and often is, a benefit to be obliged to take a comprehensive survey of your subject; or to bring your results to a point, and give them, as it were, a tangible objective existence. The besetting sins of the investigator are two: the one is the desire to put aside a subject, the general bearings of which he has mastered himself, and pass on to something which has the attraction of novelty; and the other, the desire for too much perfection, which leads him to

"'Add and alter many times
Till all be ripe and rotten;'

to spend the energies which should be reserved for action, in whitening the decks and polishing the guns.

"The necessity for producing results for the instruction of others, seems to me to be a more effectual check on these tendencies than even the love of usefulness or the ambition of fame."

It would indeed be a happy solution of the difficulty if it could be solved in this way, but we confess that on this point we fear that the system advocated by Mr. Huxley will not be all that is needed.

In the first place, take the present appointments to Chairs; are they, as a rule, given to the most distinguished investigators? If not, why not, and why should the present system be altered? In our opinion the present system of appointing teachers is good so long as large ranges of knowledge have to be professed. Take many of our present professors; are they as encumbered by teaching as the German professors are for instance? and yet where are their researches? do they not figure much more often in the "List of Examiners" than in the "Philosophical Transactions"? If these things are so, no benefit will accrue from a mere increase of numbers unless the present pay be largely increased.

There is also another most important point, and here again we quote from the Address:—

"It is commonly supposed that anyone who knows a subject is competent to teach it; and no one seems to doubt that anyone who knows a subject is competent to examine in it. I believe both these opinions to be serious mistakes: the latter, perhaps, the more serious of the two. In the first place, I do not believe that anyone who is not, or has not been, a teacher is really qualified to examine advanced students. And in the second place, examination is an art, and a difficult one, which has to be learned like all other arts."

Are then investigators to be made teachers and examiners in order that they may live, regardless of the fact that they cannot teach, and though they may be ignorant of the "art" of examining?

We believe that powers of teaching and powers of investigation by no means go together, though they are united in some great men like Mr. Huxley; and we believe, further, that on this ground alone the idea of making a man teach in order that he may carry on researches is bad in principle: it is even worse than this, because it is apt to cause the public to underrate research—to think that the end of all research is to teach, while in point of fact the end and aim of the acquisition and teaching of all old knowledge is the acquirement of new knowledge.

It is a source of satisfaction to us that Prof. Huxley agrees with us on the main point, for we are certain that when once the principle is conceded, practical methods of carrying it out, among which undoubtedly that in-

sisted on by the Lord Rector will find place, can easily be found; methods against which no objection can be urged, and from the application of which a tremendous increase in the rate of advancement of knowledge in this country may be anticipated.

POST-TERTIARY GEOLOGY *

The Great Ice-Age and its relation to the Antiquity of Man. By James Geikie. (W. Isbister and Co. 1874.)

II.

WE must next turn to beds which furnish conclusive proof of a return of cold conditions, the well-known shell-bearing clays found here and there along the coast of Scotland. The fossils and the physical condition of these beds both concur in telling the same tale, that an Arctic climate again prevailed in Britain. These deposits are marine, and have not been met with at a greater height above the sea than 360 feet, and they were therefore formed towards the termination of the period during which the land was emerging from the sea. Evidence of a similar change of climate is, however, found in the interior of the country. In the Highland glens and the high valleys of the Southern Uplands morainic deposits, distinguishable from those of the earlier ice period, are of common occurrence, sometimes scattered loosely over the mountain slopes, sometimes arranged in ridges or lines of mounds across the valleys after the fashion of terminal moraines. The climate, therefore, must have become again severe enough to allow of the accumulation of ice; but, since the second set of glaciers is shown by the moraines which they have left behind them to have been confined to the high ground, and each restricted to its own valley, the cold must have been far less intense than during the period of the first glaciation.

The second period of cold, however, passed away, and the record of its gradual disappearance is written for us in this way. In many of the upland valleys concentric lines of mounds, each marking the terminal moraine of a glacier, are arranged one within the other, and as we ascend these piles are found to grow more and more puny, till they at last vanish altogether. From this we see, as clearly as if the operation had gone on before our eyes, how each glacier shrank back step by step into the heart of the mountain glens, and at last yielded to the gradual amelioration of the climate, and melted entirely away. Another train of reasoning leads us to the same conclusion. The rising of the land was not continuous, but broken every now and then by pauses, and during each of these the sea cut a notch or shelf in the rocks and occasionally spread out terraces of shingle and silt, forming what are known as Raised Beaches. These beaches occur at many different levels, from 1,500 feet down to a few yards above the mean-tide level. The higher of these beaches furnish evidence of somewhat Arctic conditions, but as we descend in the series these traces become less pronounced.

We are now approaching the close of the glacial epoch, and the climate, though still colder than now, was approximating to what it is at present.

The author goes on to show, from a consideration of submerged forests, how the elevation of the land went on till Britain was raised above its present level, and probably connected by a land surface with the mainland of Europe; and points out how the continental climate thus produced will account for the dense forests which formerly clothed our island, while a return to insular conditions resulted in a decay of the woods and the growth of peat mosses.

Lastly, our country became again dissevered from the continent, and the submergence which brought about this change went on till the land was sunk somewhat below its present level; while it rose into its present position, low level raised beaches were formed, among which the well-known 25-feet-beach is most conspicuous.

Such then is the succession of physical changes which the Drift-deposits show has taken place in our island.

The author has passed in review also the contemporaneous formations of Scandinavia, Switzerland, and North America, and pointed out how the story they tell agrees in its main features with that deduced from our own glacial formations.

Had he done no more than this he would have produced a work of surpassing interest and value, but the concluding chapters of his book will perhaps attract more attention than any other part of it, for they deal with a question that comes in a measure personally home to us, the antiquity of man and the date of his first appearance in Britain.

The oldest races of men of which traces have yet been discovered are known as the Stone-folk, because they fashioned their implements out of stone and seem to have been unacquainted with the use of metals. These Stone-folk are clearly distinguishable into two classes—the older, known as Palæolithic, merely chipped stones into shape; the later, or Neolithic, had advanced a step farther, and constructed tools highly polished and otherwise more finished than those of their predecessors. We also find associated with the traces of Palæolithic man a group of mammals now wholly or locally extinct, while the mammals accompanying the remains of Neolithic man are many of them still indigenous to the country. In connection with this subject the author has brought prominently into notice a fact which had not received the attention it deserves, that nowhere have any signs been detected of gradual improvement on the part of Palæolithic man, by which he may have passed from abject barbarism to the more advanced skill of his Neolithic successor, but that, on the contrary, the two races are everywhere sharply marked off from one another. In the same way the accompanying groups of mammals are essentially distinct, and we nowhere find traces of the dying out of the one and the gradual coming in of the other. But one inference can be drawn from these facts: between the time when the Palæolithic race inhabited Britain and the coming in of the Neolithic race a long interval must have elapsed, during which man was by some means or other driven out of the country, and went through elsewhere the long series of modifications by which he was himself advanced in civilisation, while at the same time the group of animals associated with him became totally changed. Now we know of no physical change since the second glaciation of the country which could have been the cause of such a migration, for all the evidence both here and elsewhere tends to show, that whatever change of climate has occurred between that event and the present day has been

* Continued fro p. 321.

steadily in the same direction—that of improvement. But the great submergence, and severe period which followed it, would exactly bring about the required result, if it can be only shown that the age of Palæolithic man preceded these occurrences.

There is no antecedent improbability in such a supposition; the mild periods that recurred during the formation of the Till may well have been warm enough to allow of northern mammals, and subsequently, as the climate improved, of Palæolithic man and southern forms migrating into our area, to be again driven out each time a return of cold brought the ice-sheet down over the lowlands, and finally expelled, never again to return, by the great submergence. But more than this, our author has shown how anomalies, hitherto inexplicable, receive an easy solution on this hypothesis; how, for instance, it accounts for the mingling of northern and southern forms of mammals in the palæolithic beds; and how it gives a reason for the fact that palæolithic river-gravels are confined to those parts of Britain which were not covered by the ice-sheet, while the palæolithic deposits found in caves are not so restricted.

The hypothesis therefore stands on a firm basis, and the conclusion is irresistible that Palæolithic man was of interglacial—may be of preglacial—date. Thus much had been dimly felt rather than demonstrated by previous thinkers; but Mr. J. Geikie has shed a flood of light on the subject by pointing out that man was driven out of our country by the great submergence; that Britain was not again peopled till the elevation that followed connected it with the continent; and that the colonists belonged to the Neolithic race. In this way he has satisfactorily accounted for the great gap that exists between the two divisions of the Stone-folk.

The reasonable limits of an article are well-nigh reached, but we have by no means exhausted the contents of this comprehensive volume. The chapter on lakes must not be passed by altogether, for besides being a lucid exposition of Prof. Ramsay's theory of the formation of rock-basins, it is illustrated by an admirable map and section of Loch Lomond, and by a beautiful chart of part of the western coast of Scotland, which shows that these hollows are not confined to the land, but are also dotted over the shallow bed of the adjoining sea in exactly the places where a glacialist would expect to find them. The chapter on the English Drift would itself furnish materials for a review, as would also the note distinguishing the formations which are considered to have yielded traces of ice action. On the latter head we may point out that the presence of glaciers or icebergs is not in itself proof of a glacial epoch. Where we find, as in the Permian beds, evidence of the presence of ice at localities so far apart as Ireland, the west of England, and the centre of Germany, it looks like an indication of wide-spread severity of climate; but such a case as the Brecciated Beds of the Ord is better explained by a local development of glaciers, specially as the fauna of the associated strata forbids the existence of a general low temperature. It is worthy of note that these periods, which give the most satisfactory indications of glacial conditions, come close upon others, when a genial climate prevailed far up into northern latitudes; the Permian, for instance, followed hard upon the Carboniferous, and the Miocene epoch, if the glacial character of portions of it be fairly established, would yield a still more striking instance. But these juxtapositions of strongly-contrasted phases of climate, so far from being matter for surprise, are a necessary result of Mr. Croll's theory, according to which each hemisphere would, during a period of high eccentricity, experience alternately the severity of a glacial epoch and eras of almost perpetual spring.

Space will allow us to point out one only of the numerous results which will probably follow from the conclusions of this work. They must lead to a revision of our nomenclature of the Tertiary strata. The conditions of the Pliocene epoch were merely the commencement of a series of changes which received their full development during the Glacial era; and the latter is linked on by an equally unbroken succession of events with modern days. If therefore we are to have a Post-tertiary, Quaternary, or Recent Period, it should on physical grounds include Pliocene times; while the continental character of the Miocene epoch in Europe, and the important events that brought it to an end, mark it out as the natural termination of the Tertiary era.

In conclusion we have only to express a hope that the imperfect sketch we have given of the Great Ice Age may lead many readers to arrive at a fuller appreciation of its merits by turning to the work itself.

A. H. GREEN

SCHWEINFURTH'S "HEART OF AFRICA"

The Heart of Africa; or, Three Years' Travels and Adventures in the Unexplored Regions of the Centre of Africa. By Dr. Georg Schweinfurth. Translated by Ellen E. Frewer. 2 vols. (London: Sampson Low and Co., 1874.)

THE "Heart of Africa" is a valuable contribution to African literature, and we lay down the last volume with regret. This regret is enhanced by the grievous disappointment all geographers must feel that a man so capable and so reliable as Dr. Schweinfurth should have limited his scientific acquirements to botany and natural history without having qualified himself as a traveller by the use of astronomical instruments.

When we first glance at the elaborate map of the author's travels, embracing an extraordinary series of curves, zigzags, and the like, until we reach his most southern limit, we are delighted with this apparently valuable addition to geography, and we feel a first impulse to congratulate Germany as an ally in Central African Exploration, but to our complete dismay after these ardent expectations we find ourselves actually without one astronomical observation.

As geographers, we really have a right to complain. If Dr. Schweinfurth had been an uneducated adventurer, or even a mere sportsman attracted to wild countries by a love of wandering, we should have regretted a barren geographical result after an arduous journey of three years. Dr. Schweinfurth is, on the contrary, a man of scientific education and a botanist—in addition to being an accomplished draughtsman. He is a man of cultivated tastes, and he evidently combines the qualities requisite for a traveller in wild countries. Why should he not have fitted himself prior to his voyage by a few

months' study for the only practical and reliable work of a geographer or scientific traveller? In the absence of astronomical observations we can only regard his map as the author's *idea* of his journey. We have no compass bearings or any reference to such observations having been taken. We must therefore accept his map as simply a conscientious endeavour to introduce us to his wanderings; at the same time, geographically speaking, we can only allow that he has been wandering about in the "Heart of Africa." It is with regret, therefore, that we cannot accept him in the first rank of geographers. A future traveller over the same ground may contest every position; thus, instead of our author's journey having added to our geographical knowledge, it may simply add to those geographical strifes which are the inevitable results of un-scientific journeys.

Having, as a matter of duty, expressed this opinion upon a work otherwise most valuable, it is a pleasure to be able to grasp one geographical fact that is well established, and is independent of astronomical observations. This is the watershed towards the West which forms the boundary of the Nile Basin. The large flow of water discovered by Dr. Schweinfurth is passing towards the Atlantic. This at once disproves the theories laid down by Livingstone, but never accepted by geographers, that he rivers to the west of the Tanganika Lake flowed northward to the Nile. As Schweinfurth passed out of the Nile Basin in about 28° E. long., so also Livingstone arrived in a western watershed south of the equator in about the same meridian.

The botanical information collected by Dr. Schweinfurth is invaluable, and can only be estimated by a professional botanist. We envy the traveller in many of his floral rambles, which are described with the energy and vividness of an enthusiast. Nothing new has been added to the known list of African fauna. We conclude, from the description of the habits of the so-called "rock rabbit," that our author means the "hyrax," which, although resembling a rabbit in appearance, is not a rodent.

Dr. Schweinfurth having been properly supported by an introduction from the Berlin Academy was saved many difficulties to which other travellers have been subjected; he was well received by Djiaffer Pacha, the Governor-General of Soudan, at Khartoum, who handed him over to the care of one Ghattas, a Coptic slave trader and ivory merchant. Ghattas entrusted him to the guidance of his own people, who appear to have behaved extremely well. Dr. Schweinfurth had every opportunity of examining the mysteries of the slave trade, and he is perfectly right in his description of the immense importance of the Darfur and Kordofan route, by which vast multitudes are conveyed who can thus elude the cruisers on the White Nile. At the same time the author is in error and has been purposely deceived by his informants (themselves slave traders) when (p. 429, vol. ii.), speaking of the upper district of the White Nile, inclusive of the Albert and Victoria Lakes, as one of the territories that form the sources of the slave trade in north-eastern Africa, he says, "The expedition of Sir Samuel Baker has stopped this source. The annual produce in the most favourable years did not exceed 1,000." There were no less than ten slave stations situated in the territory under Sir Samuel Baker's command. In each of these stations were at least 1,000 slaves.

The last act of Sir Samuel Baker, on his homeward route, was to overtake three vessels from the Bohr, lat. 5°·20 N., with 700 slaves on board, which were openly on their route to pass the Government station of Fashoda! thus proving what Dr. Schweinfurth himself states respecting the connivance of the Egyptian officials, p. 442, vol. ii.—"In Kordofan, where there is a resident Egyptian Governor, the trade is truly enormous, and there is now as well the slave-trade from Darfur." In a cursory review of the slave-trade Dr. Schweinfurth makes a remark that few Englishmen would sanction, p. 433, vol. ii.—"Two great nations have speeded on the work, England in theory, North America in practice." If the payment of twenty millions sterling for emancipation was not the most practical, and not only theoretical, work, we really do not understand what practice means.

It would have been interesting had Dr. Schweinfurth given us more details of the ivory trade carried on by the people who acted as his chaperons in Africa. These were avowedly slave traders, and we should be gratified to learn that they formed some exception to the rule, and actually traded with merchandise instead of bartering slaves and stolen cattle for ivory.

The reward of ignorant ages to the returned traveller was general incredulity. Even in the present day there are ignorant persons who question the existence of cannibalism. Dr. Schweinfurth has arrived fresh from the cannibals of Monbuttoo with human skulls and bones almost warm from the saucepans of the savages. He can even describe the sauces which these gourmands use in their dainty dishes. Mushrooms and capsicums for a "sauce piquante aux champignons" are the literal civilised adjuncts for a dish off a stewed baby, only two days old, whose mother had deserted it! The baby was dying while the preparations for cooking it were already commenced. This is the real truth and no traveller's joke, as the babies and fond mothers would quickly discover should they visit the tribe of Monbuttoo. It may be asked, "How did Dr. Schweinfurth escape?" but it must be remembered that the Monbuttoo do not eat men of science, who are generally very lean. A fat missionary, with a family fresh from Exeter Hall, may meet with immediate attention, with the warm but brief Monbuttoo invitation, "walk in."

It would be useless for us to closely criticise this book. Few books are perfect. There may be a little excess of detail of the dull routine of African daily life that if omitted would have reduced two bulky volumes to a more convenient size. But on the other hand, some people like bulky volumes and enjoy as many pounds avoirdupois as they can obtain for their money; just as some people, especially the rural population, enjoy long sermons.

We cordially recommend all interested in exploration to read the book, at the same time reminding them that they may safely rely upon the high character and status of the author; for although Dr. Schweinfurth fails as a scientific geographer, he in no way fails as a scientific explorer devoted to the particular object of his studies—botany. In this branch of science he is better qualified than any former African traveller.

Such men as Dr. Schweinfurth will always have the

regard and esteem of all true friends of Science; he belongs to the same metal that has already formed a wedge which will force open the secrets of inner Africa.

OUR BOOK SHELF

Adulterations of Food, with short Processes for their Detection. By Rowland J. Atcherly, Ph.D., F.C.S. (London: W. Isbister & Co., 56, Ludgate Hill, 1874.)

THE attempt to notice the adulterations of food in 100 pages of large type is a somewhat rash one, and it is not therefore surprising that the author of the treatise is frequently compelled to dismiss his subject in a very cursory manner.

For two of the classes of readers whom he addresses, the dealer and consumer, the work will no doubt be of use, and it is also likely to be useful to the chemist, as affording him a brief conspectus of the most likely adulterants in any particular article. Of what use, however, the last 12 pages of letterpress describing the making and use of volumetric solution are to the "trained chemist," to whom the author addresses them, we are at a loss to conceive.

The information given in the part upon adulterations is generally sound, though the statement on p. 34 that prussic acid is found when nitro-benzol has been used as a flavouring is absurd; so far is this from being the case, that it would be an indication of the use of a genuine but insufficiently purified oil of bitter almonds. The process for detecting alum in bread on p. 15 is also very unsatisfactory, and certainly not adapted for the use of either dealer or consumer. The book concludes with 21 neatly executed cuts of various starches, chicory, cocoa, tea-leaves and adulterating leaves found in tea, &c., as seen under the microscope. In conclusion, we would advise the author in a future edition to considerably expand the part on adulteration and to entirely omit the part intended for the "trained chemist," leaving that person to obtain his information on volumetric solutions from the proper sources. R. J. F.

An Easy Introduction to Chemistry. Edited by the Rev. Arthur Rigg, M.A., late Principal of the College, Chester. (Rivingtons: London, Oxford, and Cambridge, 1873.)

THE present work, founded, as the editor states, on a "First Book of Chemistry," by Dr. Worthington Hooker, published in America, is intended for the use of children. Mr. Rigg calls attention to the inquiries of "young persons" as generally suggested by their observations of things touched and handled, and states that his aim has been "To supply information in a form which it is hoped may be intelligible and interesting to all parties concerned in thus learning to read the ever open book of nature."

The intention is a worthy one, and we have no doubt that the work will serve its purpose in instructing some of its readers, though we doubt if it will prove very intelligible for "persons" so young as those to whom the style of its commencement would seem to prescribe its use. We do not say this with any desire to find fault, for it would indeed be difficult to place the information in a simpler form than has been done, but because of the great difficulty of convincing young minds of the alterability of matter. Either talking or reading alone is quite incompetent to do this. Without experimental illustration they are utterly meaningless except to well-advanced intellects, and even there cannot do much, as anyone can tell who has had the honour of meeting the chemist whose knowledge extends not beyond books. In fact, chemistry is not to be taught without the laboratory and its experiments, and Mr. Rigg has shown his sense of their importance by the insertion of 46 beautifully-executed woodcuts of experiments and a frontispiece of a laboratory with its apparatus and fittings.

Excepting in a school, however, the "young persons" of the preface are not likely to meet with the actual experiments of which illustrations are supplied, and those that are of sufficient age to go to such a school might surely have a rather more advanced book placed in their hands. The question, however, which a reviewer ought to ask himself is, Is the book such a one as would fairly carry out the author's intention? and to this we must, in this case, answer "Yes." Granting the possibility of teaching chemistry to young children, Mr. Rigg's book would certainly serve its purpose well. With regard to his facts, Mr. Rigg is, as a rule, sound; but we must demur to his statement on p. 134, that "If (silica) is to these (grasses and grain) and other plants very much what bones are to animals;" and again, on p. 167, "Every stalk of grain or grass is chiefly wood. In both cases fine particles of flint are scattered in the wood to make it firm enough to stand even in a gale of wind." The experiments of Sachs and others have long since disproved this theory. Such blemishes as these are, however, of but little moment when the main principles of the science are the object of teaching, and on these Mr. Rigg is perfectly orthodox. We must, in conclusion, compliment the publishers on the very elegant get-up of the book.

Die Rohstoffe des Pflanzenreiches: Versuch einer technischen Rohstofflehre des Pflanzenreiches. Von Dr. Julius Wiesner. (Leipzig: Engelmann, 1873. London: Williams and Norgate.)

THIS is one of those elaborate German works which seem as if they were intended completely to exhaust the subject of which they treat. Every substance of economical or technical importance which is obtained from the vegetable kingdom is treated of in detail from the point of view of its practical utility rather than its physiological history; its chemical, mechanical, and microscopical properties, the mode of its preparation or manufacture, and its utility in the arts or commerce, are described. The book is, in fact, a repertorium of technical botany.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

On a Proposed Statistical Scale

AT a lecture last Friday evening, at the Royal Institution, I spoke on a subject which happens to lie at the meeting-point of many special sciences, and therefore, as I am desirous of having it well discussed, and from many points of view, it seems to me best to state it afresh in your columns for that purpose. It refers to the *definition* of the estimated *degree of development* of any quality whatever, without reference to external standards of measurement. The scale I propose depends on two processes; the one is securely based on the law of statistical constancy, the other is doubtfully based on the law of frequency of error. (1) At present we are accustomed to deal with averages and the like, which can only be obtained by measuring *every* individual by a *detached standard scale*, and going through an arithmetical process afterwards. Now I want to deal with cases for which no external standard exists, and I propose to proceed in quite another way, on the principle that *intercomparison* suffices to define. We have only to range our group in a long series, beginning with the biggest and ending with the smallest; and then we know by the law of statistical constancy that the individual who occupies the half-way point, or any other fractional position of the entire length, will be of the same size as the individual who occupies a similar position in any other statistical group of similar objects. We state his size with statistical precision by saying that his place is so and so in a series. We appeal to a standard which lies dormant in every group, and which a statistician can evoke, for temporary purposes of comparison, whenever he will. (2) What places in the

series shall we select for our graduations? Equal fractions of its length will never do—I mean such as one-tenth, two-tenths, &c. —because of the great inequality of the variation in different parts of the series, being insensible between those whose position is near its middle and great between those at either end. I propose to use a scale founded on the law of Frequency of Error, which gives a scale of equal parts wherever that law applies, and I use the "probable error" for the unit of the scale. Thus, in a row of a hundred individuals the graduations of $+2^\circ$, $+1^\circ$, 0°, -1°, -2°, respectively would be at the following places, in percentages of the length of the series:—2, 9, 25, 50, 75, 91, 98. We know that the law of Frequency of Error applies very closely to the linear measurements of the human form. Now suppose that I want to get the average height and "probable error" of a crowd of savages. Measuring them individually is out of the question; but it is not difficult to range them—roughly for the most part, but more carefully near the middle and one of the quarter points of the series. Then I pick out two men, and two only—the one as near the middle as may be, and the other near the quarter point, and I measure them at leisure. The height of the first man is the average of the whole series, and the difference between him and the other man gives the probable error. The question I put is, whether any more convenient subdivision of a series can be suggested for *universal use* than that above mentioned. Its merits are, that it applies very fitly to linear measurements of all natural groups; also to errors of observation, which are akin to many of the moral qualities, for the measurement of which the scale is especially needed. It would not apply to weight, but is less out of relation to it than most persons might think, because weights do *not* vary as the cubes of the heights. Tall men are often thin, and short ones are fat, and the curious fact seems thoroughly verified that the general relation between height and weight is *strictly* as the *squares*. (See Gould's "Sanitary Memoirs of the War of the Rebellion," Cambridge, U.S., 1869, p. 408–410.) If we arrange a series and graduate it according to equal differences of the squares of the heights of the men, we are not so far astray as if we had dealt with the cubes. But I cannot imagine any quality, unless possibly music and memory, to vary so rapidly towards the large end of the series as the latter division would show. To sum up: subdivision in *equal* parts is of no use practically, and is therefore out of the question; the law of error will do very accurately for many large groups of cases; the law of error modified by being brought into relation to bulk will rarely, if ever, be right for other qualities. It therefore seems to me reasonable to adopt the law of error series, as the best compromise, and to accept it as "the common statistical scale." If, for example, I estimate a soldier's energy at $+2^\circ$ (S.S.), I state what everybody who cared to inquire into the subject would construe in exactly the same sense as I used the phrase, and he would also be inclined to believe, until better informed, that the difference between such a man's energy and that of a man of $+0^\circ$ (S.S.) was twice as great as between him and a man of $+1^\circ$ (S.S.).

Lastly, how can we best find individuals who represent the 0°, $\pm 1^\circ$, &c., of any and every quality, that they may be studied and their abilities illustrated and described, so as to serve as permanent standards of reference? These would gradually give us means of finding the equivalent of the S.S. graduation in the natural scale—as we might learn to say, $+4^\circ$ (S.S.) of energy $= +3^\circ\cdot5$ in the natural scale. Those who have to deal with bodies of men, whether as examiners, instructors, masters, overseers, or officers, could best tell. How about the ordinary subjects of competitive examination? Is there any optical observation made under (sensibly) identical circumstances and with (sensibly) identical instruments, of which the probable error of each observer is known? If one could only get two or three hundred nautical observers together, and make them take sextant angles of the same objects, and learn the probable errors of each, we should have data to give us once for all the values of the S.S. as regards ability to observe, in terms of absolute values. Can no drawing-master give accurate descriptions of the delicacy of touch of his pupils, corresponding to the graduations of the S.S. scale? How about mechanical manipulation among operatives? How about music and memory? Each separate quality requires and deserves a monograph, which, once thoroughly well done, would become a most valuable standard of comparison and check upon the S.S. scale, which it must be remembered is securely based on no ground except that of statistical constancy, but which, when it *proves* to be a scale of equal parts, is doubly acceptable.

I will not go on writing now, being rather desirous of raising discussion and learning more, than of saying all my say.

42, Rutland Gate, S.W. FRANCIS GALTON

Simultaneous Meteorological Observations

WITH reference to the scheme of international simultaneous observations proposed by the War Department of the United States and adopted by the Meteorological Congress at Vienna in September last, a provisional arrangement was entered into at Vienna, between General Myer and myself, at his desire, by which the Scottish Meteorological Society was to assist the American Government in carrying out the proposed scheme by an exchange of meteorological observations between the two bodies. At a meeting of the Council of this Society on February 9, a letter was read from General Myer, dated January 27, 1874, formally requesting the co-operation of this Society in carrying out the international scheme, which letter being identical with the one on the same subject published in NATURE (vol. ix. p. 300), it is unnecessary to subjoin.

A considerable number of observers have been already obtained in connection with the scheme, and copies of the American *Monthly Weather Review* and *Daily Meteorological Record* have, along with the special schedules for the observations, been sent to them, as an acknowledgment on the part of the American Government for their assistance in the work. The Council are ready to receive the assistance of others of their own observers, and of any other observers who may be willing to cooperate in this cosmopolitan scheme, from which cosmopolitan benefits may be confidently looked for.

ALEXANDER BUCHAN

Scottish Meteorological Society, Edinburgh, March 2

The Limits of the Gulf-stream

MUCH discussion has recently taken place respecting the limits of the Gulf-stream, and the Admiralty Chart of the North Atlantic, published last year, is supposed to embody all that is known of its boundaries. My observations, however, which have extended over a series of years, differ so widely from it that I am induced to send you an abstract chart of them.

In December 1872 I found the stream wedged in to a distance of fifteen miles off Cape Hatteras, and following the coast-line at that distance to Roanoke Sound. On arriving in Norfolk I found that the reports of several ships corroborated my observations.

The remarkable bend east of George's Shoals is confirmed by H.M.S. *Gannet*, and also by the Nantucket fishermen and pilots.

Maury, in his "Physical Geography of the Sea," makes the stream, in summer, wash the southern shores of Newfoundland, but in no month of the year have I found it so far north as the red line in the accompanying chart. I am of opinion that if it once passed over the bank every codfish would be destroyed. The highest temperature recorded by me in September on this line is 56°.

At the points of sudden change I have seen the ripples at the distance of a mile previous to entering them. Those which are recorded may be relied on to a mile, as I have discarded those made from dead reckoning. In every case the deep blue colour of the sea, the presence of sun-fish, Portuguese men-of-war, and numerous *débris*, confirmed the observations made with the thermometer, and I may add, what is of more importance to seamen, the strong easterly set.

The southern boundary of the stream is taken from the observations of five years. As summer advances it becomes more difficult, when east of Bermuda, to detect the line of demarcation, for the rays of the sun heat the water almost to Gulf-stream temperature right down to the limit of the trade-wind. From the data which I have been able to collect, as well as from personal observation, the limits of icebergs in the Admiralty Chart appear to be equally erroneous. To me it appears impossible that bergs could drift square across the heated waters of the Gulf-stream to lat. 39° N. almost in the teeth of the prevailing summer winds, and a strong north-easterly set of two miles per hour. The Admiralty Chart gives the current a higher velocity.

The most southern iceberg ever seen by a Cunard steamer (and there cannot be a higher authority) was in lat. 43° 10′ N., long. 49° 40′ W., and the most eastern, which has come under my observation, by the *Grace Gibson*, on June 11, 1868, which ship passed four between lat. 43° 15′ N. and 43° 20′ N. and long. 41° 20′

W. to 42° 10′ W. It certainly must appear singular to geographers that the limits of the best-known stream in the world should be so ill-defined; but the temperature of the sea at the places marked in the chart cannot suddenly change 12° from any other cause than the irruption of the Gulf-stream or the ordinary waters of the ocean. Had it occurred in a single season only, the correctness of the observations might have been impugned; but extending, as they do, over several years, their accuracy cannot be challenged.

It is the opinion of many that the Gulf-stream is extending its boundaries northward, and ameliorating the climate of the British islands. Such an assumption is not an impossibility, although there are no changes of volume or velocity at its outlet into the Atlantic. There are, however, grounds for believing that the Labrador current does not run with its former force, as icebergs are seldom seen south of the parallel of 43° 30′ north latitude. Observation can alone confirm this theory, but whether correct or not it in nowise affects the accuracy of my data.

WM. W. KIDDLE

U.S. White Star Mail Steamship *Oceanic*, Feb. 2

[We have received a chart from Mr. Kiddle; but it is too large for insertion in NATURE.]

A Lecture Experiment

MR. TAIT's letter in NATURE of February 26 calls to mind an effective lecture illustration I have used in my classes to illustrate a fog or cloud produced by cooling air containing moisture. Instead of using an air-pump as described in "Heat, a mode of Motion," take a flask of one or two litres capacity, rinse it out with distilled water, and attach to the neck a cork and glass tube of about twenty or thirty centimetres in length. Place the glass tube in the mouth and exhaust, when a dense cloud will be formed; then on blowing into the flask the cloud disappears. The cloud may be produced and dissolved as often as wished, and if a beam from the oxy-hydrogen light be sent through the flask, the experiment becomes very effective.

Midland Institute, Birmingham C. J. WOODWARD

The "Treasury of Botany"

IT might be inferred from your notice of the new edition of the "Treasury of Botany" (NATURE, vol. ix. p. 300) that the stereotyped pages of the original text of that work—of which you are pleased to speak in terms of commendation—had been reprinted without alteration. Will you allow me space to state that this is by no means the case (as indeed is stated in the preface), but that a large number of corrections have been made, as may be detected by a keen eye in consequence of the slight difference which is observable in the type where the alteration has extended over two or three lines or more. Hence it is not to the Supplement alone that the reader must look for such of the "additions to botanical knowledge made during the last eight years" as it has been found practicable to include in the revised edition.

THOS. MOORE

[WE are glad of the opportunity afforded by the foregoing letter of repeating our opinion, already expressed, that in the department of botanical nomenclature and classification, the new edition of the "Treasury of Botany" is an altogether admirable and indispensable work. It is in this department only, or almost exclusively, that the corrections alluded to by Mr. Moore—and to which we perhaps ought to have called special attention—have been made, at least as far as we have been able to detect. We regret that we cannot withdraw from our statement that the same care has not been taken with the histological and physiological section. We might quote a number of instances in support of this assertion—a very ungracious task in speaking of a work so excellent in other respects—but will only refer to a single one. Notwithstanding that a very good and useful epitome of the more important properties of "Cellulose" is given in the Supplement, the statement is allowed to stand in the article in the body of the work, that "its composition, according to the latest analysis, is $C_{24}H_{20}O_{10}$" a formula which does not, and never did, even under the old notation, represent anything near its composition. —A. W. B.]

The Moons of Uranus

IN your "Notes," this week, it is stated that since Mr. Lassell's observations at Malta, no one has seen the four moons of Uranus, until the re-discovery of the two small ones lately with the new Washington telescope.

In 1869-70, the planet was observed with the Melbourne reflector; the observations were specially directed to the disc, but at the same time the positions of the four satellites were noted on successive nights and thus identified.

I speak from memory, but have no doubt that the observations are to be found in the Melbourne records. The statement "have actually been measured by Prof. Newcomb," probably refers to position, angle, and distance.

March 1 L. S.

MEN OF SCIENCE, THEIR NATURE AND THEIR NURTURE*

THE lecturer spoke of the qualities by which the English men of science of the present day were characterised; he showed the possibility of defining and measuring the amount of any of those qualities, and concluded by summarising the opinions of the scientific men on the merits and demerits of their own education, and gave his interpretation of what, according to their own showing, they would have preferred. His data were obtained from a large collection of autobiographical notes, most obligingly communicated to him, in response to his requests, from the larger part of the leading members of the scientific world. He had addressed 180, who, being Fellows of the Royal Society, had, in addition, gained medals or filled posts of recognised scientific position; 115 answers had already been received, of which 80 or 90 were full and minute replies to his long and varied series of questions. He dealt with only a small part of his deductions from this valuable material, referring to a forthcoming work for the rest.

Regarding the chief qualities in the order of their prevalence among the scientific men, they were—(1) Energy both of body and mind; (2) Good health; (3) Great independence of character; (4) Tenacity of purpose; (5) Practical business habits; and (6) What was usually the salt of the whole, strong innate tastes for science generally or some branch of it. He illustrated his remarks by reading many anonymous extracts from the returns, and explained in what way a notable deficiency in any of the above-mentioned qualities would tend to disqualify a man from succeeding in science.

As to the measurement of qualities, it was argued that the law of constancy in vital statistics might be taken for granted, being evidenced by the experience of insurance offices against fire, death, shipwreck, and other contingencies, always with the proviso that the facts are gathered with discretion, on well-known general principles. Hence we may say with assurance, that although two common nuts may differ, yet the contents of different packets, each containing 1,000 nuts, will be scarcely distinguishable, for the same number of nuts of different sizes will be found in each. Let the contents of the several packets be each arranged in a long row, in order of size, beginning with the biggest nut and ending with the smallest, and place the rows rank behind rank; then by the law of statistical constancy the nuts in the same *files* will in all cases be closely alike (except the outside ones, where more irregularity prevails). Again, if we incorporate two rows into one of double length, still preserving the arrangement as to regular gradation in size, the centre nuts of the two original series will still be found at or near the centre of the compound series, the nuts in quarter positions will still be in quarter positions, and so on. Hence, whatever be the length of the series the *relative* position in it of the nut will be a *strict criterion* of its size. This is of course equally true of all groups of qualities or characters

* Lecture on Friday evening, Feb. 27, at the Royal Institution, by Franci Galton, F.R.S.

whatever, in which the law of statistical constancy prevails, the series, in each case, being arranged according to gradations of the quality in question. Each individual is measured against his neighbour, and it is quite unnecessary to have recourse to any external standard. As regards a scale of equal parts, the lecturer made use of a converse application of the law of "frequency of error," which he illustrated by many experiments, and which showed that in a row (say as before) of nuts, if we took those which occupied the three quarterly divisions (1st quarter, centre, 3rd quarter) as the three elementary graduations of size, a range of successive graduations would be obtained by the following series, in which the places of the nuts are supposed to be reckoned from the end of the row where the large nuts are situated, and to be given in per-thousandths of the entire length of the row. It might be called the "Common Statistical Scale" (S. S.). The place of $+ 4°$ would be at 4 thousandths from large end; $+ 3°$, at 21 thousandths; $+ 2°$ at 89; $+ 1$, at 250; $0°$ at 500; $- 1°$ at 750; $- 2°$ at 911; $- 3°$ at 979; and $- 4°$ at 996, or 4 thousandths from the small end of the row. Thus if we say that the size of a nut is $+ 2°$ S. S., we absolutely define it. Anybody can procure such a nut independently by getting a quart of nuts and arranging them. Also we know that the difference between a nut of $+ 4°$ S. S. and $+ 1°$ S.S. is 3°, and therefore three times as great as between one of $+ 2°$ S. S. and the latter. It cannot be affirmed that this is a precise scale of equal parts for all qualities, but it is found to hold surprisingly well in a great variety of vital statistics; perhaps, too, the mere thickness of tissues may be a chief element in the physical basis of life. This scale appears, at all events, more likely to be nearly approximative to one of equal parts, for qualities generally, than any other that can be specified, and it certainly affords definite standards subject to the law of statistical constancy. The habit should therefore be encouraged in biographies, of giving copious illustrations which tend to rank a man among his contemporaries, in respect to every quality that is discussed, in order to give data for appraising those qualities in terms of the Statistical Scale. By the general use of a system of measurement like the above, social and political science would be greatly raised in precision.

Regarding education, the lecturer disavowed speaking of what might be suitable for boys generally, but he summarised the replies of the scientific men with reference to their own special experience, and notwithstanding the diversity of branches of science, he found unanimity in their replies. They commonly expressed a hatred of grammar and classics, the old-fashioned system of education being utterly distasteful to them. The following seems the programme they themselves would have most liked:—1. Mathematics, rigorously taught up to their capacity, and copiously illustrated and applied, so as to throw as much interest into its pursuit as possible. 2. Logic. 3. Some branch of science (observation, theory, and experiment), some boys taking one branch and some another, to insure variety of interests under the same roof. 4. Accurate drawing of objects connected with that branch of science. 5. Mechanical handiwork. All these to be rigorously taught. The following not to be taught rigorously: reading good books (not trashy ones) in literature, history, and art. A moderate knowledge of the more useful languages taught in the easiest way, probably by going abroad in vacations. It is abundantly evident that the leading men of science have not been made by much or regular teaching. They craved for variety. Those who had it, praised it; and those who had it not, concurred in regretting it. There were none who had the old-fashioned high-and-dry education who were satisfied with it. Those who came from the greater schools usually did nothing there, and have abused the system heartily.

INFLUENCE OF GEOLOGICAL CHANGES ON THE EARTH'S ROTATION

AT the annual meeting of the Geological Society of Glasgow, on Feb. 12, the president, Sir William Thomson, F.R.S., gave an address on the above subject, of which the following is an abstract:—

He first briefly considered the rotation of rigid bodies in general, defining a principal axis of rotation as one for which the centrifugal forces balance while the body rotates around it. He then took the case of the earth; and, having pointed out the position of its present axis, showed that if from any cause it were made to revolve round any other, that would be an "instantaneous axis," changing every instant, and travelling through the solid, from west to east, in a period of 296 days round the principal axis It would shift continually in the figure, owing to the varying centrifugal force of two opposite portions of the body. This would produce, by centrifugal force, a tide of peculiar distribution over the ocean, having 296 days for period. An inclination of the axis of instantaneous rotation to principal axis of 1″, or 100 ft. at the earth's surface, would produce rise and fall of water in 45° latitude, where the effect is greatest, amounting to ·17 of a foot above and below mean level.

He noticed, in passing, the application of these dynamical principles to the attraction which the sun and moon exercise on the protuberant parts of the earth, tending to bring the plane of the earth's equator into coincidence with the ecliptic. This causes an incessant change, to a certain limited extent, in the position of the axis of rotation, thereby occasioning what is known as the "precession of the equinoxes." Having illustrated these remarks by some interesting experiments, Sir William Thomson proceeded to consider more particularly the circumstances according to which the axis of the earth might become changed through geological influences, and the consequences of any such change. The possibility of such a change had been adduced to account for the great differences in climate which can be shown to have obtained at different periods in the same portion of the earth's surface. In the British Isles, for example, and in many other countries, there is clear evidence that at a comparatively recent period a very cold climate—much colder than at present—prevailed; while in the same places the remains of plants and animals belonging to several preceding eras indicate a high temperature and a comparatively tropical climate. The question arose, can changes in the earth's axis account for these changes of climate? In the present condition of the earth, any change in the axis of rotation could not be permanent, because the instantaneous axis would travel round the principal axis of the solid in a period of 296 days, as already stated. Maxwell had pointed out that this shifting of the instantaneous axis in the solid would constitute in its period a periodic variation everywhere of "latitude," ranging above and below the mean value, to an extent equal to the angular deviation of the instantaneous axis of rotation from the principal axis; and, by comparing observations of the altitude of the Pole-star during three years at Greenwich, had concluded that there may possibly be as much as ½″ of such deviation, but not more.

In very early geologic ages, if we suppose the earth to have been plastic, the yielding of the surface might have made the new axis a principal axis. But certain it is that the earth at present is so rigid that no such change is possible. The precession of the equinoxes shows that the earth at present moves as a rigid body; and during the whole period of geologic history, or while it has been inhabited by plants and animals, it has been practically rigid. Changes of climate, then, have not been produced by changes of the axis of the earth. The learned professor then inquired what influences great subsidences or

great elevations in different parts of the earth might have on the axis of rotation. No doubt the removal of a large quantity of solid matter from one part of the globe to another would sensibly alter the principal axis, as well as the axis of rotation, which so nearly coincides with it; but it could be shown that it would produce in the latter only about 1-300th part of the change produced in the former. We know too little of the changes in the interior of the earth accompanying such changes on its surface to be able to state results with certainty. But he estimated that an elevation, for example, of 600 feet on a tract of the earth's surface 1,000 miles square and 10 miles in thickness would only alter the position of the principal axis by *one-third of a second*, or 34 feet. He called attention to the effect of tidal friction and subterranean viscosity in reducing any such deviation, and pointed out that it must be exceedingly slow; using for evidence the observationally proved slowness of the diminution of the earth's rotational velocity, and of the inclination of its equator to the ecliptic. It therefore seemed probable that geological changes had not produced any perceptible change in the principal axis or in the axis of rotation within the period of geological history.

OBSERVATIONS OF MAXIMUM AND MINIMUM SEA-TEMPERATURES BY CONTINUOUS IMMERSION

WHEN the Scotch Meteorological Society was instituted, now nearly twenty years ago, observations on sea-temperature were set on foot at the suggestion of the late Prof. Fleming, and have since been continued. These observations were made by the immersion of thermometers with small cisterns attached, and were taken at the surface and at a depth of 6 feet. Besides these, special observations were made for me on the temperature of the flood and ebb tide at depths extending to 50 feet in the Pentland Frith,* and hourly observations continued at intervals during four years ending in 1863 by Capt. Thomas, R.N., at depths extending to 60 feet.† Such occasional observations seemed to me to be insufficient to show properly the changes in temperature to which the sea is subject, and in August 1872 I suggested to my friend, Prof. Wyville Thomson, the propriety of ascertaining, on his exploring voyage, maximum and minimum temperatures by means of thermometers constantly immersed in the sea. For this purpose a thin malleable iron plate of an oval shape, as shown in Fig. 1, is fixed to the outside skin of the ship so as to form a small cell into which the sea-water finds ready ingress through numerous perforations. This cell, which need not project more than two inches, so as not to cause any appreciable obstruction to the speed of the vessel, should extend so far under the smooth water level as to prevent its lower end from rising above the trough of the sea, or an upright pipe might be placed within the vessel. In sailing ships there might be a cell on each side so as to secure constant immersion while the ship "is on a wind." In this cell a frame carrying a maximum and minimum thermometer slides in checks so as to be capable of being raised above water to the level of the cabin or the deck, where there should be a porthole to admit of the instruments being read and the indices being re-adjusted.

An arrangement similar in principle to that described was made in the *Challenger* exploring vessel before she left on her voyage.

In this way, during the whole of an over-sea voyage, regular observations of maxima and minima may be obtained as often as may be desired. This arrangement is peculiarly suitable to floating lights, and the Scotch Meteorological Society have been in correspondence with the Mersey Board in order to establish observations at the North-West Lightship.

The Marquis of Tweeddale in 1872 proposed that the Scotch Meteorological Society should enter upon the investigation of the migrations of fishes, and particularly those of the herring, in connection with sea-temperatures and weather generally, and his Lordship informed me that in his opinion it was likely that the herrings followed belts of water of a higher temperature than that of the sea generally.

In carrying out his Lordship's suggestion the Society has been favoured through the courtesy of the Fishery Board with returns of the daily catch of herrings and of the weather from the different fishing districts of Scotland for the last two years; and already two elaborate reports on the subject have been drawn up by Mr. Buchan, the Secretary, and published, which give good ground to hope that some positive results of considerable importance will be obtained. With reference to this investigation, I suggested, for piers and harbours, the adoption of a cast-iron pipe for containing the thermometer as shown in Fig. 2, and application was accordingly made to the Trustees of Peterhead harbour, where observations by continuous immersion have been made by Mr. William Boyd, F.R.S.E., since May 1873. It is to be regretted that these observations have in the meantime been stopped, owing to a ship having come in contact with the pipe.

FIG. 1.

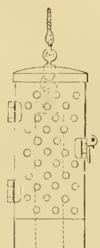


FIG. 3.

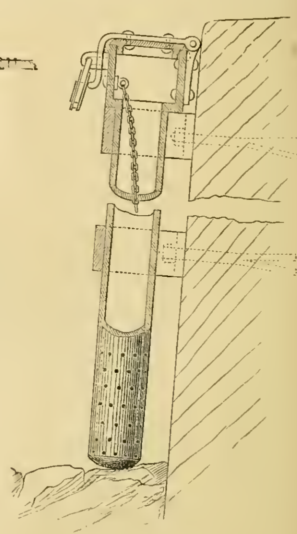


FIG. 2.

In addition to observations near the surface at floating lights, it would be extremely desirable to have thermometers immersed at greater depths, and for this purpose a copper vessel weighted below should be used, as represented in Fig. 3, with perforations in the upper part and a cistern about 4 in. deep in the lower part. The Scotch Meteorological Society, at its meeting on February 9 last, authorized an application to the different lighthouse authorities for sanctioning these deep-water observations as well as those of the surface and of the air.

THOMAS STEVENSON.

* "Edin. Phil. Jour." Nov. 25, 1857.
† "Jour. Scot. Met. Soc." vol. i., p. 256.

OZONE*

I.

TOWARDS the end of the last century, Van Marum, while experimenting with his powerful electrical machine, observed that oxygen gas through which electrical sparks had been passed acquired a peculiar odour and the property of attacking mercury. This subject attracted no further attention for upwards of half a century after the publication of Van Marum's observations.

The discovery of ozone was announced by Schönbein in a memoir which he presented in 1840 to the Academy of Munich. In this important communication he states that in the electrolysis of water, an odorous substance accompanies the oxygen evolved at the positive pole, that this substance may be preserved for a long time in well-closed vessels, and that its production is influenced by the nature of the metal which serves as the pole, by the chemical properties of the electrolytic fluid, and by the temperature of that fluid, as well as of the electrode. The same body he found to be produced by holding a strip of platinum or gold near the knob of the prime conductor of an electrical machine in good order. With great sagacity he recognised the identity of the peculiar odour which accompanies a flash of lightning with that of the new substance. In this memoir Schönbein supposes the odorous body, for which, in a note at

FIG. 2.

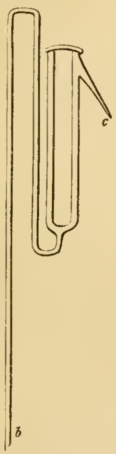


FIG. 1

the end, he proposes the name of ozone, to be a new electro-negative element belonging to the same class as chlorine and bromine; but in a paper published a little later he hints that ozone may be one of the constituents of nitrogen.

Schönbein soon afterwards discovered that ozone is formed when phosphorus oxidises slowly in moist air or oxygen.

In the following year, he returned to the consideration of the subject, and partly from his own observations, partly from experiments communicated to him by De la Rive and Marignac, he abandoned his former view of the nature of ozone, and concluded that it is an oxide of hydrogen different from the peroxide of hydrogen of Thénard.

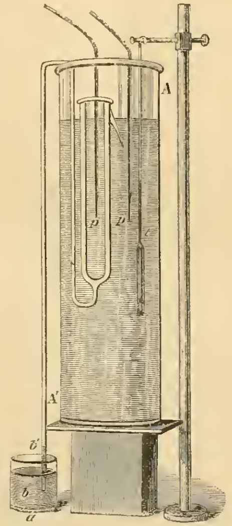
Many of the properties of ozone described by Schönbein were soon afterwards verified by Marignac, who found, as Schönbein had already stated, that it is only in the presence of moisture that air or oxygen when passed over phosphorus produces ozone, and that no ozone can be formed from air, even if moist, which has been deprived of its oxygen. He also confirmed the observations of Schönbein that the peculiar properties of ozone disappear when it is heated to a temperature between 300° C. and 400° C., and that it is not absorbed by water or sulphuric acid.

* An Address delivered before the Royal Society of Edinburgh on December 22, 1873, by Dr. Andrews, LL.D., F.R.S., Honorary Fellow of the Royal Society of Edinburgh.

In a subsequent investigation (1845) which Marignac conducted with De la Rive, the important fact was established that ozone is formed by the passage of electrical sparks through pure and dry oxygen gas. Frémy and Becquerel also showed that pure oxygen contained in a tube inverted over a solution of iodide of potassium is entirely absorbed by that liquid, if electrical sparks are passed for a sufficiently long time through the gas.

The last hypothesis of Schönbein, according to which ozone is an oxide of hydrogen, was manifestly inconsistent with the production of that body by the passage of electrical sparks through pure and dry oxygen. On the other hand, it received support from some experimental inquiries which appeared about this time, and particularly from an elaborate investigation which was conducted by Baumert in the laboratory of the University of Heidelberg, and published in *Poggendorff's Annalen* for 1853. Baumert maintained that water is always formed when dry ozone, prepared by electrolysis, is destroyed or decomposed by heat, and further endeavoured to establish its composition by determining the increase of weight of a solution of iodide of potassium when it is decomposed by ozone. He inferred, as the result of his researches, that two distinct bodies had been confounded

FIG. 3



under the name of ozone; (1) allotropic oxygen, formed by the passage of the electrical spark through oxygen; and (2) a teroxide of hydrogen, produced in the electrolysis of water. The experiments and conclusions of Baumert attracted a great deal of attention at the time they were published, and received very general assent.

Having repeated, soon after it was announced, the experiment of Baumert, in which ozone prepared by electrolysis was destroyed by heat, and having failed to obtain the slightest trace of water in numerous trials, I deemed it important to undertake a careful investigation of the subject, the results of which were communicated in 1853 to the Royal Society of London. By employing an acidulated solution of iodide of potassium, I found that its increase of weight, when decomposed by ozone, exactly agreed with the weight of the ozone calculated as allotropic oxygen from the iodine set free. The numbers deduced from five careful experiments were 0·1179 grammes for the increase in weight of the solution, and 0·1178 grammes for the calculated weight of the oxygen. As regards the supposed formation of water in the destruction of ozone by heat, it may be sufficient to mention the results of two experiments performed with great care, in one of which 6·8 litres of electrolytic oxygen containing

27 milligrammes of ozone, and in the other 9·6 litres of the same gas containing 38 milligrammes of ozone, were exposed to the action of heat, so as to destroy all ozone reactions, when not a trace of water was obtained; the increase in weight of the desiccating apparatus being in the first case only one-third, and in the second one-half, of a milligramme. If Baumert's experiments had been correct, 24 milligrammes of water should have been formed in these experiments. The general conclusions at which I arrived were: "that no *gaseous* compound, having the composition of a peroxide of hydrogen, is formed during the electrolysis of water, and that *ozone from whatever source derived is one and the same body, having identical properties and the same constitution, and is not a compound body, but oxygen in an altered or allotropic condition*." ("Phil. Transactions" for 1856, p. 13.)

The next step in the investigation of this singular body was the discovery that oxygen gas in changing into ozone diminishes in volume, or becomes condensed, recovering its original volume when the ozone is changed back into oxygen by the action of heat or otherwise. This relation between ordinary oxygen and ozone was first announced in 1860 by Prof. Tait and myself in a communication to the Royal Society of London. Oxygen gas in a dry and pure state was introduced into a tube sealed at one end and terminating at the other in a fine tube bent as shown in Fig. 1, and containing a short column of sulphuric acid. Two platinum wires were hermetically sealed into the sides of the wide tube, the distance of the ends within the tube being about 20 millimetres.

When an electrical discharge without visible sparks was passed between the extremities of the platinum wires, the sulphuric acid rose in the adjacent leg of the U-tube, and from the change of level the amount of the condensation, or diminution of volume, which the oxygen had undergone was easily calculated. The apparatus was then hermetically sealed and the reservoir heated to 270° C., so as to destroy the ozone. After allowing the reservoir to cool, the sealed end of the U-tube was opened, when the original volume of the gas was found to be restored. Strong electrical sparks were found to give scarcely one-fourth of the contraction which occurred with the silent discharge, and if sparks were passed through the gas when fully contracted by the silent discharge, the contraction was reduced to that which the spark would have produced in the original gas. In the same paper it was shown that no further diminution of volume occurred when the contracted gas was agitated with a solution of iodide of potassium so as to absorb the ozone. A similar result was obtained on agitating the contracted gas with iodine. The ozone reactions in all these cases disappeared, but without any change in the volume of the gas. With mercury and silver, not only was there no contraction, but expansion actually occurred, which was explained on the assumption that the oxide at first formed exercised a catalytic action on part of the ozone and restored it to the state of ordinary oxygen. Similar results were obtained with electrolytic ozone. Three years later these experiments on the condensation of oxygen in changing into ozone, and on the action of ozone upon a solution of iodide of potassium were repeated and confirmed by Von Babo and by Von Babo and Claus.

We did not attempt to give any absolute explanation of these singular facts; but discussed them under different aspects. We showed that on the allotropic view of the constitution of ozone its density must be enormously great; unless it was assumed that "when ozone comes into contact with such substances as iodine, or a solution of iodide of potassium, one portion of it, retaining the gaseous form, is changed back into common oxygen, while the remainder enters into combination, and that these are so related to one another that the expansion due to the former is exactly equal to the contraction arising from the latter." On this assumption, which however we did not consider probable, we remarked that "our experiments may be reconciled with the allotropic view, and an ordinary density, but still one greater than that of oxygen." A similar explanation of our experiments but connected with a peculiar view of the molecular constitution of oxygen was proposed in 1861 by Dr. Odling. "If we consider," he remarks, "ozone to be a compound of oxygen with oxygen and the contraction to be consequent upon their combination, then if one portion of this combined or concentrated oxygen were absorbed by the reagent, the other portion would be set free, and by its liberation might expand to the volume of the whole; thus, if we suppose three volumes of oxygen to be condensed by their mutual combination into two volumes, then on absorbing one-third of this combined oxygen by mercury, the remaining two-thirds would be set free and consequently expand to their normal bulk, or two volumes—

$$\overset{-}{O}\,\overset{+}{O}\,\overset{-}{O} + \overset{+}{Hg^2} = \overset{+}{Hg^2}\overset{-}{O} + \overset{+}{O}\,\overset{-}{O}."$$

Soret, experimenting in 1866 upon the mixture of oxygen and ozone obtained by electrolysis, made the important discovery, that if this mixture is brought into contact with oil of turpentine, or oil of cinnamon, a diminution of volume takes place, equal in amount to twice the augmentation of volume which the same mixture would sustain if the ozone were converted by heat into ordinary oxygen. In other words the volume of ozone, measured by its absorption by the essential oil, is twice as great as the difference between the volume of the same ozone and oxygen. Hence Soret concluded that the density of ozone is one and a half times that of oxygen gas.

The latest investigations on this subject are due to Meissner and Brodie. The former has fully confirmed my early experiments, according to which the increase in weight of an acid solution of iodide of potassium, when electrolytic ozone is passed through it, corresponds exactly to the weight of oxygen absorbed, as calculated from the liberated iodine. Meissner has also found, as I had long before stated, that when a neutral solution of iodide of potassium is employed, the results are variable and untrustworthy.

Brodie has examined the action of ozone on a variety of liquids, and has confirmed the results of Prof. Tait and myself that no diminution of volume occurs when ozone is removed from a mixture of ozone and oxygen by a solution of iodide of potassium. With other liquids he has obtained volumetric results which he considers to be definite and which differ from any previously observed. I am inclined to think that they are rather complex cases, involving the volumetrical changes already known in variable proportions. His experimental results, moreover, when examined in detail, do not appear to be sufficiently concordant to justify the sharp conclusions he has deduced from them.

Brodie has obtained for ozone prepared by the electrical discharge the same density (one and a half times that of oxygen) which Soret had previously obtained for ozone prepared by electrolysis. He considers a suggestion of Prof. Tait and myself, that oxygen may possibly be decomposed by the electrical discharge, not to be supported by the facts he has observed.

I will now give a brief statement of the methods of preparing ozone and of its leading properties.

Ozone may be obtained by the action of the electrical spark, or the glow or silent discharge on pure oxygen. With the silent discharge, as has been before stated, at least four times as large an amount of ozone is obtained as with the spark. As regards the actual amount of oxygen which, under the most favourable conditions can be converted into ozone, the highest recorded result was obtained in an experiment by Prof. Tait and myself, in which a contraction of one-twelfth of the original volume of the oxygen, or 8·3 per cent., occurred; but we were unable in other trials to produce again so great a diminution of volume. The greatest contraction attained in the experiments of Von Babo and Claus amounted to 5·74, and in those of Brodie to 6·52 per cent. The doubt which existed as to the accuracy of our solitary experiment I have lately been able to remove, and by a slight modification in the form of the apparatus I have succeeded in obtaining greater contractions than any hitherto recorded. In one of the first trials the diminution of volume amounted to more than 10 per cent., and there can be little doubt that with care even greater contractions than this may be attained.

As the method referred to enables the contraction of oxygen in changing into ozone to be exhibited as a class experiment, I will describe it in some detail. The excellent induction tube of Siemens, in which the electrical discharge from an induction coil acts upon air or oxygen, as it flows between two thin tubes of glass, whose surfaces are at a distance of a few millimetres from one another, has hitherto been employed to obtain a continuous stream of ozone in a more or less concentrated state. But this apparatus can easily be modified so as to show the contraction which takes place when oxygen is converted into ozone. Fig. 2 exhibits the modification I have given for this purpose to the ordinary form of Siemens' tube. At *c* it terminates in a capillary tube, the end of which is hermetically sealed, after a stream of pure and dry oxygen gas has been passed through the apparatus for a sufficient time to displace the air. In exact experiments the other end (*b*) is at the same time sealed and afterwards opened under sulphuric acid. For class purposes it will

be found sufficient to immerse it quickly under the acid, contained in the beaker (*a*), as shown in Fig. 3, where the induction-tube is seen immersed to within 12 millimetres of its upper surface in water contained in an *insulated* cylindrical vessel (A A′). The inner cavity of the induction-tube is also filled with water to about the same level. By means of wires covered with caoutchouc, except at the lower ends (*p p′*), the discharge from an induction-coil, capable of giving 10 millimetre sparks in air, can be passed through the apparatus. The water in A A′ is maintained as steadily as possible at the temperature of the apartment, and any slight changes in the course of the experiment are noted by means of a delicate thermometer (*t*). The variations of the barometer are also carefully observed. In very exact experiments the surfaces of the induction-tube should be covered with tinfoil, and the cylindrical vessel filled with ice. Before commencing the observation, it will be found convenient, if the temperature has not already effected the adjustment, to expel a little oxygen from the induction-tube, so that the level of the acid may stand somewhere about *b′*. On passing the electrical discharge, the acid will at first be depressed a few millimetres, from the repulsive action of the particles of the electrified gas, but will afterwards steadily rise, and for some time with such rapidity that the ascent of the acid column can be easily followed by the eye. When the current is interrupted, a sudden rise of the acid column will occur equal to the depression which took place on first making connection with the induction coil, after which the new level of the acid may be read.

Another method of obtaining ozone is by the electrolysis of water and of certain acid and saline solutions. The most convenient liquid for this purpose is a mixture of one part of sulphuric acid with six or eight parts of water, and the lower the temperature at which the electrolyte is maintained during the process the greater is the amount of ozone. The simplest and most efficacious arrangement for obtaining ozone by this method is one I have used for many years and exhibited in my lectures. It consists

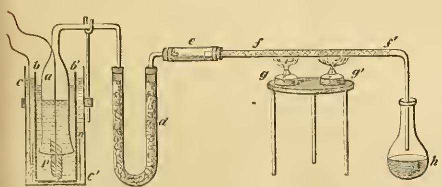


Fig. .

of a bell-jar (Fig. 4, *a*), or glass cylindrical vessel, open below, and contracted to a neck above, which is suspended in a round cell (*b b′*) of porous earthenware, leaving a clear space of two inches between its lower edge and the bottom of the porous cell. The whole is placed in a glass jar (*c c′*) of somewhat larger dimensions than the cell; a bundle of platinum wires (*p*) suspended below the bell-jar serves as the positive pole, and a broad ribbon of platinum (*n n′*) placed between the outer glass jar and the porous cell as the negative pole of a voltaic arrangement of three or four couples. A delivery tube hermetically united to the neck of the bell-jar conveys the mixture of oxygen and ozone disengaged at the positive pole to a sulphuric acid drying tube (*d*). From the desiccating tube the gas passes through the connecting tube (*e*) and thence to other tubes, for the purpose of illustrating the properties of ozone. Thus, in the figure, it is represented as traversing a tube of hard glass (*f f′*) covered with fine wire gauze, and terminating near the surface of mercury contained in the flask (*h*). So long as the gas is heated strongly as it passes through the tubes (*f f′*) by the spirit lamps (*g g′*), not the slightest change is produced upon the mercury; but when the lamps are removed, and the tube allowed to cool, the mercury is rapidly attacked. I ought, perhaps, to mention that all the junctions are made with dry and tightly fitting corks, care being taken that the ends of the connecting tubes project a little beyond the corks. With these precautions the loss of ozone, from its action on the corks, is altogether insignificant.

Ozone can also be obtained by the slow oxidation of phosphorus, and of certain ethers and essential oils in presence of moisture.

(*To be continued.*)

NOTES

One of the last and one of the best acts of the late Government was to grant a pension of 150*l.* a year on the Civil List to Prof. Sharpey. Dr. Sharpey has done as much as any living teacher for the advancement of physiological knowledge, while his personal worth has secured for him universal respect and esteem.

At the last monthly meeting of the Russian Imperial Geographical Society M. Venioukoff, the secretary, before proceeding with the business of the evening, said the Society owed a duty which must first be fulfilled, and that was to render homage to the memory of Dr. Livingstone, the importance of whose discoveries and the perseverance of whose labours had placed him in the rank of the most remarkable travellers of all times and of all nations. His biography belonged to the annals of geographical science. M. Venioukoff then read a memoir of Livingstone, which concluded as follows:—"Let England, which may be proud of having given birth to Livingstone, and of having supported him in his labours, learn that among us the merit of her great men can be appreciated." The whole assembly, which was very large, then rose in order to pay a last tribute of respect to the memory of Dr. Livingstone.

The University of St. Andrew's has conferred upon Mr. J. Gwyn Jeffreys, F.R.S., the honorary degree of LL.D.

We would draw special attention to the programme, which has just been issued, of a new course of twelve lectures on Zoology, to be delivered during the ensuing spring, in the Zoological Gardens, Regent's Park; the Council of the Society having determined to appropriate the interest of a small bequest which they hold for scientific purposes—the Davis Fund—to the subject. Mr. P. L. Sclater, F.R.S., the Secretary to the Society, will deliver the Introductory Address on April 14; and he will follow it by four lectures *On the Geographical Distribution of Mammals.* After these Mr. A. H. Garrod, the Prosector to the Society, will give five lectures *On the General Classification of the Vertebrata;* and Dr. Carpenter, F.R.S., will conclude the course by giving two *On the Aquarium and its Inhabitants.* The lectures will be delivered on the Tuesdays and Fridays in April and May, at 5 o'clock in the afternoon; they will be free to Fellows of the Society and their friends, and to other visitors to the Gardens. The subjects will be treated in a manner which will make them of general interest, and it is to be hoped that ladies will avail themselves of the opportunity thus afforded, of obtaining information on this too much neglected branch of the great science of Biology.

Mr. Philip Barnes, who died on Feb. 24, at the age of 82, was one of the oldest Fellows of the Linnean Society. He was a native of Norwich, and a cousin of the Sowerbys. Thirty-four years ago he founded the Royal Botanic Gardens in the Regent's Park, and was the oldest Fellow and father of the Society. A portrait of Mr. Barnes was in the last International Exhibition, and a bust in that of the year before. He was father of Robert Barnes, M.D., and of the late Philip Edward Barnes, the former known in the scientific world by his professional discoveries and writings, and the latter the author of a work on the Belgian Constitution.

The death, from heart-disease, of Prof. J. F. Holton is announced as having taken place in Everett, Massachusetts, U.S., on the 25th of January. Prof. Holton was well known as a botanist, having devoted many years to the study of the science. He visited South America with special reference to prosecuting his researches in this direction, and studying the relation between the physical geography and the vegetation of the Andes. His somewhat extended sojourn in that country enabled him to collect materials for a work, which was published after his return by Harper and Brothers, and is frequently quoted by botanists.

MR. WILLIAM DUNVILLE has presented a valuable endowment in trust for ever to the Queen's College, at Belfast. The endowment consists of two studentships, one for the encouragement of the mathematical and physical and the other for that of natural sciences. They are intended by the donor to enable distinguished students who attained graduation to pursue their collegiate studies further. The studentships are tenable for two years, and are of the value of 45*l*. for the first, and 100*l*. for the second year.

WE hear from Cambridge, Massachusetts, that the chair of Zoology held by Professor Agassiz during his lifetime is most probably to be discontinued, and that the teaching he was accustomed to give will, for some time at least, be carried on by Prof. McCrady and Prof. Shaler. Mr. Alexander Agassiz is to be Curator of the Museum, which post being very onerous, prevents him from accepting any professorial work. The new Zoological School at Penikese is also to be under his charge, and we hope that that promising institution will be kept up with vigour notwithstanding the great loss it has sustained in the death of its illustrious founder.

WE learn from the *Lancet* that a memorial to Agassiz is in contemplation. At Boston a meeting for the purpose was addressed by Profs. Rogers and Wendell Holmes, after which it was resolved to make the Museum of Zoology at Cambridge—the work of Agassiz's best years—a memorial monument. For this it was proposed to raise the sum of 300,000 dols. to complete its endowment. 65,000 dols. were subscribed before the proceedings closed.

THE first part of a new Russian work by M. Prijevalsky, entitled "Mongolia and the country of the Tanguts," may be expected before the end of the year. It will contain an account of the author's travels in Central Asia, together with a description of the Zoological and Botanical results he has arrived at. In all, 64 species of mammalia, and 292 species of birds were obtained, including among the most remarkable of the former, the Wild Yak, the Orongo Antelope and *Ovis polii*; of the latter *Gyps nivicula* and a new species of *Pterorhinus*. The botanical collection includes, according to the botanist Maczimovitch, a great many new and rare specimens. In the mountains of Kansu about 500 different plants were obtained, including the seeds of the medicinal rhubarb.

THE Cambridge Syndicate appointed to organise courses of lectures or classes with the necessary examinations in a limited number of centres of population have received applications from several places to supply teachers during the ensuing winter. Among the subjects suggested for choice are Political Economy, Mental and Moral Science, History, English Literature, Physiology, Physical Geography, Geology, Astronomy, Mechanics, various branches of Physical Science, and other subjects of a kindred character to these. The remuneration offered varies from 125*l*. to 200*l*. for the term of three months, there being two such terms to be provided for between October and May. The pupils [illegible] chiefly from among young men and women of the middle and working classes. The Syndicate request any gentleman willing to take part in such work to send his name and the statement of subjects he would be willing to give instruction in to Mr. Stuart, M.A., Trinity College, the secretary.

THE Council of the Senate of Cambridge University recommend that a Demonstrator of Experimental Physics be appointed at an annual stipend of 150*l*. The duties of such person shall consist of assisting the Professor in giving class instruction and making experiments. He is to be appointed by the Professor, with the consent of the Vice-Chancellor. A discussion of this report takes place to-day.

M. J. PLATEAU has recently published, in two volumes, a work entitled "Statique expérimentale et théorique des liquides soumis aux seules forces moléculaires" (London: Trübner). M. Plateau has effected the realisation, on a large scale, of a part of the figures of equilibrium, indefinite in number, which would affect liquids if gravity did not act upon them; he has thus furnished the experimental verification of a series of results obtained by geometers in respect to surfaces whose mean curvature is constant, such surfaces as those of figures of equilibrium. The work referred to contains an account of the author's researches on the forms and phenomena presented by liquids in the condition named, as well as the consequences which result therefrom. The following are two examples of these consequences:—1. The froth which is formed on champagne and other liquids is evidently an assemblage of laminæ, which enclose in their interstices small portions of gas. One might naturally expect that in this assemblage all would be ruled by chance, but it is nothing of the kind; the small laminæ never unite but three and three, and make with each other, at the small liquid edge which unites them, equal angles of 120°. Moreover, the liquid edges throughout unite four and four, and thus form between them, at the point where they meet, equal angles, angles whose cosine is $-\frac{1}{3}$. 2. The beautiful observations of Savart have taught us that a vein of liquid pierced by a circular orifice is gradually converted, during the passage of the liquid composing it, into a series of isolated masses. The illustrious French physicist, to account for this phenomenon, has tried to prove that the very act of flowing gives rise, in the orifice, to pulsations which produce in the vein successive protuberances, and this hypothesis has been adopted by most of the students who have inquired into the matter. M. Plateau shows that this ingenious notion is quite insufficient to account for the facts, that the conversion into isolated masses is a result of the molecular forces which are in action at the surface of the vein, and that from this naturally result all the particulars established by Savart.

SCIENCE seems likely to be treated royally in Sweden this year. For the expenses of the Congress of Archæology and Prehistoric Anthropology, which will be held at Stockholm from Aug. 7th to 16th, the Government has asked from the Diet a grant of 20,000 fr.; a magnificent palace has been set apart for the holding of the congress; two grand fêtes will be given by the king and by the city; and visitors will be carried by the railways at half-fares. The programme includes papers and discussions on the stone age, bronze age, and iron age, and on prehistoric archæology; and excursions will be made to places of archæological interest and remains of prehistoric man in the neighbourhood. The "Congrès d'archéologie slave" will also be held at Kiew, from Aug. 14 to Sept. 3. Altogether, students of prehistoric man will have a good time of it in North Europe this summer.

THE appointments to the Bureau des longitudes at Paris for 1875 are—M. Puiseux as president, M. Faye as vice-president, and M. Yvon-Villarceau as treasurer and secretary.

THE French Academy is publishing a large 4to volume of 300 pages, containing all the reports and maps relating to the next Transit of Venus. A copy has been presented to each member, and the book is to be had at M. Firmin Didot's, the publisher to the French Institute.

SOME carpenters are at present engaged in building in the Jardin de Luxembourg at Paris a photographic studio, for the use of the photographers who are to be sent out with the Transit expedition. The observations are soon to begin, and will be under the direction of M. Fizeau, member of the French Institute; but that gentleman will not leave Paris to follow the operations.

THE young King of Siam having come of age on October 10 last, great feasts were given to his subjects at Bangkok, the chief town of his dominion. Amongst other attractions was the ascent of a small mounted balloon, which had been constructed in Paris and had arrived by steam a few days previously.

Liberal offers were made to procure an aëronaut, but were of no avail, nobody amongst the Siamese presuming to ascend. Consequently his Majesty ordered a slave, selected from amongst the less heavy of his household, to be sent up in the car. In order to encourage the poor aëronaut, so frightened for his life, he was promised to be rewarded with his enfranchisement. The ascent took place and elicited much enthusiasm from the bystanders; but, unhappily, nothing was heard from the poor fellow or of the craft.

THE Universal Exhibition to be held in the Champs Élysées Palace in 1875 is merely a private enterprise; the French Government having no intention to interfere except in giving its authorisation. No charge will be made on the national Exchequer, but it is rumoured and hoped that the Municipal Council of Paris will grant a considerable sum of money.

MR. G. J. SYMONS writes to yesterday's *Times* suggesting various methods, all good, and we think practicable, of distributing daily, or even at certain intervals during each day, the accurate time throughout London. This is an advantage possessed for long by many provincial towns; though London in this, as in many other respects, is far more "provincial" than many a second-rate provincial town. We are glad to see, however, from Mr. W. Abbott's letter in the same paper, that the want complained of by Mr. Symons will soon, to some extent, be remedied; as one of the objects of the British Telegraph Manufactory (Limited), which has just taken over all the inventions of Sir Charles Wheatstone, is to establish a large electrical driving clock in a central position of the metropolis.

THE Commissioners of the Fairmount Park, Philadelphia, U.S., are making great efforts in the way of bringing together, in the form of a zoological garden, a complete collection of animals of North America, with a view of their exhibition at the approaching Centennial Exhibition. The Commissioners are also expecting considerable consignments from other parts of the world, as South Africa, South America, &c., and the whole enterprise bids fair to assume a very great magnitude.

AT a meeting of the California Academy of Sciences in November last, photographs of strange but beautiful hieroglyphics, cut in wood, and found on Easter Island, were received from Mr. Thomas Croft, of Papeeti, Tahiti. From vague traditions among the natives, they were supposed to represent the written language of some prehistoric nation. The stone idols found on the island exhibit a refined form of art, and other relics found there go to prove that the present population has gradually degenerated from a previous one. In the letter accompanying the hieroglyphics, Mr. Croft stated from the best information he could obtain, that none except the priests and a chosen few could decipher these strange characters. A letter was read from this gentleman at the last meeting, in which he stated that he had found a native of the island who could read them, and who was going to teach Mr. Croft the language, so that he will shortly be able to translate them. Mr. Croft thinks that he has discovered the relics of a great Malayan empire, which extended its power over that part of the ocean at some former period of the island's history.

"THE Treasury of Languages, a Rudimentary Dictionary of Universal Philology" (London: Hall and Co.), is an attempt at making an exhaustive alphabetical list, with brief explanations, of all the known languages and dialects of the world. It contains, besides, explanations of terms used in the science of language. The volume contains 300 pages, with an average of fifteen names on each page; this will convey some idea of the variety of tongues on the face of the earth. The author, who is nameless, but who, we are told, is a "literary amateur," moreover intimates that he has received additional material sufficient to make a second volume. What a bewildering field is before the student of languages, to whom the present work is calculated to be extremely useful.

WE have received a second and richly illustrated edition of Mr. Hartwig's "Polar World" (Longmans). The record of Arctic discovery has been succinctly brought up to the present time, and the work is well calculated to convey to the general reader a vivid, and on the whole correct, idea of man and nature in the Arctic and Antarctic regions of the globe.

PART I. of Vol. V. of the "Natural History Transactions of Northumberland and Durham" (Williams and Norgate) has come to hand. It contains the usual Annual Address of the President, Mr. H. B. Brady, F.L.S., who recounts the excursions of 1872, and touches on one or two important questions of the day, with clearness, vigour, and brightness. The following are the titles of the papers in this part:—"Note on the recent occurrence in Northumberland and Durham, of the Camberwell Beauty Butterfly," by T. J. Bold, who also contributes papers on "The Museum Collection of British Insects," and "The Occurrence of Lepidoptera in Northumberland and Durham in 1872;" "Note on Bones dredged from the bed of the river Weir in 1872," by Dr. D. Embleton; "Meteorological Report for 1872," by the Rev. R. F. Wheeler and the Rev. Dr. R. E. Hooppell; "First Instalment of a Catalogue of the more remarkable Trees of Northumberland and Durham," by Mr. G. C. Atkinson, who has devised a "hypsometer," a simple but useful instrument for ascertaining the height of trees; "Note on Cinerary Urns found at Humbledon Hill, near Sunderland."

PART III. of Vol. III. of "Proceedings and Transactions of the Novia Scotian Institute of Natural Science," has been sent us. Besides a summary of the Proceedings of the Society, it contains twelve papers of varying value on scientific subjects, eight of these being by three of the members; this Society, like many others at home apparently, having many names on its roll but few working members. Three papers are by the Rev. Dr. Honeyman, F.G.S., Director of the Provincial Museum:—"On the Geology of Nova Scotia and Cape Breton," "On the Metamorphism of Rocks in Nova Scotia and Cape Breton," and "The History of a Boulder." Of the other papers we may mention two by Dr. J. B. Gilpin on "The Eagles of Nova Scotia," and "The Stone Age of Nova Scotia;" "The Great American Desert," by Mr. H. S. Poole; and "The Vegetation of the Bermudas," by Mr. J. M. Jones, F.L.S. Appended is a brief note on the visit of the *Challenger* to Halifax.

THE "Report of the Birmingham School Natural History Society for the year 1873," is on the whole satisfactory. All the sections seem to be in good working order, their meetings fairly attended, and some profitable field-work is being done. The papers, abstracts of which are published in the report, are creditable to the young gentlemen who wrote them.

WE have received a large sheet containing Statistical Tables relating to the Colony of Victoria, compiled from official records in the Registrar-General's Office, Melbourne, by Mr. W. H. Archer, Registrar-General. The tables contain a vast amount of information, well and compactly arranged, concerning the population, industry, education, &c., of the colony. The sheet contains also the usual meteorological statistics for the twelve months of the year, and extending over a period varying from six to fourteen years.

THE additions to the Gardens of the Zoological Society during the past week include a Common Rhea (*Rhea Americana*) from S. America, presented by Mr. A. Maxwell; a Black-tailed Godwit (*Limosa melanura*), British, presented by Mr. H. Stacy Marks; a Red-faced Deer (*Cervus œnops*) and two Falcated Teal (*Querquedula falcata*) from China, purchased; a Chinese Water Deer (*Hydropotes inermis*), a Reeves' Muntjac (*Cervulus reevesi*), and a Japanese Teal (*Querquedula formosa*) from China; a Collared Peccary (*Dicotyles tajuça*) from S. America, deposited.

SCIENTIFIC SERIALS

American Journal of Sciences and Arts, January 1874.—This number commences with an account, by Mr. H. Gillman, of some Indian mounds and skulls in Michigan. The numerous tibiæ unearthed showed the compression or flattening which characterises platycnemic men; and the race, from Detroit River to St. Clair and Lake Huron, seems to have been marked with platycnemism to an extreme hitherto unobserved in any other part of America, or perhaps any other country in the world. The writer thinks the type of bone will be found predominant in the entire region of the great lakes.—Mr. Hilgard follows with a note on silt analyses of Mississippi soils and sub-soils (the author having used his "churn elutriator"); and Mr. Longbridge discusses the distribution of soil ingredients among the sediments obtained in silt analysis, and the influence of strength of acid and time of digestion in the extraction of soils.—Mr. Lesquereux communicates the remarkable discovery that traces of land vegetation exist in the Lower Silurian of America; branches or small stems of a species referable to *Sigillaria* having been found by the Rev. H. Herzer in clay beds of the Cincinnati group. The only records hitherto had of vegetable remains from the Silurian of North America are some fragments of stems and rhizomes of *Psilophyton* observed by Dawson in the Gaspé group of Canada; the only link of connection of the Devonian flora with that of the Silurian period. In Europe, too, the first remains of land plants have been found in the Lower Devonian; and as yet only a single specimen of *Sigillaria*. The same writer, in another note, argues against the view, recently advanced, that the lignite beds of the Rocky Mountains have been formed by the heaping up of drifted materials. We also find notes on the geology of Western Texas (Jenney), on the results of recent dredging expeditions on the coast of New England (Verrill), on fossil woods of British Columbia (Dawson), on a combination of silver chloride with mercuric iodide (Lea), &c.—An appendix contains a paper (with two plates) by Prof. Marsh, treating of the structure and affinities of the Brontotheridæ.

Poggendorff's Annalen der Physik und Chemie, No. 11, 1873.—This number contains the concluding part of M. Kundt's paper on the vibrations of square air plates.—Dr. Schüngel describes some experi nents made with reference to change in the pitch of sounds through a movement of translation of the sounding body. He arranged an apparatus in which a tuning fork, mounted, with its case, on a little waggon, was rapidly drawn along (by a cord passing round a drum) towards the observer, who stood beside another fork making a slightly greater number of vibrations than the moved one. In this way a different number of beats was obtained; less than that produced when both forks were at rest. The pressure of a key, giving rise to this motion (through electro-magnets, &c.), caused a telegraphic strip of paper to be at the same time impressed, showing a continuous line; and a second pendulum, closing a current at each swing, produced a series of points on the same strip. By this means could be measured the time in which a certain number of successive beats was heard, and the rate of motion of the travelling fork. The author points out how the method may be employed for determining the velocity of sound, and commends it to the attention of physicists for further development.—M. Zöllner replies, at some length, to the considerations urged by M. Reye against his explanation of the sun-spots and protuberances; and M. Behrens communicates a note on porcelain and allied products.—A mercury air-pump, of improved construction, is described by M. Mitscherlich; and a variation-barometer by M. Kohlrausch; the latter instrument being formed with the vacuous metallic ring of a Bourdon aneroid.—M. Herwig makes a calculation of the number and weight of ether-molecules contained in electrical conductors.—Among the extracted matter, we note several important papers; one by Dr. Heinrich Streintz (Vienna Acad.), on the changes in elasticity and length of a wire traversed by a galvanic current; one by M. Plateau (Belgian Acad.) on the measurement of physical sensations, and the law which connects the intensity of these with that of the exciting cause; and one by M. Helmholtz (Berlin Acad.) on galvanic polarisation in gasless liquids.

Astronomische Nachrichten, No. 1,974.—In this number Prof. Spoerer writes a very interesting account of his sun-spot and prominence observations, from which he concludes that faculæ occupy the same places where protuberances arise or where the points of the "flaming chromosphere" are situate; and further, that protuberances are in most cases connected with spots, and are very conspicuous before and at the commencement of a group of spots. In many cases, he says, it is possible to calculate when a spot will appear, from the observation of a flaming protuberance, and that the spots are produced by the substances thrown up becoming cooled and producing a cloud of products of condensation.—Dr. Hugo Goricke contributes a number of observations of position of the minor planets Asia, Flora, Thetis, and Hera.

Astronomische Nachrichten, No. 1,975.—In this number Prof. Schmidt gives an account, in full, of his observations on Sunspots, the number of groups being given for each day in 1873, the maximum number on any one day being 9, and the minimum 1. There is no day on which the sun was free from spots. Prof. Schmidt says that clouds have prevented observations on 12 days; we, in this country, should be content with missing 120 days. Prof. Schmidt also gives the maxima and minima of a number of variable stars, and we regret that want of space prevents our reproducing his results, which are worthy of perusal by those interested in the matter.

Der Naturforscher, Jan. 1874. In this number we may first note an account of some observations by M. Hann, at Hong Kong and in Ceylon, as to the decrease of temperature with the height. It appears that the yearly average of decrease is much the same in the tropics as in central Europe. During the regular monsoons, the decrease is much more gradual on the windward side of a mountain than on the lee. The quick decrease in time of rain is due, in part, to increase in quantity of rain with the height, and greater cooling in consequence.—From experiments on alcoholic fermentation, by M. Brefeld, it is concluded that alcohol yeast always requires free oxygen for its growth; it cannot grow on oxygen from a compound like sugar; further, that living, but non-growing, yeast-cells (free oxygen being excluded) may yet excite fermentation in sugar solution. As showing the affinity of the yeast-cell for free oxygen, the author states that it may grow in CO_2 containing less than $\frac{1}{1000}$ of its volume of such gas, and will fully absorb it.—We also find a note of some experiments on butyric fermentation, by M. Paschutin; and in the botanical department there are several interesting notes.—On the reaction of plant protoplasm to mechanical injuries, by M. Hanstein; the cause of periodical motions in leaves, by M. Batalin, stated to be, chiefly, unequal growth, preponderating at one side or the other, through varying conditions of light, temperature, and turgescence; on the morphological differentiation of the lower plants, by M. Pfingsheim, and others.—In a suggestive mineralogical paper, M. Hirschwald theorises on the cohesion-relations in drops and in crystals.—Physics is represented by several extracted notes—on evaporation, on phenomena of polarisation produced through dispersion of light, on relations between capillary and electric phenomena, on intermittance of the electric current, &c., most of which have already been noticed elsewhere in our columns; and in physiology there is an account of a valuable investigation by M. Forster, as to the significance of ash-constituents in food.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, Feb. 12.—"On the influence of Ethyl Alcohol on the Bodily Temperature, the Pulse, and the Respirations of a healthy man." By E. A. Parkes, M.D., F.R.S., Professor of Hygiene, Army Medical School.

The author made a large number of experiments on a strong healthy soldier, T.R., aged twenty-five, height 5 ft. $8\frac{3}{4}$ in., weight (naked) 67·46 kilogrammes, or 148 lbs.

The course of the experiments was as follows:—His breakfast was taken at 6.30, was finished every day by 7 A.M.; he took for breakfast 8 ounces of bread, $\frac{1}{2}$ ounce of butter, and 17 fluid ounces of tea with sugar, and with 3 ounces of milk. Immediately after breakfast he went to bed again, and did not get out of the recumbent position for any purpose until 2 o'clock. He then dined on 12 ounces of beefsteak, 4 ounces of bread, and 8 ounces of water.

After dinner he took exercise and smoked, had tea (same food as at breakfast) at 6, and a glass of water at 9 P.M., when he went to bed. He took daily precisely the same diet and quantity of water.

Thermometers (tested for accuracy and exactly corresponding) were placed in the axilla and rectum at 6 o'clock, and, except

at breakfast, they were removed only for the purpose of being read at first every 30, and then every 15 minutes, and were at once replaced, until 2 o'clock; after which time the temperatures were only taken every two hours.

After several days' preliminary examination (during which time he took no alcohol) the experiments were commenced and carried on for six days without alcohol; then during five days undiluted brandy containing 50 per cent. of absolute alcohol was given once daily, viz. at 11 A.M., four hours after breakfast.

On the first day one fluid ounce of brandy (= ½ ounce of alcohol) was given; on the second day two ounces, on the third day four ounces, on the fourth day six ounces (= 3 ounces of alcohol), and on the fifth day also six ounces.

The following were the conclusions arrived at:—

1. The change in the temperature of the axilla and rectum produced by brandy was very slight. It was never increased, but was probably slightly lowered; but the result is not quite certain; and if any lowering occurred, it did not exceed 0°·35 Fahr., and may not have been more than 0°·07 Fahr.

2. The pulse, which was lessened in number by long rest in a recumbent position, was increased in frequency by a single dose of brandy for three hours, but subsequently fell in number, so that the daily work done by the heart was the same on the water and the brandy days. What occurred was accelerated work for a certain time, and compensation for this by lessened work afterwards. That brandy increases the force as well as the number of the pulse, was shown by sphygmographic tracings in the papers already communicated to the Royal Society; and in order not to disturb the state of rest, no sphygmographic observations were taken in this case.

3. The respirations appeared to be slightly lessened by brandy; but the evidence is not very strong.

The author made another series of experiments to determine the effect of alcohol after sixteen hours' fasting.

The following conclusions may be drawn from the observations formerly recorded ("Proceedings of the Royal Society," Nos. 120, 123, and 136), and from those now laid before the Royal Society:—

1. When alcohol in dietetic doses (=2 fluid ounces, or 57 cub. centims., of absolute alcohol) was given to a healthy man fasting and at rest, a decided though slight lowering of bodily temperature (as judged of by the heat of the rectum) was caused. The amount of lowering was under half a degree of Fahrenheit; and sometimes even this amount was not perceptible, being probably counteracted by the opposing influence of the heat-producing changes in the body, which cause slight variations of temperature independent of food and movement. The greatest effect was produced about from one to two hours after the alcohol was taken, and the effect was evidently passing off in three hours.

2. When alcohol in dietetic doses was given to a healthy man at rest, and in whom the process of digestion was completed, and whose temperature, raised by the food, was again commencing to fall, a lessening of temperature was also proved, but its amount was not so great; it could not have been more than 0°·35 Fahr., and may have been only 0·07 Fahr.

3. When alcohol was given with food with either usual or increased exercise, no effect on temperature was perceptible, even though the alcohol was given in large quantities, viz. from 4 to 8 fluid ounces of absolute alcohol (114 to 227 cub. centims.) in twenty-four hours. It is to be presumed that the amount of heat generated from the food and movement concealed the effect of the alcohol, which would require a more delicate method for detection.

4. In no case did alcohol raise the temperature.

5. The effect of alcohol on the pulse was uniform in the four men experimented upon. The contractions of the heart were more frequent during complete rest, from five to ten beats per minute for some time; and when exercise was taken the increase was greater. The mean pulse of the twenty-four hours was, however, not increased unless the amount of alcohol was large and repeated. In other words, the heart's beats were less frequent than natural when the effect of the alcohol had passed off. The pulse became both fuller and softer to the touch; and this relaxation of the radial artery was shown also by the sphygmograph. That the smaller vessels were relaxed was shown by the redness of the surface and by the evident ease with which the blood traversed the capillaries, as shown by the sphygmographic tracings.

6. The respirations were not increased in number by alcohol; they were indeed lessened, and were deeper in some of the experiments; but the effect was not very marked.

Feb. 26.—"The Winds of Northern India, in relation to the Temperature and Vapour-constituent of the Atmosphere," by Henry F. Blanford, F.G.S., Meteorological Reporter to the Government of Bengal.

Geological Society, Feb. 20.—His Grace the Duke of Argyll, K.T., F.R.S., president, in the chair. In handing the Wollaston Gold Medal to the foreign secretary, Mr. W. W. Smyth, for transmission to Prof. Heer, of Zurich, the president referred to the fact that last year the council had awarded the balance of the proceeds of the Murchison Geological Fund to Prof. Heer, and remarked that it gave him much pleasure that the Wollaston Medal, the highest honour which the Society had it in its power to confer, should be so worthily bestowed. He alluded briefly to the labours of Prof. Heer in the difficult departments of Fossil Botany and Entomology, and to the admirable works in which he had given to the world the results of his indefatigable researches.

Mr. W. W. Smyth, in reply, said:—"My Lord President, it is with a great pleasure that I undertake the transmission to Prof. Heer of this new testimony of the importance attached by this Society to his long-continued labours. I have received from our valued foreign member a letter stating that my announcement of the award had found him extended on the bed of sickness, and begging me to assure the Society that, but for this misfortune, nothing would have given him greater pleasure than to have been present at this meeting, and to have thanked the Society personally for the high honour which has now been awarded to him."

The President then presented the balance of the proceeds of the Wollaston Donation Fund to the foreign secretary for transmission to Dr. H. Nyst, of Brussels, remarking that this distinction had been well earned by Dr. Nyst by his admirable researches upon the Molluscan and other fossil remains of his native country.—Mr. W. W. Smyth briefly thanked the president on behalf of Dr. Nyst.

The president next presented the Murchison Medal to Dr. J. J. Bigsby, F.R.S., and remarked in so doing that there was a peculiar fitness in this award, which would have met the approval of the distinguished geologist in accordance with whose last wishes this medal was given. It was awarded to Dr. Bigsby in recognition of his long and valuable labours in that department of geology and palæontology with which the name of Murchison is more particularly connected.—Dr. Bigsby replied, thanking the Society for the honour conferred upon him, and the president for the terms in which he had spoken of his labours.

The president then handed half the balance of the proceeds of the Murchison Geological Fund to R. Etheridge, F.R.S., for transmission to Ralph Tate, F.G.S., expressing a hope that it would be regarded by him as a testimony of the value set by the Society upon his palæontological researches, especially on the Fauna of the Lias, and that it would enable him to enlarge the sphere of his investigations.—Mr. Etheridge, in reply, read the following letter of acknowledgment from Mr. Tate:—

"My Lord President and Gentlemen, To say that I am unworthy of the honour that you have awarded me by the bestowal of the 'Balance of the Proceeds of the Murchison Fund,' would be to call into question your judgment, and would render nugatory its value to me. The encouragement that such an award conveys is ample recompense for labour bestowed in palæontological research, and is a real incentive to more diligent work. It is in this spirit that I accept the award, and tender my warmest thanks to you for the distinction it confers. It is now twelve years since I was led to select for special study the geological history of the Lias, which appeared to me not to have received that attention at home that it had upon the Continent, and which it claimed by offering the earliest phase of Mesozoic life, and presenting a number of physical problems that seemed upon the threshold of the inquiry to reward even the casual observer with a rich harvest. I have published from time to time fragments relating to the stratigraphy and palæontology of this period, but I hope soon, in conjunction with my friend Mr. J. F. Blake, F.G.S., to submit, in a work entitled 'The Yorkshire Lias,' a comprehensive review of the chief characteristics of the period, embracing the remarkable variation of mineral conditions, and the particular distribution of organic life, as indicative of peculiarities of depth of ocean, the direction and proximity of land, &c. Despite all these efforts, the ambition to acquire the position of an expositor of the life of this interesting group of strata urges

me to the completion of a *Prodromus* or *Thesaurus Liassicus*, the materials for which have been accumulated during several years; but from the great labour demanded to bring into harmony the nomenclature of the fossils, without which the compilation can have no real value, some time must elapse before the results can be submitted to you.—Faithfully yours, Ralph Tate."

The President then presented to Mr. Alfred Bell the other half of the balance of the proceeds of the Murchison Geological Fund, and stated that this was awarded to him in recognition of his valuable researches upon the fossils of the newer Tertiary beds of this country, and to assist him in the completion of his work upon the Crag deposits of the eastern counties. Mr. Bell, in reply, said that he was most grateful for this token of the Society's appreciation of the value of his labours, and stated that up to the present time he had been enabled to distinguish about 3,000 fossil species from the newer Tertiaries of Britain, and that he hoped yet to add very largely to their number.

The President then proceeded to read his Anniversary Address, in which he stated that the pressure of his official duties during the period of his presidency had prevented his keeping himself thoroughly acquainted with the recent progress of geological research, and he therefore proposed in his present address to advert rather to those questions in geology which seemed to him still to require an answer. He referred to the relations between geology and cosmogony, to the effects and causes of volcanic and earthquake action, and finally to the great questions which are still unsettled as to the origin of life and the sequence of organic beings on the face of the earth. The address was prefaced by some obituary notices of Fellows and Foreign Members and Correspondents deceased during the past year, including Mr. J. Wickham Flower, Mr. J. Garth Marshall, Prof. Agassiz, and M. de Verneuil.

The Ballot for the Council and Officers was taken, and the following were duly elected for the ensuing year:—President—John Evans, F.R.S. Vice-Presidents—Robert Etheridge, F.R.S.; R. A. C. Godwin-Austen, F.R.S.; Sir Charles Lyell, Bart., F.R.S.; Joseph Prestwich, F.R.S. Secretaries—David Forbes, F.R.S.; Rev. T. Wiltshire, M.A. Foreign Secretary—Warington W. Smyth, F.R.S. Treasurer—J. Gwyn Jeffreys, F.R.S. Council—The Duke of Argyll, K.T., F.R.S.; H. Bauerman; Prof. G. Busk, F.R.S.; J. F. Campbell; Frederic Drew; Sir P. de M. G. Egerton, Bart., F.R.S.; R. Etheridge, F.R.S.; John Evans, F.R.S.; David Forbes, F.R.S.; Capt. Douglas Galton, F.R.S.; R. A. C. Godwin-Austen, F.R.S.; J. Gwyn Jeffreys, F.R.S.; Sir Charles Lyell, Bart., F.R.S.; C. J. A. Meyer; J. Carrick Moore, F.R.S.; Joseph Prestwich, F.R.S.; Prof. A. C. Ramsay, F.R.S.; Samuel Sharp, F.S.A.; Warington W. Smyth, F.R.S.; Prof. J. Tennant, F.C.S.; W. Whitaker, B.A.; Rev. T. Wiltshire, F.L.S.; Henry Woodward, F.R.S.

Anthropological Institute, Feb. 24.—Sir Duncan Gibb, Bart., M.D., in the chair.—Mr. Biddle Lloyd, C.E., F.G.S., read a paper on the Beo hucs, a tribe of Red Indians, supposed to be extinct, which formerly inhabited Newfoundland. The author, after reviewing the various accounts related of the aborigines of the island from the time of Sebastian Cabot downwards, gave the results of the information he picked up from various sources during an exploratory cruise he made last summer round the coast of Newfoundland, respecting the strange tribe of Indians which inhabited the island up to a period which terminated about forty years ago, when, by reason of the cruelties practised on them by the English fishermen, and the warfare carried on against them by the Mic-mac Indians, they were reduced in number, and finally the few of them that were left, it is supposed, crossed over the straits of Belleisle, or at all events disappeared. Several singular circumstances in connection with the Beothucs, as they styled themselves, were noticed: namely, the curious shape of their birch-bark canoes, the fact that the dog was not domesticated by them, and their manner of hunting the Caribou by means of long lines of fencing put up to keep the herds of deer along certain tracks.—Mr. Lloyd also read notes on Indian remains found on the coast of Labrador. The Indian remains found on the coast of Labrador consisted of rudely-constructed buildings, of stone slabs, which were discovered on the sea-shore at the western entrance of the straits of Belleisle. They were described to the author as Indian graves, but there was no evidence to show that such was the use to which they had been applied. On the contrary, it seemed probable they were stone wigwams built by some Indian families for a summer residence. The author was fortunate enough to discover at L'Anse du Diable, which is a cave situated about 20 miles east of the locality where the so-called Indian graves were found, a few arrow-heads of quartzite and hyaline quartz on a sandy "barren" which stretched inland from the head of the cave. From circumstances connected with the cave, the author concluded that the locality had been chosen by some unknown tribe of Indians for the manufacture of their arrow-heads during an occupancy of some considerable time on the spot.—A paper was read by Dr. Sinclair Holden on a peculiar Neolithic implement from Antrim.

Royal Horticultural Society, Feb. 10.—Annual General Meeting.—Viscount Bury, president, in the chair.—The Report of the Council having been taken as read, it was moved by Mr. Haughton as an amendment to the motion for its adoption, and seconded by the Rev. C. P. Peach, that the meeting be adjourned to enable the opinion of the Court of Chancery to be taken as to the legal position of the Society. (The commissioners of the Annual International Exhibitions dispute the validity of the election of the Council chosen last year.) The amendment being put to the vote was lost by a majority of six, the numbers (including ladies' proxies) being, for, 225; against, 231. The report was then put and carried. The following vacancies were filled for the ensuing year:—President—Viscount Bury, K.C.M.G. Treasurer—Mr. Bonamy Dobree. Secretary—Mr. W. A. Lindsay. Members of Council (extraordinary vacancies)—Lieut.-Gen. Hon. Sir A. H. Gordon, K.C.B.; Mr. Joseph Robert Tritton; Mr. Burnley Hume; Mr. Henry Webb.

General Meeting, Feb. 18.—Henry Little in the chair.—The Rev. M. J. Berkeley commented on a plant shown by Mr. Bull, under the name of *Rapatea pandanoides*. It is a species of *Saxofridericia*. He also gave some account of Dr. Cunningham's microscopic examinations of air in Calcutta.

Scientific Committee.—A. Smee, F.R.S., in the chair.—A large number of subjects were brought before the Committee. Among the more important were—Mr. Grote: The Tea-bug of Assam, supposed by Prof. Westwood, from the figures, to belong to the Cimicideous family, Capsidæ, and nearly allied to a species which injures chrysanthemum-buds. Mr. A. Müller thought it much more likely to be some aphis, though it might be immature.—A communication was sent through Dr. Hooker on a new disease of the coffee plantations in India (Tellicherry). The leaves turn yellow, and the back is found to be covered with a rust-coloured dust. Further information was requested.—Prof. Thisselton Dyer exhibited specimens of the Balaniform gabsy gall of the oak with specimens of the Cynips which had been bred from them. These had been identified by the Rev. T. A. Marshall as *C. radicis*, Fab. He also read a note from Mr. Fenn, of Woodstock, as to the practical impossibility of making keeping wine from out-door ripened grapes without the addition of sugar—a point of interest in connection with the supposed deterioration of the English climate; also a note on the condition of an armour-plated ship which was being rapidly destroyed by dry-rot, and a photograph of the tree of the orange or Pearmain apple, with a drawing of the branch which had produced the russet sport exhibited to the Committee last November.

Entomological Society, Feb. 16.—Sir Sidney Smith Saunders, C.M.G., president, in the chair.—Mr. Weir exhibited a sample of wheat from Australia infested with a weevil, *Sitophilus oryzæ*; the cargo was so much damaged that about two tons were utterly useless. The weevil was accompanied by *Læmophlœus ferrugineus*. Some wheat from Japan was also infested with *Sitophilus granaria* and *Rhizopertha pusilla*.—Mr. Higgins exhibited a number of *Cetoniidæ* from the Philippine Islands, which had been described by Dr. Mohnike.—Mr. F. Smith read extracts from a letter from Mr. J. T. Moggridge of Mentone, on a small beetle, *Coluocera attæ*, Kraatz, found in the granaries of *Aphænogaster* (*Atta*) *structor*; and stating that *Platyarthrus* was also very common in the nests. He was much struck by the frequent occurrence of the nests of trap-door spiders in the very soil of the ants' nests; the spiders' tubes often running quite close to, and in the midst of, the galleries of the ants. As ants form a large portion of the food of trap-door spiders, this helped him to understand how it was that the spiders got a living without leaving their nests.—Some conversation took place on the ravages of the Colorado potato beetle (*Doryphora decemlineata*) in North America; a writer in the *Times* recommending the encouragement of small birds as the best security against the pest; but it was much doubted whether the small birds would

care to meddle with the insect, as it was stated that when crushed it caused blisters on the skin, and that if a wound was touched severe inflammation and painful ulcers followed.

Institution of Civil Engineers, Feb. 10.—Mr. T. E. Harrison, president, in the chair.—The paper read was on the construction of Harbour and Marine Works with artificial blocks of large size, by Mr. Bindon Blood Stoney, M.A. The author described a new method of submarine construction, with blocks of masonry or concrete far exceeding in bulk anything hitherto attempted. The blocks were built in the open air on a quay or wharf, and after from two to three months' consolidation, they were lifted by a powerful pair of shear legs, erected on an iron barge or pontoon. When afloat, the blocks were conveyed to their destination in the foundations of a quay wall, breakwater, or similar structure, where each block occupied several feet in length of the permanent work, and reached from the bottom to a little above low-water level. The superstructure was afterwards built on the top of the blocks in the usual manner by tidal work. By this method the expenses of cofferdams, pumping, staging and similar temporary works were avoided, and economy and rapidity of execution were gained, as well as massiveness of construction, so essential for works exposed to the violence of the sea.

EDINBURGH

Royal Society, Monday, March 2.—Sir Robert Christison, honorary vice-president, in the chair.—The following communications were read:—"On the Parallel Roads of Glen Roy, with a Notice of finding Fossil *Diatomaceæ* in the Deposits," by the Rev. Thomas Brown.—"On the Perception of Musical Sounds," by Dr. M'Kendrick.—"On the Establishment of the Elementary Principles of Quaternions on an Analytical Basis," by Mr. G. Plarr. Communicated by Prof. Tait.—"Preliminary Note on Spectra under exceedingly small Pressures," by Prof. Tait and Mr. J. Dewar.—"Laboratory Notes," by Prof. Tait (1) On Atmospheric Electricity; (2) On the Thermoelectric Position of Sodium.

DUBLIN

Royal Irish Academy, Feb. 9.—Rev. J. H. Jellett, president, in the chair.—W. H. Baily, F.L.S., read a preliminary report on the plant-fossils of the Kiltorkan district. In this preliminary report Mr. Baily stated that the most frequent plant met with is *Palæopteris hibernica*, first noticed by the late Prof. E. Forbes, under the provisional name of Cyclopteris, afterwards referred to Adiantites by A. Brogniart, and now placed by Schimper in his genus Palæopteris, differing as it does from the former genus in the arrangement of its leaflets and from the latter in its mode of fructification. Some of the fronds met with were nearly five feet long and three wide. Two new species were described as *Sphenopteris hookeri* and *S. humphresianum*, both of which were comparatively rare.—A fine example of the stem of *Sagenaria baileyana* of Schimper was met with, the total length of which was 20 ft. 4 in., and at its lowest portion it was 6 in. in diameter; it branched at about 15 ft. from the base; and the upper portion of these branches corresponds with *Cyclostigma minuta* of Haughton. Cone-like bodies, somewhat resembling Lepidostrobus of the coal were met with. They are composed of elongated scales, terminating in long linear processes showing large and very distinct sporules.—These presumably belong to the Sagenaria but have never yet been found attached.—The report was referred to Council for publication.—Mr. G. Kinahan, of the Geological Survey, believed the report was a most valuable one, and that the researches of Mr. Baily had proved that many of Mr. Carruther's species were but portions of the same plant.—Prof. M'Nab read a report on some researches into the physiology of plants. These experiments were first a series to determine the amount of water transpired by leaves, and secondly the ascent of water in the stem. The plants selected for both series of experiments were the cherry-laurel, the common privet, and the common elm. It would be impossible to condense the large series of experiments made by the author. One series, to determine the amount of water transpired by leaves, made on August 7, 1873, showed that, with very nearly the same exposure and under the same conditions, the cherry-laurel lost, of water, 51·81 per cent. of the weight of the branch employed; the privet, 26·78; the elm, 65·61. Very many experiments were made to determine the actual rate at which fluid ascends in the stem. In Sach's experiment on this subject he fixed the rate to be 9 in. per hour. In Dr. M'Nab's first experiments he obtained a rate of 24 in. per hour. The present series of experiments were made on the same species of plants mentioned above. In the privet the rate was 6 in. per hour; in the elm the rate was 15·6 in. per hour. But in both plants the leaves and stem soon became placid, and the experiments were not completely satisfactory. In the cherry-laurel the rate in one experiment was 24 in. per hour; in a second, 13·2 in. per hour; and in a third, 18·6 in. per hour. The author also recorded a large series of experiments: 1. As to the rapidity of the ascent of fluid in stems when in (*a*) sun, (*b*) diffused daylight, and (*c*) darkness. 2. Rapidity of ascent in branches cut off in the dark. 3. Rapidity of ascent in branches with the cortical tissue removed. 4. Rapidity of ascent in stems deprived of their leaves. 5. Rapidity of absorption of lithium when applied at apex of the branch; and 6. Rapidity of ascent when fluid was taken up under pressure of mercury, intended to represent the root pressure of the plant.—This report was also referred to Council for publication.

VIENNA

Geological Institute, December 3, 1873.—One of the most obscure questions in the geology of the Austrian empire has been the geological position of the Vienna and Carpathian sandstones which form a broad continuous zone on the northern flank of the Austrian Alps, and by far a broader one still on the northern and eastern flank of the Carpathians in Moravia, Silesia, Hungary, Galizia and Transylvania. Only in Silesia, by the investigations of the late Hohenegger, and in Northern Hungary, by those of M. C. Paul, a more satisfactory knowledge has been obtained on this subject. They agree that in both regions the Carpathian sandstones may be divided into several easily distinguishable groups which belong partly to the older tertiary, and partly to the cretaceous formations. Two very valuable memoirs on this subject were read; the first from M. F. Herbich, on the Carpathians in Eastern Transylvania, between the Gyimes and the Tomos Pass. The lowest member of the Carpathian sandstones is formed here by white or yellowish sandstones, which, higher up, pass into coarse conglomerates and belong to the middle neocomian formation; they are covered by a large series of dark-grey sandstones which contain characteristic fossils, and belong to the upper neocomian. The next member, developed near Zaizon, is a grey limestone with Caprotina Lonsdali, identical with the well-known Caprotina limestone of the Alps, and belonging also to the upper neocomian. Above the neocomian strata follow again different sandstones, which M. Herbich thinks to be identical with the Godula sandstones of Hohenegger, and therefore to belong to the Gault. The second memoir, by M. Ch. Paul, treats of the Carpathian sandstones in the eastern Bukowina. They are divided in five different stages, viz., (1) Lower Teschen slates; (2) Neocomian Aptychus limestones; (3) Ropianka beds; which were formerly thought by the author to belong the Eocene series, whilst now he considers them as probably Cretaceans. They are of very great importance, because they contain in Galicia and Bakowina, as well as in Hungary, exclusively the sources of petroleum. 4. Menilith schists, with nests of fossil fishes, which are generally thought to belong to the middle oligocene formation. 5. Magara sandstone, probably upper oligocene.—Dr. Neumayer on the character and the distribution of some Neocomian cephalopods. The author, referring to a former memoir, ("Jahrb. d. k. k. geol. Reichsaunstalt," 1871, p. 521), states that the European jurassic deposits form three different provinces, the Mediterranean, the middle European, and the Russian province. By very interesting observations on the faunas of these provinces, as well as on that of the neocomian period, he establishes some facts relating to the physical geography of the mesozoic period. First he states, that at the end of the jurassic time, the middle parts of Europe were laid dry, and whilst therefore the marine life in the middle European province ceased, it continued, and was differently developed in the Mediterranean (deposits of Stramberg, of Berrias, &c.) and in the Russian province. Afterwards, about the time of the Valenginien, the middle part of Europe was again submerged and now peopled partly from the northern and partly from the southern seas; that the immigration went really partly from the north, is proved by the very curious and close affinities between some of the middle European neocomian cephalopods and those of the upper jurassic strata of Russia.

Academy of Natural Sciences, Dec. 11, 1873.—M. Hoernes described the geological features of the island of Samothrace, from observations made in the spring of 1873.—Prof. Knoll presented a paper on the reflex effects produced

on respiration, by introducing some volatile substances into the air passages under the larynx. When chloroform is inhaled through a tracheal canula (the mucous membrane of the nose being guarded against its action), there is acceleration and shallowing (*Verflachung*) of the respiratory movements, with low position of the diaphragm, and, sometimes, entire stoppage in the position of inspiration. Ether, benzine, and oil of mustard have a similar, though less, effect. Section of the vagi at the neck shows that these changes depend on reflex action of the vagi. The vapour of a strong solution of ammonia produces great change in the respiration, often lasting several minutes, and varying between a retarding and deepening effect, with long stoppage in position of expiration, and retardation and shallowing in position of inspiration. This also is due to reflex action through the vagi. Inhalation of pure carbonic acid through the tracheal canula produces, both when the vagi are cut and uncut, first, a moderate acceleration, then a considerable retardation of the respiratory movements. No phenomenon occurs which can be explained by a direct stimulation of the vagi by the Co_2.—Dr. Fitzinger communicated a paper on the species of the family of deers (*Cervi*) according to their natural relations. He enumerates twenty different species, four of which he has himself introduced, viz., *Strongyloceros*, *Elaphoceros*, *Doryceros*, and *Nanelaphus*. To Wagner's species *Macrotis* and *Furcifer*, he gives the names *Otelaphus* and *Creagrocerus*, the two former names having had a previous application in zoology. Dr. Schenck presented a note on the eggs of *Raja quadrimaculata* within the oviduct; describing the structure of the shell, and the development of the embryo.—Drs. Nowak and Kratschmer made a communication on phosphoric acid as a re-agent with alkaloids. They find that it gives, with several alkaloids, peculiar colour-reactions, in some of which characteristic reactions of smell are developed. In both respects it presents some advantages over the similarly-acting sulphuric acid. It is specially preferable to this in determination of atropia, for reasons which the authors give.

PHILADELPHIA

Academy of Natural Sciences, Oct. 7, 1873.—Dr. Ruschenberger, president, in the chair.—"Law of Seed Germination in Swamp Plants." Mr. Thomas Meehan said that it was an error to suppose that Nature placed trees in places the best suited to their growth. Almost all of our swamp trees grew much better when they could get into dryer places, if in ordinary good land. He referred among others to *Magnolia glauca*, *Acer rubrum*, *Celtis occidentalis*, *Ilex opaca*, *Cupressus chamæcyparis*, *Cephalanthus occidentalis*, *Salix babylonica*, especially as, within his own repeated observations, growing better out of swamps than in them. Why it was that they grew in swamps was no enigma to those in the habit of raising forest trees from seed. It was found that seeds of these trees would only germinate in damp places, and, of course, in a state of nature the tree had to remain in the place where the seed germinated. He thought the principle taught that plants required water to grow well was true only in so far as a humid condition of the soil was concerned. Plants as a general thing, though they were of the class known especially as water plants, preferred to grow out of the water, except in those which grew almost entirely beneath the surface. As was well known, the *Taxodium distichum* in the southern swamps sent up "knees" from various points as the roots extended, often as large as old-fashioned bee-hives, and several feet above the surface.

Oct. 21.—Dr. Ruschenberger, president, in the chair.—"Stibiaferrite, a new Mineral from Santa Clara County, California," by E. Goldsmith.

Oct. 28.—Dr. Ruschenberger, president, in the chair.—The following paper was presented for publication:—"Descriptions of Mexican Ichneumonidæ," by C. T. Cresson.

Nov. 18.—Mr. Vaux, vice-president, in the chair.—The following papers were presented for publication:—"On the Homologies and origin of the Types of Molar Teeth in Mammalia Educabilia," by E. D. Cope; "Contribution to the Ichthyology of Alaska," by E. D. Cope. Prof. Cope remarked that he had observed in the Rocky Mountain region circles of stones arranged by human hands, in countries not now inhabited by the Indians. One of these is in South-western Wyoming near South Bitter Creek, inside the horseshoe of the Mammoth Buttes. The locality is a very barren one, and could hardly be regarded as a camping-ground. The circle consists of three uninterrupted concentric rings close together, the hole having a diameter of about 15 ft. The stones are of moderate size, composed of a dark silex, and evidently derived from the drift material brought down from the Uinta Mountains, which is found on the summits of the bad-land mesas. Five or six miles from this place was found a flint factory with numerous implements and cores. Two other circles were observed, in Colorado, about a hundred miles east of Long's Peak, and about five miles from a spring in a well-grassed country. The locality is unsuitable for a camp, in consequence of the remoteness of wood and water. The country is not inhabited by Indians, the nearest, a temporary camp, for travelling Cheyennes, Sioux, &c., being forty miles distant.

Nov. 25.—Dr. Ruschenberger, president, in the chair.—The following paper was presented for publication:—"Description of Seven New Species of Unionidæ of the United States," by Isaac Lea. The committees to which were referred the following papers:—"On the Homologies and Origin of the Types of Molar Teeth in Mammalia Educabilia," by Edward D. Cope; and "Contributions to the Ichthyology of Alaska," by Edward D. Cope," reported in favour of their publication in the *Journal*.—Disposition of the *Flexor perforans*, *Flexor longus hallucis*, and *Flexor accessorius* in *Paradoxurus musanga* Gray, by Dr. H. C. Chopman.

PARIS

Academy of Sciences, Feb. 23.—M. Bertrand in the chair. The following communications were made:—On the undulatory movement of a train of wagons due to a shock, by M. H. Resal.—On the acid waters which rise in the Cordilleras, by M. Boussingault.—Determination of vapour densities, by H. Sainte-Claire Deville. The author criticised the apparatus for the determination of vapour densities, recently devised by M. Croullebois.—M. Dumas communicated a note on a process invented by Dulong for taking vapour densities.—Observations concerning the last communication by M. Clausius, on the equation $\int \frac{dQ}{T} = 0$, by M. A. Ledieu.—M. Milne-Edwards gave news of l'Abbé A. David, now travelling in Western China, and presented, on the part of this naturalist, a note containing descriptions of several new birds.—Memoir on the swim-bladder from the point of view of station (*station*) and locomotion, by M. A. Moreau. The author described some experiments made upon a perch (*Perca fluvialis*).—Organogenesis compared with Androgenesis in its relations to natural affinities (*Class Œnotherinæ*), by M. A. Chatin.—On a new mode of ramification observed in plants of the family of the Umbelliferæ, by M. D. Clos.—Observations relative to a recent memoir by M. Helmholtz upon "Aërial Navigation," by M. W. de Fonvielle. On the lines which are doubly tangential, to the "*surface lieu*" of the centres of curvatures of a surface of the second order, by M. Laguerre.—On the permanent magnetism of steel, by M. E. Bouty.—Note on the distribution and determination of thallium, by Mr. T. L. Phipson.—On the presence of metallic silver in gallena, by the same author.—Anatomical researches on rickets of the vertebral column," by M. Ch. Robin.—Geological sketch of the Isle of Tros, by M. H. Gorceix.—On a new apparatus for registering the direction of clouds, by M. H. de Parville.—On three new human skeletons discovered in the caves of Menton, and on the disappearance of chipped flints and their replacement by sandstone and limestone instruments, by M. E. Rivière.—On pine-culture in Central France, by M. de Béhague.

CONTENTS

THURSDAY, MARCH 12, 1874

THE LINNEAN SOCIETY

ON Thursday last the Fellows of the Linnean Society met together in a general meeting, which had been specially convened to consider the disputes which have almost paralysed its work for the past two months. One painful episode which arose out of these disputes has already been alluded to in these columns. This alone gave importance to matters which otherwise it would have been difficult to discuss with patience. But so serious a crisis as the resignation of a president so distinguished as Mr. Bentham brought together a larger meeting of the Fellows than had probably ever assembled together before in the history of the Society, and produced the very decided feeling that at least the prospect of a settlement must be reached before the meeting dispersed.

The result was, on the whole, a satisfactory one. After a debate which lasted for about two hours, and in which a considerable number of Fellows took part, a motion proposed by Major-General Strachey was finally carried with only three dissentients, to the effect that the Council possessed the confidence of the Fellows, and that the question of the disputed bye-laws should be referred to some authoritative legal adjudicator, whose decision should be regarded as final.

Those who have had no opportunity of taking any part in the proceedings will naturally wonder what can have been the nature of the portentous questions which have so violently disturbed so grave and staid a body as the Linnean Society. So far as we can arrive at a clear comprehension of the facts, they may be stated as follows :—

At the commencement of the present year the charter and bye-laws were out of print, and the Council having determined to reprint them, before doing so made and submitted to the Fellows a number of amendments in them which appeared to be advisable. It is necessary to explain that, by the constitution of the Society the Council alone has the power to legislate, and the general body of Fellows is only able to reject or ratify what the Council has done. At the meeting on January 15, when the amendments in due course came before the Fellows, the President was requested to put them to the vote *seriatim*, and not *en masse*. This was *primâ facie* a reasonable request, and might, perhaps, have been acceded to without any great inconvenience. The President, however, ruled against it, and his ruling may be defended on two grounds. In the first place the custom of the Society on other occasions appears to have been in accordance with it, and as a general principle it seems obvious that it would be inconvenient for the Fellows to modify in detail a scheme which the Council had presented to them as a whole. In the second place, although the charter is a most difficult instrument for a layman to interpret, it is held by those who ought to be able to construe it, to require that the Council's propositions should be accepted or rejected in their entirety and without modification. The amendments were accordingly put to the meeting *en masse*, and were carried by the necessary majority of two-thirds. The minority declared themselves much aggrieved by the course that had been taken. It is not easy, however, to appreciate their objection ; for it is clear that to put all the amendments *en masse* cannot facilitate their acceptance, but that, on the contrary, it brings to bear collectively upon the whole scheme all the objections which might be raised separately to different parts of it.

At the meeting in which the amendments were carried, only one of them was actually objected to. The effect of this amendment was to enable the Council to pay a Fellow to assist in editing the publications. The sum proposed was not large, and it seems very desirable that the work should be paid for, and not voluntary. It is quite obvious that in the former case the secretaries would have no scruple in criticising, if necessary, what was done, which might easily seem an ungracious proceeding in the case of unpaid labour.

Subsequently, however, to the meeting, the minority discovered that another amendment, removing the appointment of the Librarian from the general suffrages of the Fellows to the Council, was repugnant to the provisions of the charter. A competent legal authority has declared that this is not the case ; nevertheless, certain of the Fellows hold a contrary opinion, and regard the change as a derogation from their privileges.

We have already referred to what took place on February 5. Mr. Carruthers, who took the lead in the opposition, proposed to discuss the legality of the amendments, and attempted to raise this question upon the confirmation of the minutes of the meeting at which they had been carried. He and his supporters being in a majority in a very thinly-attended meeting refused to acquiesce in the ruling of the President against the regularity of this proceeding; the meeting broke up in confusion, and Mr. Bentham resigned the chair which he has occupied so long to the great advantage of the Society. The difficulties of the Society began like a slight and neglected illness which terminates fatally : before the general body of Fellows had time to even realise the nature of the dispute it had culminated in an event which it will never be possible to look back upon except with the strongest regret. It was, however, a matter for satisfaction that the Fellows assembled last Thursday were anxious to efface this from Mr. Bentham's recollection ; and Mr. Carruthers, whose action was the immediate cause which led to the President's resignation, spoke with befitting dignity of the regard he felt for Mr. Bentham's services to the Society and to Science generally, and of his own extreme regret that the course he had considered himself compelled to take had led to such an untoward result.

As to the points apparently in dispute it is difficult to estimate seriously the position of the dissidents from the Council's action. It is objected that the person employed as sub-editor ought not to be a Fellow, or ought on accepting the position *ipso facto* to cease to be one. But where, it may be asked, can the Society expect to find, except in its own ranks, anyone competent for the work? and why should there be any more scruple about employing a Fellow for such a purpose than there is in employing Fellows as printers and engravers?

As to the election of a Librarian, what arrangement could be more objectionable than for the Society at large to elect to an office of this kind? How could testimonials

be properly weighed by the members generally, or the fitness of candidates in any way tested? And when it is argued that the clerk and housekeeper, as well as the Librarian, ought to be appointed by the Society also, and not by the Council, the acme of absurdity in the matter seems to have been reached.

It is quite evident, from what has been said, that the less a learned Society indulges in legislation the better. What must be called the "opposition" were anxious, at the meeting on Thursday last, for a further revision of the whole laws of the Society; fortunately, however, the common sense of the Fellows was against them. Sir John Lubbock pointed out, at the conclusion of the debate, that none of the speakers had made out even a *primâ facie* case for further change. It may be hoped, therefore, that when the technical question of the legality of the amendments has been disposed of, the Society will enjoy undisturbed peace and quietness.

One practical suggestion seems to educe itself from what has been said. The only way to settle matters of dispute of this kind is to have an authoritative arbitrator. If we ever get a minister to take charge of our scientific institutions, a legal assessor might be conveniently attached to his staff to act in lieu of a Visitor to the learned Societies which now possess a quasi-official status from being housed at the public expense. If the points which the dissentients raised in the present case could have been authoritatively and impartially settled off-hand, there would have been no need for an important scientific Society to have wasted a considerable portion of its session over matters in themselves of the slenderest possible consequence, and absolutely without importance in a scientific sense.

THE MOON

The Moon Considered as a Planet, a World, and a Satellite. By James Nasmyth, C.E., and James Carpenter, F.R.A.S. With 24 illustrative plates of lunar objects, phenomena, and scenery, and numerous woodcuts. (London: Murray, 1874.)

THE illustrations to this book are so admirable, so far beyond those one generally gets of any celestial phenomenon, that one is tempted to refer to them first of all. No more truthful or striking representations of natural objects than those here presented have ever been laid before his readers by any student of Science; and I may add that, rarely if ever, have equal pains been taken to insure such truthfulness. Mr. Nasmyth, not content with the drawings he has been accumulating for many years, has first translated them into *models*, which, when placed with a strong light shining obliquely upon them, should reproduce the ever-changing lunar effects of light and shadow. Having obtained models which bore this test, he has photographed them with the light falling, now on one side, and now on the other, to represent the sunrise and sunset appearances on our satellite, as observed in the telescope. The result is perfect; far more perfect than any enlargement of photographs could possibly have been, because, by every such enlargement, a softness is brought about, whereas, the more powerful the telescope employed and the more perfect the atmospheric conditions, the more does the unevenness and sharpness of every lunar detail come out.

But, though I have given the first place to a general reference to the illustrations, I by no means intend thereby to imply that the text is of secondary importance. In fact, the more carefully the text is read, the more obvious does it become that Mr. Nasmyth has used his drawings as a means to an end, and that he and Mr. Carpenter between them have produced a work which is not only a very beautiful and a very readable one, but one of some importance. From this point of view it is to be regretted that the book had not been published a month or two later, as then the authors might further have illustrated their subject by a reference to Mr. Mallet's most important paper on volcanic energy, which has just appeared in the "Philosophical Transactions"—a paper which supports the authors' views in many important particulars, and though it clashes with others, if we are not mistaken, a discussion of the question from the two points of view presented will ultimately enable us to carry our conclusions further than they have gone hitherto.

Again, it is not a little curious that another communication presented to the Royal Society not long ago, and

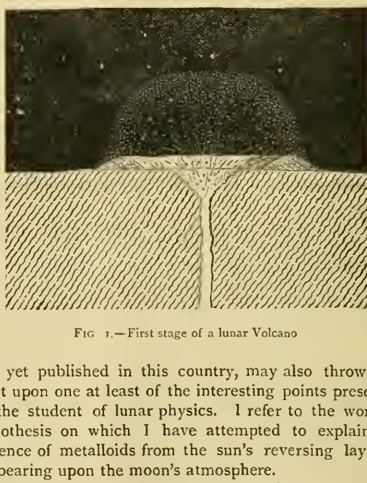


FIG. 1.—First stage of a lunar Volcano

not yet published in this country, may also throw new light upon one at least of the interesting points presented to the student of lunar physics. I refer to the working hypothesis on which I have attempted to explain the absence of metalloids from the sun's reversing layer in its bearing upon the moon's atmosphere.

Before, however, more detailed reference to these points, it is as well to state briefly, for those less conversant with lunar matters, the principal points in which Selenology differs from Geology, or rather the principal effects which have been produced on the moon in past time which differ from the effects which have been produced on our planet in past time.

First among these is undoubtedly the evidence of volcanic action on a scale far surpassing anything that we have an idea of here. Witness craters 74 miles in diameter, and if the walled plains are accepted as craters, then diameters of craters reaching 300 miles, the volcanic energy not being scattered here and there, but making up the entire surface over large areas.

Next, after the tremendous evidence of vulcanicity afforded by the craters and walled plains, come the bright streaks which have ever been a puzzle to observers. These are seen under various illuminations to radiate from several craters for hundreds of miles. Here I will quote from the book, p. 133:—

"There are several prominent examples of these bright streak systems upon the visible hemisphere of the moon; the focal craters of the most conspicuous are Tycho, Copernicus, Kepler, Aristarchus, Menelaus, and Proclus. Generally, these focal craters have ramparts and interiors distinguished by the same peculiar bright or highly reflective material which shows itself with such remarkable brilliance, especially at full moon; under other conditions of illumination they are not so strikingly visible. At or nearly full moon, the streaks are seen to traverse over plains, mountains, craters, and all asperities; holding their way totally disregardful of every object that happens to lie in their course. The most remarkable bright streak system is that diverging from the great crater Tycho. The streaks that can be easily individualised in this group number more than one hundred, while the courses of some of them may be

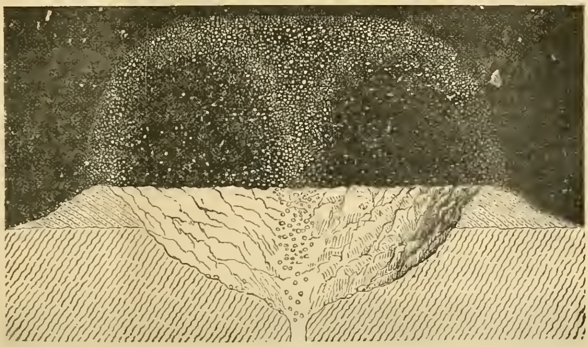


FIG. 2.—Second stage. The crater increases its diameter

traced through upwards of six hundred miles from their centre of divergence. Those around Copernicus, although less remarkable in regard to their extent than those diverging from Tycho, are nevertheless in many respects well deserving of careful examination; they are so numerous as utterly to defy attempts to count them, while their intricate reticulation renders any endeavour to delineate their arrangement equally hopeless."

Quite different from these radiating streaks are very definite "cracks," some of which are easily seen with moderate telescopic powers. There are, however, a very large number recorded, some of which are excessively delicate objects.

Last among exceptional phenomena to be recorded is the circumstance that our satellite has no atmosphere to speak of: no clouds, no fogs have ever been seen on the moon as on Mars, while no effects have been produced

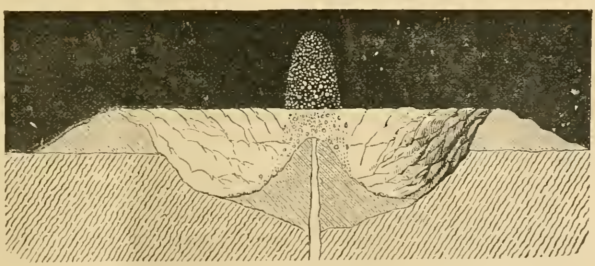


FIG. 3.—Third stage. The central cone is formed by a reduced action

at occultations of stars and planets by the moon such as should be produced did an atmosphere in any way comparable to our own exist on our satellite.

Although the most important part of the text consists of an attempted explanation of all but the atmospheric phenomena, much of it deals, and in a very admirable way, with lunar topography, a perusal of which will be desirable before the discussion is taken up, in the case, at all events, of those unfamiliar with the moon's surface. The consideration of the various questions involved is preceded by chapters on the cosmical origin of our system and the generation of heat, the result of which was that at one time the moon was an incandescent sphere with a cooling crust, and even then if I understand the authors, there was no lunar atmosphere (p. 17), for they give an answer, or think they do, in this sense to the question

"How can a volcanic theory of the lunar phenomena be upheld consistently with the condition that it possesses no atmosphere to support Fire?"

In the chapter on the cooling of the crust (Chap. III.), special attention is directed to observations tending to show that cast-iron and even slag and Vesuvian lava expand on cooling. This will be new to physicists:—

"The broad general principle of the phenomenon here referred to is this: That fusible substances are (with few exceptions) specifically heavier while in their molten condition than in the solidified state, or in other words, that molten matter occupies less space, weight for weight, than the same matter after it has passed from the melted to the solid condition. It follows as an obvious corollary that such substances contract in bulk in fusing or melting, and expand in becoming solid. It is this expansion upon solidification that now concerns us.

"Water, as is well known, increases in density as it cools, till it reaches the temperature of 39° F., after which, upon a further decrease of temperature, its density begins to decrease, or in other words, its bulk expands, and hence the well-known fact of ice floating in water, and the inconvenient fact of water-pipes bursting in a frost. This action in water is of the utmost importance in the grand economy of nature, and it has been accepted as a marvellous exception to the general law of substances increasing in density (or shrinking) as they decrease in temperature. Water is, however, by no means the exceptional substance that it has been so generally considered. It is a fact perfectly familiar to iron-founders, that when a mass of solid cast-iron is dropped into a pot of molten iron of identical quality, the solid is found to float persistently upon the molten metals—so persistently that when it is intentionally thrust to the bottom of the pot, it rises again the moment the submerging agency is withdrawn" (p. 20).

There will be many for whom this part of the work will possess great interest, but I take it few will accept the startling conclusions drawn from the asserted expansion.

"This expansion of volume which accompanies the solidification of molten matter furnishes a key to the solution of the enigma of volcanic action; and that such theories as depend upon the agency of gases, vapours, or water are at all events untenable with regard to the moon, where no gases, vapour, or water appear to exist" (p. 27).

I will return to this point presently, but meantime let us follow the contracting globe. Messrs. Nasmyth and Carpenter quite accept tangential pressure as being the only true cause of elevation, and its effect is very well put:

"When the molten sub-stratum had burst its confines, ejected its superfluous matter, and produced the resulting volcanic features, it would, after final solidification, resume the normal process of contraction upon cooling, and so retreat or shrink away from the external shell. Let us now consider what would be the result of this. Evidently the external shell or crust would become relatively too large

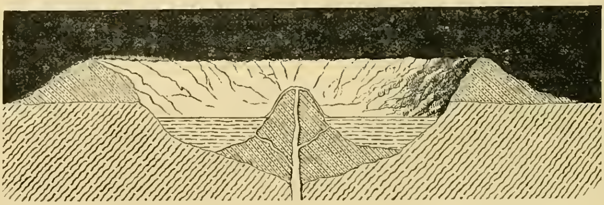


FIG. 4.—Fourth stage. The old crater is nearly filled with lava, leaving the cone visible in the centre

to remain at all points in close contact with the subjacent matter. The consequence of too large a solid shell having to accommodate itself to a shrunken body underneath, is that the skin, so to term the outer stratum of solid matter, becomes shrivelled up into alternate ridges and depressions or wrinkles" (p. 28).

The preceding extracts will give an idea of the authors' view of the general phenomena which accompanied the cooling of the crust. We have no atmosphere, the crust as it cools expands and cracks, and through these cracks the interior liquid is ejected, and finally tangential pressure does the rest.

Now leaving the question of the atmosphere for a time, let us compare this with Mr. Mallet's reasoning. As a planet cools, the crust thickens, and the nucleus contracts; the crust must follow the nucleus, hence tangential pressure and its concomitants, elevation where possible, where not possible then tremendous interior motions, which motions are converted into heat, which heat + water produces volcanic activity. Further, the smaller a globe is, the more rapidly will it cool, and the more marked will the phenomena which accompany cooling be. Hence Mr. Mallet's hypothesis is competent to explain all the extreme development of volcanic activity on the moon by exactly similar causes which we know to have gone on here.

Now as I have said, Mr. Mallet wants water for his volcanoes, both here and on the moon, but Messrs. Nasmyth and Carpenter will not even allow that an atmosphere, still less water, has ever existed there. Now here I unhesitatingly range myself on the side of Mr. Mallet. I believe in an absolute uniformity throughout all Nature in such matters. I do not mean uniformity of matter, so far as chemical materials go, but of manner.

Now what is an atmosphere? or to put the question more specifically, what is our atmosphere? Is it not a residue? We have free oxygen in the atmosphere at the present time; had we not very much more before the various metals which now exist in combination with that metalloid existed in their pure state? Now how has combination been brought about? By exposing the metals to the atmosphere and its contained oxygen. Now suppose the machinery, the function of which in past time has been to bring these metals to the surface, had been a thousand times more powerful, would there be as much oxygen in the air now as there is? A child can answer this question, and it is one of several which might be asked all tending to show that it is as unnecessary as it is unphilosophical to suppose that there never was a lunar atmosphere, because there is only a tenuous one at the best now. I shall not

follow this subject out further now because it is part of a larger one, which deals with the atmospheres and densities of all the bodies of our system, and to discuss it at length would lead me too far from the present subject; suffice it to say that the enormous atmospheres of Saturn and Jupiter and the absence of a lunar atmosphere result from one single cause, that cause being if I mistake not the chemical constitution of the exterior parts of the solar nebula as each planet was thrown off, and the subsequent action on each globe.

To come to details. Whether the walled plains are really due to volcanic action or not, our authors offer no opinion beyond referring to the hypothesis of Prof. Dana, as being the most rational. Dana suggested that, as at Kilauea, the lava was simply boiling, and gradually extending its boundaries from a centre, so that at last, if the heat continued, a quasi-crater might be formed of any extent. That the smaller craters are true craters Messrs. Nasmyth and Carpenter take great pains to show, and their evidence is of the closest and most satisfactory kind. The woodcuts which we produce will show how the central cones, which *are scarcely ever absent in the craters we are now discussing*, have originated on the theory advanced; at the same time it is shown how, on this idea, even when the central cone is absent or the crater is filled to the brim, as in the case of Wargentin, one of the most curious of lunar objects, the effects observed may be explained.

Mr. Nasmyth long ago illustrated the bright streaks on the moon by the experiment which he here details, and a very striking one it is. He took a glass globe, filled it with water, and having hermetically sealed it, plunged it into warm water, "the enclosed water expanding at a greater rate than the glass, exerts a disruptive force on the interior surface of the latter, the consequence being that at the point of least resistance the globe is rent by a large number of cracks diverging in every direction from the focus of disruption."

From the photograph, it is clear that the result is strikingly similar to the rays which have Tycho for a focus, and on the strength of this similarity the authors claim this as another effect of expansion due to cooling. I so, however, the experiment with the glass globe is not in point. But however the cracks were produced, they imagine that thus having them travelling along for hundreds of miles irrespective of surface inequality, there was an up-flow of molten matter which spread out on both sides and turned the narrow crack into a broad streak.

I trust I have said enough about this book to induce all interested in physical problems to peruse it for themselves; it is altogether an admirable production, and if space permitted each picture even would merit a special paragraph.

J. NORMAN LOCKYER

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Natural Selection and Dysteleology

IN his reply to a criticism which appeared in NATURE, Prof. Struthers alluded to a question of considerable interest to evolutionists, viz., whether or not the presence of useless organs "proves too much for the argument." * The difficulty is one often met with, and has been well stated by Prof. Huxley, thus:—"Prof. Haeckel has invented a new and convenient name, 'Dysteleology,' for the study of the 'purposelessnesses' which are observable in living organisms—such as the multitudinous cases of rudimentary and apparently useless structures. I confess, however, that it has often appeared to me that the facts of dysteleology cut two ways. If we assume, as evolutionists in general do, that useless organs atrophy, such cases as the existence of lateral rudiments of toes, in the foot of a horse, place us in a dilemma. For, either these rudiments are of no use to the animal—in which case, considering that the horse has existed in its present form since the pliocene epoch, they surely ought to have disappeared—or they are of some use to the animal, in which case they are of no use as arguments against teleology," &c.†

Now it appears to me (as I think it must to all upon adequate consideration), that the dilemma thus presented is only apparent; its first-mentioned horn having no existence. In other words, we can never in any single case be sure that any length of time would have been sufficient to enable natural selection totally to obliterate a useless organ.

Mr. Darwin, in the "Origin" and in the "Variation," has mentioned three causes which operate towards the removal of useless structures. These causes are Selection, Disuse, and Economy of Growth. Recently he has suggested a fourth cause, which may be epitomised as the dwarfing influence of impoverished conditions, progressively reducing the average size of the useless structure, by means of free intercrossing.‡ I shall endeavour to show that these causes are not sufficient to obtain the complete extinction of rudimentary parts in all cases.

Selection may be considered as applying only to those rare instances in which changed conditions of life may be supposed to have rendered a previously useful organ injurious; for so far as selection operates in obliterating a merely useless organ, it will be more convenient, for the sake of brevity, to identify it with the Economy of Growth.§ Since, however, it is obvious that an injurious organ must pass through the merely useless stage before it becomes wholly suppressed, we may dismiss this cause without further comment.

Disuse and Economy of Growth are so much entangled in their operation, that it is hopeless to find examples illustrating their separate action. In so far, therefore, as we choose to disentangle them, we must discuss the question in the abstract.

Disuse may be left out of the question, so far as its influence is due to the principle of inheritance at corresponding periods of life; for, as Mr. Darwin tersely observes, "as most organs could be of no use at an early embryonic period, they would not be affected by disuse; consequently they would be preserved at this stage of growth, and would remain as rudiments." ‖ It may,

* NATURE, vol. ix p. 83.

† "Critiques and Addresses," pp. 307–8.

‡ NATURE, vol. viii. pp. 432 and 505.

§ I think, also, that if the Economy of Growth is really a principle independent of the "more general principle," viz., the *direct* influence of "natural selection in continually trying to economise every part of the organisation" (Compare "Origin," 1873, pp. 117–18), it may yet, without any great stretch of inference, be considered as due to the *indirect* influence of natural selection. For, the survival of the fittest demands that each individual shall utilise its stock of nutriment to the best advantage; and, this demand being continued through many generations, it does not seem in itself improbable, that it should thus at last secure to all the members of the surviving species an inherited tendency so to economise their nutritive power when fresh occasion requires—an advantageous innate *temperament* distinct from the external *eliminative* agency of Natural Selection. Only in some such way can we account for the facts of acclimatisation, in those cases where the adaptive changes take place immediately after the transportation of the organism: also for an analogous class of facts, such as that of the shells in the same species of Mollusca, differing in their thickness upon the weather and the lee sides of the Plymouth breakwater.

‖ "Variation," vol ii. p. 317. I may mention, also in passing, that it seems to me not unopen to question whether disuse is the *principal* cause even of reduction There is no doubt that disuse causes more or less of atrophy in the individual, and from this fact it is argued, that the principle of inheritance at corresponding periods of life must entail the continued reduction of a disused part in the species. Now the only effect of the principle relied on is that of prolonging, as it were, the life of the disused part over many generations—thus affording it an indefinite time to succumb to the conditions which reduced it in the life of the individual. But it is necessary for the validity of the inference that it would so succumb, to show that these conditions are the efficient causes of this reducing process in the one case, as they prove themselves to be in the other. Suppose, for instance, that failure of nutrition is the principal cause of atrophy under disuse, does it follow when such failure has done, to all appearance, its utmost during the life of the individual (as we see in disease), that it could do any more were that life indefinitely prolonged? Of course in the case of short-lived animals, where the dwarfing influences may not have time to exhaust themselves in a single generation, the principle of inheritance at corresponding ages may be drawn

however, be objected that the doctrine which Mr. Darwin elsewhere inculcates,* and deems sufficient to account for the total suppression of rudimentary organs, viz., inheritance at earlier periods of life, is fatal to dysteleology as a prop to evolution—at least in the case of long-lived species. And so it would be, were not this principle of so shadowy an application that, while it is perfectly legitimate to point to it as a possible cause of total suppression in some cases, it would be simply absurd to argue that such must be its effect in all.

We next come to the Economy of Growth. Suppose an organ to become suddenly useless, this principle would at first cause its rapid reduction. In proportion, however, as its presence ceases to be injurious, the arresting process becomes slower and slower, until a point is reached at which it is presumably *nil*. That such a point of rest must somewhere be attained seems evident, if we consider that the smaller the diminishing organ becomes the less is it subject to the influence of the Economy of Growth. In other words, when the organ undergoing reduction becomes so minute relatively to the size of the animal (or, more correctly, to the available store of nutrition), that the supply of nourishment it requires is no longer perceived by the organism at large, it then remains permanently of that size. "The economy of growth will not account for the complete or almost complete obliteration of, for instance, a minute papilla of cellular tissue representing a pistil, or of a microscopically minute nodule of bone representing a tooth;"† and, the whole principle being one of relation, it is a question, for instance, whether the rudimentary digits of a horse consume a greater relative amount of nutrition than does the "minute papilla." Besides, without entering into details, I think there is very good reason to believe that the Economy of Growth is unable to reduce an organ which was originally large, to the same absolute size as it can an organ which was originally small. From all this it follows, that if the struggle for existence were in any case so keen as to afford Selection (*i.e.*, Economy) the opportunity of totally obliterating every rudimentary organ, it seems probable that the species itself would require to become extinct.

Turning now to the last of the causes propounded by Mr. Darwin, there can be no doubt that it is (theoretically) sufficient to procure total obliteration. Forasmuch, however, as we can never know in any given case whether or not the requisite conditions have been supplied,—*i.e.* impoverished nutriment for an enormous length of time,—this newly added cause affords no further justification for the old statement, that the theory of Natural Selection fails to account for all the facts of Dysteleology.

The perusal of the last-mentioned thoughtful conception has suggested to me the probable existence of another cause, having a more general application; but as it can never induce complete suppression, I shall reserve it for the subject of another communication.

Mr. Mivart supposes that organs may become suddenly aborted ‡; but, apart from the weighty objections to this view,§ there is no case on record, so far as I am aware, of an organ thus becoming *totally* suppressed in any domestic species. A sport of this kind always leaves a rudiment, and it is upon the analogy of such sports alone that Mr. Mivart's argument is founded.

Having now enumerated all the causes ever proposed by evolutionists to account for the reduction of useless parts, it is evident that we should antecedently expect to find innumerable examples of such parts in the condition of rudiments.‖ Indeed the only difficulty is to account for that final disappearance of organs which must, by any theory of evolution, be postulated to have taken place. The solution is afforded by the exhaustive contemplations of Mr. Darwin, for, whether or not we believe in pangenesis, we cannot but deem it in the highest degree probable that the influence of inheritance is not of unlimited duration. If so, we have at once an adequate cause for the eventual destruction, even in the embryo, of rudimentary parts; but, as it is a cause which would only act after an immense lapse of time, it would have no influence until the original specific type had undergone a considerable modification. Thus, the facts of dysteleology, far from "cutting two ways," afford the strongest confirmation of the natural selection theory; for, as time is thus shown the chief agent in the final destruction of rudiments, and as species are always undergoing change, on the one hand we have an explanation of the fact, that the greater the divergence of the specific type from its original the fewer rudiments do we find of organs characteristic of the latter, while on the other hand, the less such divergence the greater the number of such rudiments—a fact of which the necessary consequence is, that "with species in a state of nature, rudimentary organs are so extremely common that scarcely one can be named which is wholly free from a blemish of this nature."

GEORGE J. ROMANES

upon until the point of such exhaustion is attained; but is it not open to question whether this point can never be reached at all? It must de remembered, too that in the case of wild species the effects of disease are always associated with other reducing causes, so that here we may easily over-rate the share it has in the work; but in the case of domesticated species the effects of disease are much more isolated (in consequence of Economy of Growth, etc., being, to a great extent, in abeyance); and here we find that atrophy of disused parts, although at first very rapid, eventually does not proceed to nearly so great an extent as it does in the case of wild species. The question thus raised, however, is of no practical importance, since whether or not disuse is the chief *cause* of atrophy in species, there is no doubt that atrophy *accompanies* disuse.

* "Variation," vol. ii. p. 80.

† "Variation," vol. ii. p. 397.

‡ "Genesis of Species," 1st ed. p. 103.

§ See "Origin," pp. 201—204.

‖ It is unnecessary to consider the *collective* action of these causes, for a moment's reflection will now make it evident that none such exists below the point at which the Economy of Growth ceases to be felt.

The Action of the Heart

HAVING replied to Mr Garrod's criticism of my "Locomotion of Animals" (NATURE, vol. ix. p. 281), I now wish to show that the explanation given by him of the diastole of the heart is not in accordance with fact.

In a recent number of NATURE (vol. ix. p. 282) I asked Mr. Garrod to explain "how the left ventricle of the heart opens after a vigorous contraction in which all the blood contained in the ventricular cavity is ejected and the ventricle converted into a solid muscular mass, if not by a spontaneous *elongation* of all its fibres." He replies:—"At first sight it might seem that the active dilatation of the heart during the diastole did depend on an inherent power in the muscular fibres of the ventricles to elongate, but the peculiarities of the coronary circulation are quite sufficient to explain the phenomenon without the introduction of so unnecessary a theory as that of Dr. Pettigrew. For in the heart when removed from the body, as in the living body during diastole, the injection of fluid into the coronary vessels causes the whole heart to open up from the congestion of the ventricular walls, and so produce the active dilatation which is well known to occur" (NATURE, vol. ix. p. 301).

The explanation given by Mr. Garrod of the manner in which the ventricles of the heart open up during the diastole is eminently unsatisfactory. In fact it is no explanation at all. He informs us that the active dilatation of the ventricles is due "*to peculiarities in the coronary circulation*" . . . "for in the heart when removed from the body the injection of fluid into the coronary vessels causes the whole heart to open up from the congestion of the ventricular walls, and so produce the active dilatation which is well known to occur."

The coronary vessels, as everyone is aware, simply supply the blood which nourishes the substance of the heart. There is no peculiarity whatever in the circulation of the blood through them. The blood flows through the coronary vessels in a more or less steady stream as through all the other vessels of the body. In other words the substance of the heart is full of blood during the closure or systole of the ventricles, as well as during the opening or diastole of the ventricles. The presence of the blood, therefore, within the coronary vessels can exert no influence in opening up or actively dilating the ventricles. This is proved by direct experiment. If the heart be cut out of the living body and the coronary vessels divided, the ventricles go on opening and closing with the utmost regularity for protracted periods. Here, however, the power which, according to Mr. Garrod, opens the ventricles is inoperative. The same thing happens when the heart is cut out of the body and the vessels laid open. If, however, the ventricles open and close when the coronary vessels are freely divided, and the blood which is said to distend or open up the ventricles is allowed to escape from the cut surfaces, it is quite clear that the blood pressure within the ventricular walls can exert no influence whatever in producing the diastole. If blood is not admitted into the coronary vessels, or if admitted it is allowed freely to escape, it cannot of course act as a distending medium. Allowing, however, for the sake of argument, that the flow of blood through the vessels of the ventricles occasioned the opening or dilatation of the ventricles, it is evident, for the same reason, that the presence of the blood within the ventricular walls, from the fact that the blood is nearly constant in quantity and virtually incompressible, would prevent the closing or contraction of the ventricles. Mr. Garrod, I opine, is

here on the horns of a dilemma. He evidently puts the cart before the horse. It is the movements of the heart which determine the movements of the blood, and not the converse.

The cardiac movements are due to a change of shape in the sarcous elements or ultimate particles of the muscular fibres of the heart, and in the adult organ can only be effected by a vital and alternate elongation and shortening of all the fibres composing the heart; the elongation occurring during the diastole and the shortening during the systole. Similar remarks are to be made of the voluntary muscles which, as stated in my work on "Animal Locomotion," are endowed with centrifugal and centripetal movements.

That the opening and closing of the ventricles of the heart are in no way connected with the passage of blood through the substance of the organ, is proved indirectly by the movements of the heart of the embryo. Here the heart opens and closes with time-regulated beat, while yet a mass of cells, and before it contains blood either in its cavities *or in its substance.* But that the presence of blood is not necessary to such movements is placed beyond doubt, for rhythmic movements occur in the vacuoles of certain plants, as *e.g.* the *Volvox globator*, *Gonium pectorale*, and *Chlamydomonas*, where no blood is present.

Lastly, if a frog be slightly curarised and its spinal cord destroyed, it is found, on exposing the heart, that the sinus venosus, vena cava inferior, the auricles and ventricles *are quite destitute of blood*, and yet the organ beats normally and with the utmost regularity. Mr. Garrod has consequently not yet succeeded in answering my query as to how the diastole of the left ventricle is produced He has failed to show that it is not effected by the *active elongation or centrifugal movements of all its fibres.*

J. BELL PETTIGREW

Lakes with two Outfalls

HAVING observed the discussion lately carried on in your pages as to the existence of lakes with two outfalls, I think the following description of such a lake by Prof. Bell, of the Geological Survey of Canada, may be interesting to some of your readers. It occurs on the summit of the high Laurentian country between Lake Superior and Hudson's Bay:—

"In crossing the country from Lake Nipigon to the Albany River, we first followed the Ombabika River to its source, which is in Shoal Lake, three and a half miles long and one mile wide, lying at a distance of twenty-five miles north-east of the mouth of the river. This lake lies due north and south, and discharges both ways, the stream flowing northward towards the Albany, called the Powitik River, being nearly as large as the southern outlet. No portage occurs on the Ombabika for about nine miles before reaching Shoal Lake, nor for nearly five miles beyond its northern outlet; so that we passed the height of land with the greatest possible ease, having had about seventeen miles of uninterrupted canoe navigation, from the time we made the last portage, in going up the southern side, till we came to the first on going down on the northern. Shoal Lake has an elevation of scarcely 300 ft. over Lake Nipigon, or about 1,200 ft. above the sea."—"Report of Progress Geological Survey of Canada for 1871-72," p. 107.

GEORGE M. DAWSON

Montreal, Feb. 19

The Ink of the Cuttle-fish

WITH reference to the interesting account in NATURE, vol. ix. p. 332, of a gigantic Cephalopod captured in American waters, and of a still larger one, which attacked the boat belonging to some fishermen near Newfoundland, by twining its arms round the vessel, and which, having had two of those arms cut off by the fishermen, moved off, "ejecting a large quantity of inky fluid to cover its retreat," I desire to draw attention to an observation respecting this fluid, which I made on the occasion of a visit to the Crystal Palace Aquarium. My friend Mr. Lloyd was good enough to dislodge a cuttle from its place of concealment, and the usual inky discharge followed, as the creature shot across the tank. Mr. Lloyd states in his interesting "Handbook to the Marine Aquarium," "that the ink (which is viscid) does not generally become diffused through the water as writing ink would be, but is suspended in the water in a kind of compact cloud till it gradually settles down, and is dispersed in flakes." Now I quite think, with Mr. Lloyd, that this being the case, it is difficult to perceive how, according to the generally received opinion, its retreat is covered by the ejected cloud. It seems to me more likely that this discharge is to divert the attention of a pursuer—a dog-fish for instance—which would for the moment be startled by the sudden appearance of masses of dark colour in the water, and in the confusion the cuttle makes his escape.

Now that public aquaria are becoming so general in our great towns, it is much to be hoped that this and many other interesting problems in marine zoology may be solved.

Birmingham, Feb. 28

W. R. HUGHES

Transmission of Light in a Squall

ON the Admiralty Pier, Dover, during a "squally" gale, I remarked an occasional jerking or unsteadiness in one of the adjacent lights, say two miles off, to one of the coast-guard's men with whom I was talking at the time.

To him this was a well-known observation in squally weather. At times, he said, two lights could distinctly be seen for a second or so; frequently the shape of the light was changed, by elongation, vertically and horizontally.

The above phenomenon, if not generally known, might be worth noticing and verifyin in your excellent paper.

I suppose an explanation is to be found in the different densities of the atmosphere through which a ray of light must pass in rough unsteady weather; the second image being simply the persistence of the one seen immediately before the change in position of the ray by refraction.

JAMES C. INGLIS

DR. LIVINGSTONE AND THE CAMERON EXPEDITION

IN NATURE for Feb. 26, we expressed the desire which we felt, in common with our readers, for information respecting the orders that have been sent to Zanzibar as to the disposal of Dr. Livingstone's body. We now have great pleasure in being able to announce that Lord Derby acted with the promptitude and energy which might be expected from a statesman who has always shown a warm sympathy for the cause of geography. With the concurrence of the family, his Lordship has sent a telegram ordering the body of the illustrious traveller to be sent to England, and we believe that it is to be accompanied by one or two of Livingstone's faithful negro followers.

The melancholy death of Dr. Dillon and the return of Lieut. Murphy, leaves Lieut. Cameron alone, to proceed to Ujiji, to recover the box of papers left there by Livingstone, and to prosecute further geographical exploration. Heavy unforeseen expenses obliged Lieut. Cameron, who has proved himself to be a resolute and observant explorer, to purchase stores at exorbitant rates at Unyanyembe. The necessity for providing for the march of Murphy and Dillon to the coast, with Livingstone's body and most of his followers, is his complete justification for incurring this unauthorised expenditure, and there can be no doubt that the Geographical Society will treat its gallant emissary in a generous and liberal spirit. Cameron has suffered cruelly from fever and ophthalmia, and he is now resolutely pressing onwards in the performance of his work—the Society's work—in the face of greater difficulties than were encountered by any previous expedition. He carries with him our warmest wishes for his success, and the sympathy of every true geographer in England.

ON THE NEW RHINOCEROS AT THE ZOOLOGICAL GARDENS

A GLANCE at our list of additions to the Zoological Gardens during the last week will inform the reader that the Zoological Society has been successful in adding to its already unrivalled collection of specimens of the genus Rhinoceros still another species, which is exhibited for the first time in the Society's collection, and most probably in this country.

It is well known amongst naturalists that in Asia there are to be found two species of Rhinoceros, with a single horn developed on the top of the nose. The

larger of these is the gigantic Indian Rhinoceros (*R. unicornis*), many specimens of which have been brought to this country, and a very fine male example of which is living in the Regent's Park Gardens. In it the skin, which is immensely thick, is thrown into massive folds or shields, making the animal appear as if clad in armour-plating. Each shield is thickly studded with nearly circular slightly-raised tubercles, which look very much like the heads of innumerable bolts intended to strengthen and retain the shield in position. The folds that surround the neck, where it joins the head, are very ample, producing the appearance of the now so fashionable ruff, somewhat modified. According to the observations of the late Mr. Edward Blyth, the Indian Rhinoceros is found only at the foot of the Himalayan hills, and in the province of Assam, along the valley of the Brahmapootra.

The second species of one-horned Rhinoceros is generally called the Javan Rhinoceros (*R. sondaicus*). It is found in Java, and in the country stretching from Malacca up through Burmah to Assam. It is considerably smaller than the Indian species; the shields are not so strongly marked, and are not arranged in an exactly similar manner, the gluteal shield not being completely divided into two by a transverse fold situated half-way down it; and the middle neck fold, instead of running backwards on each side before it reaches the spine, crosses the middle line, and so divides off a saddle-shaped shield, which is median, and as deep from before backwards as from side to side. The fold which surrounds the neck is also much less significant, and the head is narrower and less formidable in aspect. The tuberculation of the shields is more slightly marked, and each tubercle is proportionately smaller in diameter.

It is a specimen of this Javan Rhinoceros (*R. sondaicus*), a nearly full-grown male from Java itself, which the Zoological Society has succeeded in purchasing, and which is now exhibited in the same house as the Indian species, so that every opportunity is at last afforded for a more minute study of the differences which will most probably be found to distinguish the two species.

The other species of Asiatic Rhinoceroses, namely, the Sumatran Rhinoceros (*R. sumatranus*), and the Hairy-eared Rhinoceros (*R. lasiotis*), are both two-horned, and have been divided off as a separate genus, that of *Ceratorhinus*, by Dr. J. E. Gray. The skin is not divided into shields, and is thinner than in the one-horned species. The type specimen of the Hairy-eared Rhinoceros, the only example known, is now living in the Zoological Gardens. About a year ago the Sumatran animal was also represented, and rumour says that the gap caused by its loss will not be long unfilled.

NEIL ARNOTT, M.D., F.R.S.

WE have this week to record the death of this well-known man of science, which took place at his residence in Cumberland Terrace, Regent's Park, on the 2nd inst. He was born at Arbroath in May 1788, and had consequently reached his eighty-sixth year.

While Neil was yet young his father died, and the family removed to Aberdeen. Neil went to the Aberdeen Grammar School, being there with Lord Byron, and succeeded so well in the one thing then taught, Latin, that he gained a bursary by a competition in Marischal College, which he entered in 1801. In his third year he came under Patrick Copeland, Professor of Natural Philosophy, renowned for his admirable course of lectures, and especially for his power of experimental illustration. Arnott was one of Copeland's best pupils, and afterwards turned to full account the careful notes that he had made of the lectures.

He began the study of medicine in Aberdeen, and in 1806 he went to London to prosecute the study. Young Arnott, while his medical education was still incomplete, went aboard an Indiaman, as assistant-surgeon, making the usual voyage of a trading East Indiaman in those days. He was the intellect and soul of the ship, associating with everyone that could learn or teach anything; he was the resource in all serious emergencies, of whatever kind.

On his return to England, in 1811, he settled as a medical practitioner in London. He was the chief medical adviser to a colony of French refugees who settled in Camden Town, and also became physician to the French and Spanish Embassies, his fluency in languages serving him in good stead. It was about 1823 that he first turned to account his studies in natural philosophy, by giving in his own house a course of lectures both on the general subject and on its applications to medicine. These lectures formed the basis of the "Physics," the first volume of which appeared in 1827, and gained for the author an instantaneous and wide-spread reputation. The first edition was sold in a week after being reviewed by the *Times*. In a few years five editions were exhausted, and the work was translated into all the languages of Europe. The freshness and popular character of his style recommended the book to the general public, and did not prevent its favourable reception by the highest scientific authorities; Herschel and Whewell both gave emphatic testimonies to its accuracy and originality. The author was thenceforth recognised as a man of science and an inventor of no mean order. His practice as a physician was extended, and he became a Fellow of the Royal Society. On the foundation of the University of London in 1836 he was nominated a member of the Senate, and in 1837 he was named Physician Extraordinary to the Queen.

In 1838 he published a treatise on warming and ventilating, and in this he described the stove since called by his name. He introduced the water-beds, and made many other useful applications of physics to medical and surgical practice. For many years he had withdrawn from medical practice. He had a large circle of friends in and out of the profession. His conversational powers, his large range of scientific knowledge, and his geniality of manner, will be long remembered by those who now regret his loss.

OZONE *

II.

SOME of the properties of ozone have already been referred to. At the common temperature of the atmosphere, it may be preserved, if dry, for a very long time in sealed tubes, but by slow degrees it becomes changed again into ordinary oxygen. This conversion goes on more rapidly as the temperature is raised, and at 237° C. it is almost instantaneous ("Phil. Trans." for 1856, p. 12). The alteration of volume which occurs at the same time has been already sufficiently described. A similar effect to that of heat is produced by several oxides, such as the oxide of silver or the peroxide of manganese, which by contact, or, as it is termed, catalytically, instantly change ozone into ordinary oxygen. Ozone is also destroyed by agitation with water, provided the ozone is in a highly diluted state. But the most interesting fact of this kind is one which I have recently observed, and which I hope to be able to exhibit to the Society. Dry ozone, even if present in such quantities as freely to redden iodide of potassium paper, is readily destroyed by agitating it strongly with glass in fine fragments, although, as we have seen, it may be preserved for an almost indefinite period in sealed glass tubes. This experiment, as it appears to me, forms a new and closer link than any hitherto observed between a purely mechanical action and a chemical change.

Ozone is a powerful oxidising agent. It attacks metallic mercury and silver with great energy, and converts them into oxides. The experiment with mercury is very striking, and is a delicate test for ozone, either in the dry or moist state. A few bubbles

* An Address delivered before the Royal Society of Edinburgh on December 22, 1873, by Dr. Andrews, LL.D., F.R.S., Honorary Fellow of the Royal Society of Edinburgh. (Continued from p. 340.)

of oxygen containing not more than $\frac{1}{100}$th part of ozone will alter wholly the physical characters of several pounds of mercury, taking away the lustre and convexity of the metallic surface and causing the mercury to form an adhering mirror to the surface of the glass vessel in which it is contained. If ozone in a diluted state is slowly passed through a tube filled with silver leaf, the metal will be oxidised to the distance of 2 or 3 millimetres, but the oxidation will not proceed further, although the ozone reactions are wholly destroyed. This striking result is due to the catalytic action of the portions of oxide which are first formed. So small is the amount of oxide produced in this case that, in a glass tube through which many litres of electrolytic ozone had been passed, the increase in weight from the formation of oxide only amounted to a scarcely appreciable fraction of a milligramme.

Ozone is absorbed by oil of turpentine, oil of lemon, and other essential oils. These oils have also, like phosphorus, the power of changing oxygen into ozone, while they are slowly oxidising; so that if oil of turpentine is shaken for some time in a flask filled with air or oxygen, the oil will acquire ozone properties.

Ozone decomposes a solution of iodide of potassium, liberating the iodine, which may be discovered by its red colour, or its blue compound with starch. If the action is continued sufficiently long, the free iodine disappears from the formation of iodate of potassium and the solution becomes colourless. Reddened litmus paper moistened with a solution of iodide of potassium is turned blue, when exposed to the action of ozone, in consequence of the caustic alkali formed by the decomposition of the salt. In employing this test it will often be found advantageous to remove the free iodine by washing the paper with strong alcohol. This form of the iodide of potassium test has been proposed by Houzeau for the discovery of ozone in the atmosphere. Ozone produces other reactions of a similar character which it will be sufficient here barely to mention. Paper moistened with sulphate of manganese becomes brown when exposed to this agent from the formation of the hydrated peroxide. Solutions of thallous oxide are in like manner converted into the brown peroxide; the black sulphide of lead into the white sulphate, and the yellow ferrocyanide of potassium into the red salt. The action of ozone on tincture of guaiacum, which it turns blue, was made a subject of special study by Schönbein.

The bleaching properties of ozone are highly characteristic and have attracted a great deal of attention. It deprives indigo of its blue colour, converting it into isatin, and bleaches readily litmus and other vegetable colouring matters. Attempts have been made to apply this property of ozone in the arts, and particularly to the refining of sugar and the bleaching of linen. It has been even stated that these and other applications of ozone, as a decolorizing or bleaching agent, have been successful; but the results of my inquiries on this point have, I regret to say, been unfavourable, and it remains yet to be seen whether this singular body can be made subservient to the useful purposes of life. For the preparation of ozone on the large scale from ordinary air, a modification of the tube-generator of Siemens has been proposed by Beanes, and is an efficient and powerful instrument.

I will not detain the Society by an account of the history or properties of the problematical body to which Schonbein gave the name of antozone. He considered this body to be oxygen possessing permanently positive properties, while ozone itself he regarded as negative oxygen. Ordinary or inactive oxygen, according to him, is formed by the union of ozone and antozone. These views have not been supported by recent investigations, which leave little doubt that the antozone of Schönbein is identical with the peroxide of hydrogen of Thénard. From ozone the peroxide of hydrogen can be readily distinguished by the solubility of the latter in water.

Soon after the discovery of ozone, Schonbein having observed that the air of the country frequently coloured a delicate ozone test-paper in the same manner as ozone itself, inferred that ozone is a normal constituent of our atmosphere. He concluded that the amount of this body present in the air is different in different localities, and in the same locality at different times, and with great boldness he attempted to connect its presence or absence with the prevalence or rarity of certain catarrhal affections. A new field for investigation was thus opened up, which has been assiduously cultivated by a large and zealous band of observers. Before referring however to their labours, it will be necessary briefly to allude to the present state of our knowledge regarding the existence of ozone in the atmosphere.

Schönbein always maintained that ozone is a constituent of atmospheric air, and his various papers on this subject alone would, if collected, fill a large volume. In his last memoir he observes that the active substance in the air acts in a parallel manner on iodide of potassium and sub-oxide of thallium papers, although more slowly on the latter; and that the thallium paper, which has been coloured brown by the air, behaves towards reagents in the same manner as that which has been exposed to artificial ozone. From these facts he infers that the active substance in the air is neither peroxide of nitrogen nor sulphuretted hydrogen. He further states that the atmosphere never contains free nitric acid, although nitrate of ammonium in small quantities is frequently present; and that neither chlorine nor bromine can be present in the free state in air, on account of their affinity for hydrogen. Houzeau also maintained that the existence of ozone in the air was proved by the alkaline reaction of iodide of potassium paper, which had been decomposed by exposure to the atmosphere. Although experiments and arguments of this kind were sufficient to give probability to the view that the active substance in the atmosphere which produces these reactions is ozone, they were at the same time far from conclusive, and some of the ablest chemists of Europe accordingly considered the question doubtful, while others attributed the effects observed to the presence of oxidising agents altogether different from ozone. I will only cite on this point the opinion of M. Frémy, whose researches in conjunction with M. Becquerel on ozone have already been referred to. "Without denying," he remarked at a meeting of the Academy of Sciences in 1865, "the importance of the indications given by the paper of M. Schonbein, or by that of M. Houzeau, I do not find that these reactions demonstrate with sufficient certainty the existence of atmospheric ozone. I am of opinion that the presence of ozone in the air must be established anew by incontestable experiments"

In 1867 I made a set of experiments which I had contemplated some years before for the purpose, if possible, of finally settling this important question. The method I proposed was to ascertain whether, in addition to the power of decomposing solutions of iodide of potassium and of certain other salts, the active body in the atmosphere possessed the other properties of ozone, some of which are highly distinctive. The inquiry was a delicate one, in consequence of the very minute quantity of the active body which is present, even under the most favourable conditions, in atmospheric air. The results of this investigation are given in a short note which was published in the "Proceedings of the Royal Society" for 1867. (1) By passing a stream of atmospheric air, which gave the usual reaction with iodide of potassium paper, for some hours over the surface of mercury in a U-tube, the metal was distinctly oxidised. (2.) The ozone reactions disappeared when the air was passed through a tube containing pellets of dry oxide of manganese. The experiment was continued till 80 litres of air had traversed the manganese tube without producing the slightest discoloration of a delicate test-paper. (3.) But the crucial experiment was to ascertain whether the active body in the air loses its characteristic properties, or is destroyed, at the same temperature (237° C.) as ozone. To determine this point, a stream of atmospheric air, which gave strong ozone reactions, was passed through a globular glass vessel (Fig. 5), covered with wire gauze, of 5 litres capacity, and afterwards through a U-tube 1 metre in length, whose sides were moistened internally with water, while the tube itself was kept cool by being immersed in a vessel of cold water. After traversing the globular vessel and the moistened U-tube, the air was blown over a slip of delicate test-paper, in order to ascertain the presence or absence of ozone. When the atmospheric air was drawn through this apparatus at a uniform rate by means of an aspirator raised by clockwork, the iodide of potassium paper was distinctly reddened in two or three minutes, provided no heat was applied to the glass globe. But on heating the air as it passed through the globe, to a temperature of about 260° C., not the slightest action was produced on the paper, however long the current of air continued to pass. On the other hand, when air free from ozone, but containing traces of chlorine or of the higher oxides of nitrogen, was drawn through the apparatus, the test-papers were equally affected, whether the globe was heated or not. These experiments have since been successfully repeated by Dr. C. Fox.

The identity of the active body in the atmosphere with ozone we may now assume to be established beyond dispute, and the accuracy of Schonbein's views on this subject to be fully con-

firmed. To determine, however, the actual amount of ozone in the atmosphere is a problem of surpassing difficulty, on account of the extremely small proportion in which it exists, even when at a maximum. Its presence can be easily discovered by any of the ordinary iodised starch-papers, or even more readily by white bibulous paper which has been moistened with a dilute solution of iodide of potassium, and allowed to dry spontaneously in a dark room. If a slip of this paper is exposed for five minutes to a current of air, which will be often supplied by the wind, or may be produced by walking briskly, it will be found to have acquired a delicate red tint, if ozone be present even in the smallest quantities. The tint will be best observed by comparing the slip after exposure with another slip of the same paper which has not been exposed. The action of the diffused light of day on the paper is rarely perceptible after so short an exposure, but this source of error can be easily avoided by enclosing the paper in a hollow cylinder of wood.

Although with the experimental resources now at our command, we can scarcely venture even to estimate the actual amount of ozone at any time present in the atmosphere, yet it may be possible, as Schönbein long ago proposed, by applying a chromatic scale to the indications of the test-papers, to ascertain approximately its relative amount in different localities, and its variations in the same locality. Such estimates must, however, be most uncertain, since the shades of colour produced on test-paper hardly admit of being defined by numbers ; and in this particular case they are liable to a special source of error, as there can be little doubt that a large but unknown part of the ozone in

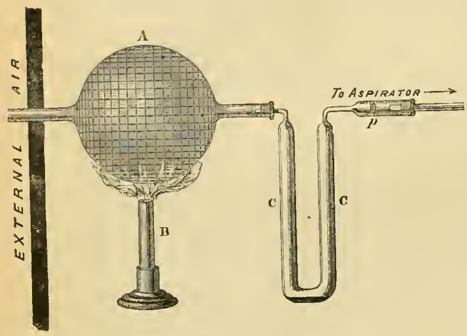


FIG. 5.

the air which comes into contact with the paper is catalytically destroyed, and produces no chemical effect whatever. At the same time the ozonometer, especially when used with an aspirator, does unquestionably give indications of value regarding the ozone states of the atmosphere, and till more accurate methods are devised these observations ought certainly to be continued.

Ozone is rarely found in the air of large towns, unless in a suburb when the wind is blowing from the country ; and it is only under the rarest and most exceptional conditions that it is found in the air of the largest and best ventilated apartments. It is, in fact, rapidly destroyed by smoke and other impurities which are present in the air of localities where large bodies of men have fixed their habitation, and I have often observed this destructive action extending to a distance of one or two miles from a manufacturing town, even in fine and bright weather.

Ozone is rarely, if ever, absent in fine weather from the air of the country, and it is more abundant, on the whole, in the air of the mountain than of the plain. It is also said to occur in larger quantity near the sea than in inland districts. It has been found to an unusual amount after thunderstorms—a fact which is favourable to the view that the presence of ozone in the atmosphere is due to the action of the free electricity of the latter on the oxygen of the air. The amount of ozone in the air is greater, according to some observers, in winter than in summer, in spring than in autumn ; according to others, it is greater in spring and summer than in autumn and winter. As regards the influence of day and night, the observations do not all tell the same tale. Ozone has usually been found more abundantly in the air at night than by day, but some careful observers have found the reverse of this statement to be true.

Schönbein was the first who attempted to connect the fluctuations of atmospheric ozone with the prevalence or absence of epidemic disease ; and since this suggestion was first published, numerous observations have been made in different countries with the view of ascertaining whether there is really any connection between the indications of the ozonometer and the health of a district. It has been asserted, for example, as the result of observation, that an outbreak of cholera is accompanied by a marked diminution of atmospheric ozone ; but this statement has been disproved by later and more trustworthy observations. On the whole, I think it may be safely asserted that no connection has yet been proved to exist between the amount of ozone in the atmosphere and the occurrence of epidemic or other forms of disease.

The permanent absence of ozone from the air of a locality may, however, be regarded as a proof that we are breathing, if I may venture to use the phrase, adulterated air. Its absence from the air of towns, and of large rooms, even in the country, is probably the chief cause of the difference which every one feels when he breathes the air of a town, or of an apartment however spacious, and afterwards inhales the fresh or ozone-containing air of the open country. It is, indeed, highly probable that many of the most important actions, by which the products of vegetable and animal waste are removed by oxidation from the air, are due to the action of ozone, and could not be effected by ordinary or inactive oxygen. If the amount of ozone in the atmosphere appear too small to produce such large results, we must remember that, from its powerful affinities, ozone is being continually used up, and must, therefore, be constantly renewed.

The physiological action of ozone on the animal system is a subject of interest, and I am able to state the general results of two independent inquiries—one conducted a few years ago, by Dr. Redfern, in Queen's College, Belfast, the other recently communicated to this Society by Mr. Dewar and Dr. McKendrick. Dr. Redfern's experiments have not been published, but he has kindly supplied me with the following note on the subject :—"The general results," he says, "I obtained from about forty experiments conducted from May to September, 1857, to find the effects of oxygen and ozone on different animals, are as follows. The respiration for a very short time of oxygen, containing about $\frac{1}{240}$th part of ozone, is certainly fatal to all animals. The same gas, when passed over peroxide of manganese and freed from ozone, is comparatively harmless, even when respired for long periods. Respiration of such a mixture of ozone for thirty seconds kills small animals, some dying after respiring it only fifteen seconds, whilst similar animals will live in good health for months after respiring oxygen alone for thirty-seven hours, the carbonic acid being removed during the experiment. Death is not due to the closure of the glottis, for it occurs when a large opening has been made in the trachea. Ozone causes death by producing intense congestion of the lungs with emphysema, and distention of the right side of the heart with fluid or coagulated blood, frequently attended by convulsions. If ozone be respired in a dilute form, the animals become drowsy and die quietly from coma, the condition of the lungs and heart being the same, except that the emphysema is less marked. Animals which have respired oxygen for more than twelve hours will now and then die suddenly from the formation of coagula in the heart, even after they have appeared in good health for some days."

The following are the conclusions which Mr. Dewar and Dr. McKendrick have deduced from their researches. Inhalation of an atmosphere highly charged with ozone diminishes the number of respirations per minute, and reduces the cardiac pulsations in strength, the temperature of the animal being at the same time lowered from 3° to 5° C. After death the blood is found to be in a venous condition. Neither the capillary circulation nor the reflex activity of the spinal cord is appreciably affected. The same remark applies to the contractility and work-power of the muscles. Ozone acts on the coloured and colourless corpuscles of the frog like carbonic acid. Ciliary action is not affected by ozonised air or oxygen, but if the layer of liquid be very thin, the cilia are readily destroyed.

The thermal changes which accompany many of the reactions of ozone are well marked, and their investigation, which has been undertaken by Mr. Dewar, promises to yield a valuable addition to our thermo-chemical knowledge.

THE COMMON FROG*

XI.

THE eye of the frog is a beautiful and brilliant object, and relatively large. It is furnished with two eyelids, but, unlike those of man, it is the inferior one which is the more movable. In addition to these it is defended by a third eyelid, called the victitating eyelid, which is similar to that one which may be seen (if watched for) so frequently and rapidly to cross the eye of birds, *e.g.* of a hawk.

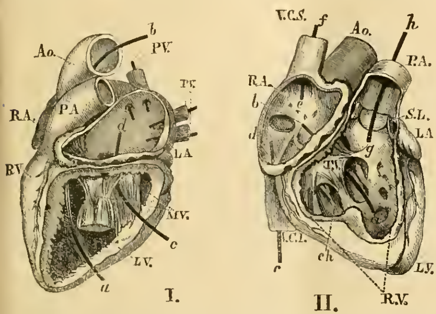


FIG. 74.—I. The left side; and II. the right side of the Heart dissected. I.—*LA*, the left auricle; *PV*, the four pulmonary veins; *cd*, a style passed through the auriculo-ventricular aperture; *MV*, the mitral valve; *ab*, a style passed through the left ventricle into the aorta; *RA*, *RV*, parts of the right side of the heart; *PA*, pulmonary artery.
II.—*RA*, the right auricle; *VCS*, superior vena cava; *VCI*, inferior vena cava, the styles *fe*, *cd*, being passed through them into the auricle; *ab*, style passed through the auriculo-ventricular aperture; *TV*, tricuspid valve; *RV*, right ventricle; *SL*, semi-lunar valves at the base of *PA*, the pulmonary artery, through which the style *gh* is passed; *LA*, *LV*, auricle and ventricle of the left side of the heart.

This structure, however, is no mark of affinity to birds, as it is one which reappears, when wanted, in widely different forms. Thus we find it in the whale, *i.e.* in the

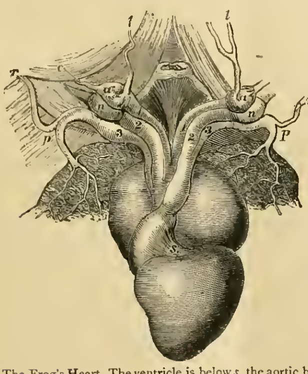


FIG. 75.—The Frog's Heart. The ventricle is below *s*, the aortic bulb is on the left of *s*, and ends in six aortic trunks, three on each side. The first of these (1), ends in the carotid gland (*a*), whence spring the lingual (*l*), and the carotid (*c*), arteries. The second trunk (2), is the root of the great dorsal aorta. The third trunk (3), ends in the pulmo-cutaneous artery (*r*), and the pulmonary artery (*p*), which is shown sending ramifications over each lung.

highest class of the Vertebrate sub-kingdom, and in certain sharks, *i.e.* in the lowest class of the same.

Eyelids do not exist in all members of the frog's class. Even in its order they are extremely minute, in *Pipa* and *Dactylethra*, which have very small eyes. In *Amphiuma* they are completely wanting, and in *Proteus* and in the *Ophiomorpha* the minute eyeballs are covered with the ordinary and unchanged skin of the head.

The ear of the frog's class presents us with the incipient condition of that part as an organ destined to respond to sonorous vibrations conveyed to it by the atmosphere.

In man the internal ear (enclosed in the densest bone

FIG. 76.—Section of heart. *a* and *b*, openings of the auricles into the ventricle; *c*, opening of the aortic bulb into the ventricle.

of the skull, named, from its density, "petrous") is a very complex organ. The aperture, surrounded by the folds of the external ear, leads by a canal towards a cavity called the tympanic cavity, which cavity is shut off from the exterior by the tympanic membrane (or drum of the ear), which stretches across the canal at a considerable distance from its external aperture. On the inner side of the tympanic cavity lie the convoluted tubes (richly supplied with nerves) which constitute the real organ of hearing or internal ear.

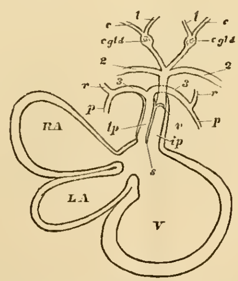


FIG. 77.—Diagram of section of Frog's heart. *LA*, left auricle; *RA*, right auricle; *V*, ventricle; *s*, movable septum dividing the left aortic passage *lp* from the right aortic passage *ip*; *v*, valve; 3, 3, aortic trunks leading to *p*, pulmonary artery and *r*, cutaneous respiratory artery; 2, 2, aortic trunks going to form the great dorsal aorta; *cgld*, carotid gland interrupting the flow of blood into *l*, the lingual artery, and *c*, the carotid artery.

Although the tympanic cavity is shut off from the exterior by the tympanum, it nevertheless is not altogether shut off from the exterior, since it communicates with the back of the mouth by a long and narrow canal termed the Eustachian tube.

It is the existence of these Eustachian openings into the

* Continued from p. 307.

ear from the mouth which causes people when intently listening to keep their mouth slightly open.

In the frog there is no such external canal, but the tympanum is plainly to be seen in the way already described, on the side of the head, covered only by a slightly striated portion of the skin of the body. The Eustachian tube, however, still exists in the frog, though it is short and wide, and the opening of each is to be seen on one side of the back of the mouth.

This condition of things, however, does not exist in all the members of the frog's order, still less of his class. But in *Proteus*, *Siren*, and *Menobranchus* there is no tympanic cavity whatever, and the organ of hearing is simply imbedded in the skull, and probably responds but to sonorous vibrations conveyed to it by the denser aquatic medium, and not at all, or but very imperfectly, to those of the atmosphere.

In the ordinary efts we still meet with an Eustachian canal, but the tympanum is absent.

In the frog's own order, as in *Pelotates* and *Bombinator*, we may fail to find any tympanum, while the Eustachian tubes are all but obliterated, being reduced to the most minute dimensions.

Another condition, however, may be presented which offers a singular contrast, and is the more remarkable from the widely separated geographical situations of the forms which present it. In the South American *Pipa*, as well as in the South African *Dactylethra*, the two Eustachian tubes run together and open at the back of the mouth, by a median and common aperture.

Strange to say, this is the very condition which exists in birds, though most certainly it cannot be taken as any sign of affinity. In the crocodile these tubes have also a common median opening, but, unlike birds, each tube has also its own lateral opening into the throat, so that there come to be three Eustachian openings.

Can the resemblance between *Pipa* and *Dactylethra* in this matter be taken as a serious indication of genetic affinity, in spite of the wide, deep, and probably ancient Atlantic which rolls between the two species now?

This is a question which cannot be confidently answered, seeing in how many other instances structural peculiarities have evidently had an independent origin. Nevertheless, the fact that these two genera agree also in the small size of the eyes, rudimentary eyelids, and vastly expanded sacral transverse process would seem to point to some ancestral and fundamental relationship. If so, however, it is remarkable that no other such forms, or no intermediate ones should have been preserved, seeing that neither kind can be suspected of having migrated to its own habitat from the existing habitat of the other; and therefore that forms similar to that from which we may, if we please, conceive both to have been derived must have had a more or less widely extended geographical distribution and have been numerous in order to have given origin to genera in many respects so different as the two in question.

The Circulation of the Frog

Not only every animal, but every living being, requires, in order to carry on the functions of life, to interchange some of the gaseous elements of its body with gases of the medium (air or water) in which it happens to live.

Another function of extreme generality is that of conveying to all the parts and organs of the body nutritious matter for their growth or for the repair of those destructive effects which the processes of life inevitably produce in them.

In all members of the highest sub-kingdom of animals (*i.e.* in all Vertebrata) these processes of gaseous interchange and nutrition are effected by means of closed vessels, along which the stream of nutritious fluid (the blood) is continually carried in a definite and constant course. During some or other part of that course the blood becomes exposed to conditions specially favourable to the gaseous interchange, the blood parting with carbonic acid gas and obtaining in its place an increased supply of oxygen.

This process of blood oxygenation is termed respiration, and the organs which subserve it are termed respiratory or breathing organs. Such organs in man are the lungs. The central organ of circulation in man is, as all know, the heart, which is a muscular organ, divided into four chambers, or cavities.

These chambers are called "auricles" and "ventricles," and there are two of each—there being an auricle and a ventricle on the right side and also on the left.

Blood that has performed its nutritive functions, and is therefore charged with carbonic acid gas, is called venous blood, and is conveyed by the veins to the right auricle, whence it passes into the right ventricle, which sends it to the lungs for purification.

The oxygenated, or arterial blood, is returned from the lungs to the left auricle, and hence it is directly transmitted to the left ventricle, whence it is driven through the great artery (the *aorta*) into other arteries, and so distributed all over the body. The aorta passes downwards in front of the backbone, when it is called the *descending aorta*. Before turning downwards, however, it gives off great arteries to the arms and head, the *carotid arteries* carrying blood to the latter.

Now it is very important that the blood should not proceed in a direction the reverse of that indicated, and to prevent such misdirection, or regurgitation, special valves are placed at different openings; these valves freely allowing the blood to flow in the proper direction, but instantly opposing an effectual obstacle to a contrary flux.

The openings of the auricles into the ventricles are guarded by valves, as also is the opening of the left ventricle into the aorta, and that of the right ventricle into the artery going to the lungs.

The valve which guards the entrance into the right ventricle is called *tricuspid*, and consists of three flaps attached by delicate tendinous cords in such a way as to hinder the tending backwards of the flaps into the right auricle, and so allowing the blood to flow back into that chamber.

The valve which guards the entrance into the left ventricle is called *mitral* (from a fancied resemblance to a bishop's mitre), and consists of two flaps. The aperture leading from the left ventricle to the aorta is guarded by three crescentric flaps—called the "*semilunar*" valves of the aorta.

In man the whole of the blood is sent to the lungs for purification during each circuit of this most important fluid, and every organ is supplied with oxygenated blood.

If in any animals the process of purification is incomplete it is manifestly desirable that these organs of the body, the functions of which are the most important, should be supplied with that part of the blood which is pure. This consideration eminently applies to the brain, the director and controller of the entire body.

Now all birds and beasts without exception, share with man this perfect aëration of the entire blood, the whole of the blood in the classes *Mammalia* and *Aves* being purified in the lungs before being distributed to the body.

The conditions by which the frog, at the various stages of its existence, oxygenates its blood and directs the purified stream in the most desirable manner, are curious and instructive.

It is generally known that the lower air-breathing Vertebrates (Reptiles and Batrachians) have the heart less completely divided than in the higher classes, so that the oxygenated (or arterial) blood and the unoxygenated (or venous) blood become mixed in the single or imperfectly divided ventricle.

It might well be supposed, and in fact has generally

been so, that in animals with a heart so imperfectly divided, the blood sent to the lungs would be necessarily a mixture of venous and arterial fluid, and similarly that the blood distributed by it to all the organs and parts of the body is alike a mixture of pure and impure fluid.

In fact, however, this is by no means the case, and in the frog, in spite of the reception into a single chamber of both venous blood from the body, and of arterial blood from the lungs, special mechanical arrangements effect such a definite distribution of the two sorts of blood, that the unoxygenated fluid from the body is sent to the purifying respiratory surfaces (lungs and skin), and that the pure oxygenated blood alone goes to the head and to the brain.

For the detection of this beautiful mechanism, we are indebted to the careful investigations of Ernst Brücke.*

The heart of the frog consists of a right and left auricle (divided by a delicate septum), both opening into a single ventricle. From the latter proceeds an aortic root (bulbus aortæ) which gives rise to three arterial trunks on each side.

The first of these, or carotid trunk (1), ends in an enlargement (*a*) termed the carotid gland, of spongy structure, which gives rise to two arteries, one the lingual (*l*), the other (*c*), the carotid which goes to the head and brain.

The second, or systemic trunk (2) meets its fellow of the opposite side beneath the spine, and thence passes backwards as the great dorsal (in man descending) aorta, giving off arteries to all parts of the body.

The third, or pulmo-cutaneous trunk (3) ends by dividing into two arteries. The anterior of these (*r*) goes to the skin (which, as we have seen, is in the Frog an important agent in respiration), the posterior one (*p*) goes to the lungs.

The heart itself is of a more or less spongy texture, but the main cavity of the single ventricles open at its extreme right into that of the aortic bulb (*c*). In close proximity to the opening are the openings from the right (*b*) and the left (*a*) auricles respectively.

The aortic bulb is constitutionally divided by a movable septum (Fig. 77, *s*) in such a way, that the passage on the right side of it leads to the carotid and systemic arterial trunks, while the passage on the left side of it leads to the third pair of trunks—namely, those ending in the pulmonary and cutaneous arteries; moreover, there is a valve in the first of these two passages which tends to retard the flow of blood (*v*).

The consequences of these arrangements are as follows:—

When the auricles contract, the venous blood from the right auricle (*RA*) is sent into both right and left passages of the bulb, but by the action of the valve (*v*), and by the structure of the carotid gland, the blood is checked on the right side (*ip*), while on the left it runs freely into the pulmo-cutaneous trunks (*r* and *p*), and thus the respiratory structures receive unmixed venous blood for purification.

As the lungs get gorged with blood, the resistance on the two sides of the septum of the bulb becomes at first equalised and soon becomes the greater on the left side; then the septum is forced over to the left, and the blood, now mixed with pure blood, flowing in from the left auricle, flows freely along the systemic arteries (2 and 2). The obstruction of the carotid glands (*c gld*) being the greatest and the last to be overcome, the carotid and lingual arteries (*c* and *l*) receive the very last of the blood—that, namely, which coming from the left auricle is purely arterial—and in this way oxygenated blood only is supplied to the head, sense organs, and brain.

It should be borne in mind that in order to develop this most beautiful and complex apparatus, the co-ordinate development in due proportion of these beneficial obstructions and checks must have been simultaneously effected in order that their purpose should be duly served. In other words, to account for its formation by an indefinite series of minute happy accidents would seem to require such a successive occurrence of coincidences as to become an improbability so great as to be indistinguishable from impossibility.

St. George Mivart

(*To be continued.*)

* "Beiträge zur vergleichenden Anatomie und Physiologie der Gefäss-Systemes." In the third volume of the "Denkschriften der Mathematisch-Natur-wissenchaftlichen classe der Kaiserlichen Akademie der Wissenschaften." Vienna: 1852.

THE "CHALLENGER" EXPEDITION

Bermuda

FROM the two visits made by the *Challenger* to Bermuda we learn a good deal about the vegetation of that island. Along the coast, which in some parts is irregular and rocky, and in others of a sandy nature, frequently with heaps of drifted sand, may be seen in abundance a species of *Borrichia*, a low shrub belonging to the compositeæ, *B. arborescens* D.C. being common in the West Indian Islands, and noted for having both glabrous and silvery leaves on the same plant, as well as the two forms on separate plants. In close proximity to the *Borrichia* was seen *Tournefortia gnaphalodes* R.Br., a Boragineous shrub from 2 to 6 feet high, with white flowers and downy leaves, and *Ipomœa pes-capræ* Sw. with its long stem, which frequently creeps to 100 feet or more, and its purple flowers. In the crevices of the rocks grow *Euphorbia glabrata* V., a shrubby glabrous plant common to the West Indies, and on the shores of Florida, Honduras, &c. A species of Tamarix is also abundant, as well as *Conocarpus erectus* L., and *Coccoloba uvifera* Jacq., known in the West Indies as the seaside grape, from the violet-coloured, pulpy acid-flavoured peiranth; an astringent extract like kino is likewise prepared from the bark, and the bark itself is used for tanning leather.

Many trailing plants scramble about on the sand dunes, assisting to bind the loose sand together. Amongst the most important of these is a hard, prickly grass, probably a species of *Cenchrus*, *Cakile æqualis* L.'Her, a singular cruciferous plant allied to our Sea Rocket, and a species of *Scævola*. The Mangrove (*Rhizophora mangle* L.) occurs in swamps similar to those which have been so often described by travellers; but beside the true mangrove swamps, there are others occupied by trees of *Avicennia*, *A. nitida* Jacq. being known in the West Indies as the black, or olive mangrove.

In the peat bogs, or marshes, which are surrounded by low ranges of hills, the most striking character of the vegetation is the ferns; species of *Osmunda* are abundant, as well as *Pteris aquilina* L. Some of the marshes, however, have their special character of fern vegetation some species, as for instance *Acrostichum aureum* L. (*Chrysodium vulgare* Fee), being found only in particular spots. The Junipers (*Juniperus bermudiana* Lun.) also thrive in the marshes, but none of the trees at present standing approach in size those that are occasionally found below the surface. These large trunks usually lie at a depth of about two feet. The average diameter of the trunks of existing trees may be taken at from two to three feet, and these are mostly unsound in the centre owing to the marshy ground in which they grow. The largest known living trees in the island measure respectively fifty-nine inches and thirty-nine inches in diameter; the first is hollow, but the second is apparently sound. Amongst other noticeable marsh plants are *Myrica cerifera* L., a shrub the berries of which, in Central America, yield wax from which candles are made, and *Rhus toxicodendron* L., the Poison Oak of North America.

In the fresh-water ponds or lakes inland, some of which are a quarter-mile long, and often are in close contiguity

to a peaty marsh, though the waters appear not to be affected by the peat but are said to be salt at certain periods, occur abundance of confervæ and minute algæ, as well as a species of *Ruppia*. In the shady damp hollows, at the entrances of the caves, is usually seen a rich growth of ferns, jessamine, and coffee trees of good size.

The general features of the indigenous vegetation of the islands are the Junipers, *Lantana camara* L., a verbenaceous shrub which grows in dense masses, and the Oleander, which also grows in abundance and is used for hedges. A few trees of the Date and Cocoa-nut palms may occasionally be seen, but their fruit produce is not sufficiently abundant to be of any importance. One of the greatest pests in the island in the form of a weed is *Leucæna glauca* Bth., which sends down its tap roots to a great depth, and is difficult to eradicate. It is a leguminous plant, and in its native state forms an ornamental tree.

The least cultivated part of the island is at Paynter's Vale, where orange and lemon-trees luxuriate in their wild state. From the prevailing dampness of the atmosphere all over the island, a species of Nostoc abounds not only in the caves and on the rocks near the seashore, but also amongst the roots of grass on lawns. Out of about 160 flowering plants collected in Bermuda *Morus rubra*, *Hibiscus arborea*, and *Chrysophyllum cainito* are the only three that do not occur in an absolutely wild state. Perhaps not more than 100 are true Bermuda plants. Many of the plants of the island were no doubt originally brought from the West Indies by the Gulf Stream, or the cyclones. The presence of American plants is perhaps to be traced more to the migrations of birds, which come in large numbers, more especially the American Golden Plover. Then, again, to account for the presence of other plants, there is the fact of the annual importation of large quantities of hay, and also of seeds, such as onion seed from Madeira and potato seed from America, with which other seeds are, no doubt, constantly introduced. Shipwrecks, also, which occur on the coast, are probably fruitful sources from whence new plants arise; as a proof of this, it is stated that a vessel with a cargo of grapes was recently wrecked and the boxes of grapes washed ashore, the seeds of which, being saved, were sown, and produced an abundance of young plants.

INDUSTRIAL CHEMISTRY

THE Society of Arts seems to be increasing its efficiency every year, "lengthening her cords and strengthening her stakes;" quite recently a Chemical Section has been added, which we believe will be productive of much practical benefit. At the opening of this Section on the 6th inst., the chairman, Dr. Odling, gave a valuable and interesting address, which, by the courtesy of the secretary of the Society, we are able to present to our readers :—

I have been desired by the Council to say a few words at this introductory meeting on the importance of Industrial Chemistry, but really to do so is to urge upon you a theme which requires no advocacy, I should think, on the part of anyone, and I am afraid it would be as tedious as thrice-told tales. If we look at the objects with which we are surrounded and consider how very few of them are in a state in which they are presented to us by nature, we shall find that the metamorphoses to which they have been subjected are essentially chemical ones; that is to say, wherever we find one kind of matter in nature, and somehow or other the matter is turned into another kind of matter, we submit it to a chemical change; and how very few indeed of the different kinds of matter with which we are surrounded are really in their primitive forms When we have mentioned wood and stone, I mean building stone, we have mentioned almost all. When we consider the gas which, though now gas, was a short time ago in the form of coal, or the glass of our windows which a short time back was in the form of sand, soda, and limestone, or if we look at the plaster of our rooms, which was originally limestone, which has undergone varied metamorphoses, and more particularly I might direct your attention to the metallurgical industries, especially iron, which was a short time before in the ironstone—all these are instances of the chemical metamorphosis to which we subject the different natural objects, and so change one kind of matter into another.

Among all these metamorphoses which are of a chemical nature there are some to which we more particularly apply the name of chemical manufactures. In reality, a brick is as much a product of chemical change; it was not originally the same matter it now is, but was produced by a change of chemical composition of its elements. But among these more particularly called chemical manufactures, the production of which is conducted in works which are called chemical works, are those performed in so-called alkali works; and I think I need have no hesitation in saying that these works have proceeded to a far greater development in this country than in any other, notwithstanding the fact that among the constituents received and metamorphosed by these works are many which are of foreign extraction, more particularly the pyrites, or other sources of sulphur, and the manganese or other sources indirectly of the chlorine manufactured at these works. And we see, that in the course of lectures which has been provided for us, three have reference especially to these manufactures, which are conducted exclusively at works which are denominated chemical works. We have a process for the manufacture of soda by Mr. Vincent; another on pyrites, as a source of sulphur, copper, and iron, by Dr. Wright; and another on the manufacture of chlorine, by Mr. Weldon.

Starting from the crude substances, coal and limestone, and pyrites and common salt, we have a production of soda which will be treated of more particularly in Mr. Vincent's address. Then we have the further manufacture of copper, sulphur, iron, and chlorine, which are the necessary economical concomitants. It is indeed remarkable, at the present day, how much the production of chemical manufactures takes in the working up of what were formerly waste products. Perhaps we could not have a more singular instance of this than in the utilisation to which that class of refuse, which was formerly known as burnt pyrites, is now put. Not only do we obtain from the original pyrites sulphur in a form which was formerly thrown away on a very large scale, but, moreover, copper and iron, which were also formerly thrown away in the burnt pyrites. And we have also one very remarkable product now obtained from pyrites on a comparatively large scale, and I may say, with regard to the manufacture of copper from pyrites, that the amount now produced—as Mr. Wright will tell you—from a material which was formerly thrown away, constitutes a very large proportion of the entire quantity now manufactured in the United Kingdom.

But in addition to that there is a very considerable manufacture of silver now going on also extracted from these waste pyrites. This extraction of silver from these pyrites, in which it occurs in an exceedingly minute proportion, has an essential interest for chemists in this point of view, that the processes which are adopted for its extraction really resemble most closely the processes which purely scientific chemists adopt in the laboratory. The pyrites are first of all heated with common salt, whereby the copper is converted into chloride of copper soluble in water, and the silver into the state of chloride of silver, which is soluble in the common salt solution; and not only so, but in this process of removing the soluble copper and the soluble silver from these pyrites,

the arsenic and the sulphur, which formerly prevented the burnt pyrites being put to any use, are got rid of, so that what remains is useful in a further stage of the iron manufacture. But with regard to the extraction of the silver, we find how important a knowledge of even delicate chemical processes is, in order to allow the extraction to be pursued with advantage. By the ingenious process of Mr. Claudet and Mr. Phillips, it is first of all examined by the nicest chemical means to see the exact amount of silver it contains, by a process rivalling in delicacy that which is pursued in laboratory research, and having ascertained exactly the quantity of silver contained in the solution, the exact quantity of extremely expensive reagent, iodide of potassium, which is required, is added to it to precipitate the amount of silver; and when the iodide of silver is thrown down the iodine is recovered to be used over and over again, and the silver itself is set free by means of metallic zinc, which forms iodide of zinc, thus setting free the silver. In this way, a considerable portion of silver is extracted.

I mention this as an illustration of the remarkably close association which is every day taking place between sure chemistry in the laboratory, and manufacturing chemistry in the factory. Now-a-days we have such out-of-the-way bodies, as they were formerly considered, as these different aniline products, as alizarine and chloral, which were formerly barely obvious in the laboratory, now made on a manufacturing scale. On the other hand, we find these different products of estimation, formerly confined to the laboratory, are now carried on in the manufactory, and thereby such an element as silver is produced by processes which are essentially laboratory processes. In this way it happens that we find many improvements in manufacturing chemistry are now produced by men who have obtained a reputation in other fields. For instance, I need scarcely refer to the names of Hoffmann, Perkin, and Nicholson, gentlemen known as scientific chemists and men of the highest eminence, before their attention was directed to manufacturing operations, and they realise on a manufacturing scale the results of their laboratory experience. In mentioning them, I ought not certainly to dissociate from them our lecturer this evening, Mr Field, who was so long and so highly esteemed in purely scientific circles for his admirable researches into a great number of compounds, more especially connected with mineral chemistry, before he devoted his great ability to the elucidation and improvement of the manufacture of aniline dyes, and subsequently to these metamorphoses of the bodies which we now use for illuminating purposes in the form of paraffine and ozokerit, and also the other candles which are composed of stearic acid, palmitic acid, and so on.

But while in this way manufactures derive a very great advantage from the light thrown on them by purely scientific chemists in one way or another, I do not think we ought to overlook the benefit which pure chemistry derives, on the other hand, from manufacturing operations. I do not mean the mere material gain that purely scientific chemists have enjoyed by the opportunity of examining minutely a great number of bodies, which previously it was almost impossible for them to obtain, but I think they have gained a very much greater knowledge of the especial subject of their studies — I mean chemical phenomena. We chemists take in our province every change by which one kind of matter becomes metamorphosed into another kind of matter, whereby that which was ironstone, for instance, becomes iron, whereby that which was sand, chalk, and soda becomes glass, and which takes place wherever one kind of matter is metamorphosed into another; but, after all, a great number of the metamorphoses which we must study take place in the test-tube and small vessels of similar character; and we are rather too apt, I say, to shut our eyes to those metamorphoses which take place on a large scale around us.

Those changes manifest themselves particularly in two forms. We have those by which the different forms of agricultural produce are furnished us by the vegetable kingdom, and by which they are metamorphosed into the animal kingdom. Here we have one great illustration of industrial chemistry—the chemistry by which crops are produced, and by which stock is fed and flesh is made. This feeding of stock and production of crops is one very large function of industrial chemistry, and I would venture to say that any scientific chemist who devotes his attention entirely to what takes place in the test-tube, and who neglects those changes which are constantly taking place around him, has a very imperfect notion of the subjects which he professes to investigate. And in addition to these changes thus taking place in natural processes, modified to a certain extent by art, we have three other processes which take place on a grand scale, by which from such substances as ironstone we produce metallic iron, from common salt, on the one hand, carbonate of soda, applied to the manufacture of glass and other useful purposes, and by which we provide also chlorine in its different combinations, applicable to so many purposes, more particularly in the preparation of our wearing apparel, and in our linen and fabrics of every description.

I think, then, that when we have the advantage of having these industrial subjects brought under our notice by men like our friend here, who are familiar, on the one hand, with the most recondite points of theoretical chemistry, and, on the other hand, with the greatest practical achievements which have been obtained in manufacturing chemistry, it will be of immense benefit to those who wish to study chemistry in its pure aspect, as they will see what can be done on a large scale, and what habitually is done, and what perseverance, assisted with chemical knowledge, has obtained for us. It must also be interesting to practical men, by throwing out suggestions capable of improvement in various branches of manufacturing art. I think, then, that the Society of Arts has really done a very useful work in bringing together men engaged in the purely scientific pursuit of chemistry on the one hand, and, on the other, men who are pursuing the application of the science with a view to the practical good of their kind. I do not know that I need trouble you with any further remarks, but I have attended here this evening with the greatest pleasure, because I feel how much advantage is likely to be derived by all classes of the community by the discussion of these problems which are so interesting to all, and I would venture to say as much in a purely scientific as in a practical point of view.

NOTES

SUFFICIENT attention has not been attracted to the fact that one of the recommendations of the Committee on Scientific Instruction has borne early fruit. Mr. Phillips Jodrell, desirous to promote research in physiology, has attached to the professorship of that science in University College, London, an endowment of 7,500*l.* to enable the professor to devote to biological investigation whatever time is not needed for the discharge of his duties as lecturer. This endowment is accompanied by the further sum of 500*l.*, to be expended in the purchase of the necessary apparatus. It is difficult to speak in terms sufficiently high of Mr. Phillips Jodrell's intelligent munificence, which, we have no doubt, will bear good fruit. It is gratifying that the recommendations of the Commission have so far had such an excellent result, and we only hope that Mr. Jodrell's handsome example will be largely followed by others who have enough and to spare.

OUR readers will no doubt learn with surprise and regret that M. Alglave, editor of the *Revue Scientifique*, and Professor of

Law in the faculty of Douai, has been suspended from his professorial duties for one month, and has received notice that he must either resign his position as professor or give up the editorship of the *Revue Scientifique*. The reason for this vexatious proceeding we have not learned; but to outsiders it must seem a wanton and mischievous exercise of authority, although the fearless way in which the *Revue* states scientific facts and conclusions may have something to do with it. The *Revue Scientifique* holds the first rank among French scientific journals, contains from week to week the cream of scientific work both French and foreign, and any interference with its efficiency would be a great blow to the cause of Science in a country where a knowledge of the methods and solid results of Science is much needed. If the threat with which M. Alglave is menaced be carried out, those who thus abuse their little brief authority will be despised by the whole educated world. We read in the *Progrès du Nord* that M. Terrat has been appointed to take M. Alglave's place, and that when the former entered the class-room the students retired silently and in perfect order, leaving M. Terrat to lecture to the walls of the amphitheatre and two members of the *Cercle Catholique* who did not deem it prudent to join in the protest of their class-fellows; the students, we believe, have presented to their professor a unanimous address of sympathy. Let us hope that before the expiry of the month those who are responsible for this treatment of M. Alglave will think better of it, and restore the professor to the position he appears to have filled so well, permitting him at the same time to retain charge of the journal which is among the things that reflect the highest credit on France.

THE Chimpanzee, which during the last two and three-quarter years has been an endless source of instruction and amusement to visitors at the Zoological Gardens, after an illness of two months' duration, died on Friday last. The post-mortem examination showed that the cause of death was acute tuberculosis of the peritoniteum, almost exclusively confined to the serous membrane covering the liver and spleen, the omentum and small intestine being slightly affected. A large bronchial gland was on the verge of suppuration, but the lungs were healthy. There were no symptoms of hectic during life, and much subcutaneous and omental fat were found after death.

THE French Meteorological Society has resolved to hold an extraordinary *réunion* during Easter-week, a time when a considerable number of French and foreign meteorologists are in Paris. This meeting has for its object to strengthen the relations which exist between the Society and provincial observers, and to study in common questions of general interest in meteorology.

THE Meteorological Office has resolved, in compliance with the wish of the majority of subscribers to the lithographed sheets of hourly readings from their observatories, which are about to appear, to issue the sheets in monthly, not quarterly parts.

IN addition to the *Bulletin Météorologique du Nord*, of which we lately announced the publication, we are glad to learn that Capt. Hoffmeyer, the Director of the Meteorological Institute of Denmark, has commenced the issue of a daily lithographed chart, for his own country, Norway, Sweden, and North-west Russia. He has also published an explanation of the chart for the use of subscribers. This chart is most valuable, as it supplements our own daily weather charts and those of the *Bulletin International*, for a district whence accurate information is seldom obtainable by telegraph in Western Europe.

IN a recent number we intimated that the Perthshire Society of Natural Science had interrogated the Parliamentary candidates for the county and city of Perth as to their opinions on the questions of State help to Science, a responsible Minister of Education, and the promotion of Scientific Exploring expeditions. Answers—favourable, we are glad to say—were returned at the time only by the two Conservative candidates, one of whom, Sir W. Stirling Maxwell, is now M.P. for Perthshire. We are now glad to give place to the somewhat tardy reply, addressed to the secretary, of the Hon. Arthur Kinnaird, Member for the City of Perth:—"1, Pall Mall East, 18th Feb. 1874.—Dear Sir,—I was surprised to find copied into a London paper from a Scotch journal the questions put in your letter of the 29th January last, with the statement that they had not been answered by me. The fact of my being, as I believe I am, one of the patrons of the Perthshire Society of Natural Science should have been, it appears to me, a sufficient guarantee of my approval of the objects of your institution; and my active co-operation with Capt. Wells in his efforts during the last session of Parliament to obtain the sanction of Government to a proposed grant for the furtherance of Arctic exploration, further approves my appreciation of the objects you advocate, in my willingness to support State expenditure for well-devised schemes of scientific research and educational purposes.—Yours truly, A. Kinnaird."

H. N. MARTIN, B.A., Cantab, D.Sc. Lond., has been appointed Lecturer on Physiology at Christ's College, Cambridge. Dr. Martin obtained an open scholarship for Natural Science at Christ's College, and graduated in the Natural Sciences Tripos, obtaining the first place. Lately he has acted as assistant to Dr. Michael Foster in the Physiological Laboratory of the University. A paper by Dr. Martin on the "Structure of the Olfactory Mucous Membrane" appeared in the last number of the *Journal of Anatomy*, and was reprinted in the Studies from the Physiological Laboratory of the University, Cambridge, edited by Dr. Michael Foster.

THERE will be offered, at the Matriculation exhibition at New College, Oxford, beginning on Wednesday, May 21, at 9 A.M., two Exhibitions, tenable for three years, of the annual value of 50*l*. each. These Exhibitions are open to all persons who have not already been matriculated at another College. In the election to one of the Exhibitions a preference will be given to proficiency in Natural Science, if there is any candidate of sufficient merit in the judgment of the examiners. Further account of the examination will be supplied on application to the Warden.

THE Science and Art Department has published a catalogue of apparatus for teaching chemistry, containing 112 items, with prices from which a deduction of 50 per cent. is given. We should advise all our readers who are interested in the subject to obtain the catalogue. The same Department has also formed a collection of travelling apparatus for illustrating instruction in Physical Geography, which will be lent, for a short time, to teachers of the subject referred to. The apparatus consists of a set of physical maps of the world and the various continents, by Prof. Sydow, models of Mount Vesuvius, of Mont Blanc, and of the Thames Valley.

WE regret to record the death of Dr. Forbes Winslow, which took place at Brighton on the 3rd instant, at the age of 63 years.

WE formerly announced the proposal for an international memorial to Captain Maury, which is to take the shape of a Lighthouse on the Rocos, to the importance of which Maury called attention in his "Sailing Directions." We learn from *Ocean Highways* that the President of the Board of Visitors of the Virginian Military Institute addressed a letter to the Governor of Virginia on Jauuary 23, requesting him to lay the question of the Maury memorial before the General Assembly, for such moral support as may fitly be given by the representatives of a State which gave Maury to the world. A joint committee of members of the Senate and House of Delegates has since been appointed; and the hearty co-operation of the Govern-

ments and Scientific Societies in Europe is confidently expected; for Maury's services have benefited not his own country only, but the maritime interests of the whole world.

ON the 19th of February, Dr. Peters, of Hamilton College, New York, discovered a planet in $11^h\ 19^m$ right ascension, plus 4 deg. 25^m declinatlon.

M. CHARLES SAINTE CLAIRE DEVILLE, the meteorologist, announced publicly before the French Institute, that the week from March 9 to 16 would be a very cold one. The prognostication is in a fair way of being fulfilled.

THE last scientific letter written by the lamented M. Quetelet was to General Myer, the Director of the American Meteorological Service. Its purpose was to inaugurate the daily intercommunication of meteorological news between the States and Belgium. The scheme so originated is working regularly and was not interfered with by the death of the learned and respected Belgian astronomer.

THE *Lancet* says that the authorities of the University of Aberdeen have now under consideration a proposal to institute a new degree in arts—that cf Bachelor of Science.

HERR VON DEM BORNE writes to the *Deutsche Fisherei Verein*, in Berlin, that he is at present occupied upon an exhaustive treatise, on the most recent and best methods and implements of fishing with the hook and line, especially as used in England and North America, and is desirous of receiving information on these subjects from dealers and others, to be embodied in his proposed work.

VELOCIPEDES are becoming an institution in Paris for forwarding messages from the Exchange (Bourse) to the central telegraphic office, rue de Grenelle. The rates charged by "velocemen" are two shillings. The run there and back, including delivery of messages, takes about 25 minutes for a distance of 3 miles 1,320 yards. It is contemplated by some speculators to establish a public company. When Marshal Bazaine's trial was going on, velocipedes were used for conveying messages from Versailles for the *Moniteur*, one of the Parisian papers. The single run was charged a pound sterling, and was accomplished in 45 minutes for a distance of 12½ miles, at a quicker rate than the railway trains. But the road descends all the way, Versailles being on a higher level than Paris, and the railway is circuitous; stoppages are also very frequent on the line.

CARRIER-PIGEONS are largely used by Parisian periodicals for carrying latest intelligence. They start from Versailles from two o'clock in the afternoon till three. The average number is thirty pairs, and the charge four shillings each pair. The journey is accomplished in twelve minutes when fogs are not frequent. It is not legal for newspaper editors to hire a wire for their private use.

M. HENRY GIFFARD, the inventor of the *Injecteur*, has constructed a railway carriage with a patent suspension of his invention, which prevents the passengers from feeling any inconvenience from oscillation. The first public experiments will be on the Versailles railway, just after the impending parliamentary holidays.

THE election of a successor to the late Dr. Nelaton has given rise to a severe contest in the Secret Committee of the French Academy of Sciences; for more than a month it has obstructed the usual routine of the Academy. The reports for yearly prizes, which are ready for adoption, were not read over. The number of competitors is greater than usual, amounting to seven.

THE Parisian Municipal Corporation has decided upon the building of a large bridge on the Seine, which in point of length will be equal to Blackfriars or Waterloo Bridge, London; but instead of being placed at right angles to the current, it will be placed in an oblique direction. This extraordinary step is taken to connect the rue des Etats on the left bank with the old arsenal quarter on the right bank.

M. FIGUIER has issued through Hachette his *Année Scientifique*. It is the 17th volume of the whole series.

AN International Agricultural Exhibition is to be held on a grand scale at Bremen, under the patronage of the Crown Prince of Germany, from June 13—21 next. The North German Lloyd will grant special facilities to the English exhibitors for the conveyance of implements from London, Southampton, and Hull.

THE enormous extent of the destruction of buffaloes on the Western plains of the United States seems to have undergone no diminution during the present winter, and there is every reason to fear that, should this continue a few years longer, the animal will become as scarce as is its European congener at the present day. At present, thousands of buffaloes are slaughtered, every day, for their hides alone, which, however, have glutted the market to such an extent that, whereas, a few years ago, they were worth three dollars apiece at the railroad stations, skins of bulls now bring but one dollar, and those of cows and calves sixty and forty cents, respectively. A recent short surveying expedition in Kansas led to the discovery of the fact that, on the south fork of the Republican, upon one spot, were to be counted six thousand five hundred carcases of buffaloes, from which the hides only had been stripped. The meat was not touched, but left to rot on the plains. At a short distance hundreds more of carcases were discovered, and, in fact, the whole plains were dotted with putrefying remains of buffaloes. It was estimated that there were at least two thousand hunters encamped along the plains, hunting the buffalo. One party of sixteen stated that they had killed twenty-eight hundred during the past summer, the hides only being utilised.

A COPY of the Calender for 1873-4, of the Imperial College of Engineering, Tokei, Japan, has been forwarded us. The course of study prescribed, both general and special, theoretical and practical, and the regulations for the government of the College, appear to us to be all that at present could be desired.

WE are asked to state that the Annual Dinner of the members of the Institution of Civil Engineers has been appointed to take place at Willis's Rooms, St. James's, on Saturday, March 21. Mr. T. E. Harrison, the president, will occupy the chair.

WE are glad to see that Guido Cora's well-conducted Italian geographical journal, *Cosmos*, is to be henceforth issued monthly, instead of every two months.

AN aëronautical society of Paris, the "Aërial Sport," has published a programme of an aërial spring meeting to be held in the neighbourhood of Paris, very likely Vesinet. The object is to send in the air small fire balloons carrying *des mèches illumées*, whose length has been calculated so that the cargo of the balloon may fall close to a post chosen. Every champion is to choose his own wind; but nobody has a right to approach closer to the post than three miles. It is a kind of drill for shelling a place with balloons by taking advantage of the wind.

THE additions to the Zoological Society's Gardens during the last week include a Javan Rhinoceros (*Rhinoceros sondaicus*) from Java, purchased; a Negro Tamarin (*Midas ursulus*) from North Brazil, presented by Mr. W. Thomson; two Goshawks (*Astur palumbarius*), European, one presented and the other deposited by Mr. G. Lascelles; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. S. Waight; two Verreaux, Guinea Fowl (*Numida eduardi*) from East Africa; two Crowned Pigeons (*Goura coronata*) from New Guinea, and a Common Cassowary (*Casuarius galeatus*) from Ceram, purchased.

SCIENTIFIC SERIALS

Ocean Highways, March.—The following are the original articles in this number:—"Dr. Livingstone and the Cameron Relief Expedition;" "Francis Garnier—In Memoriam," a highly and deservedly eulogistic memoir (by Colonel Yule, C.B.) of this brave and high-minded soldier and explorer, whose untimely death we recently noticed; "Bhawalpur;" "An Account of the Early Jesuit Missions in the La Plata," by A. A. Geary; and "The British India Steam Navigation Company."

THE *Geological Magazine*, March.—The following are the original articles in this number:—"The Leinster Coal-field," by J. M'C. Meadows (with a page map); "On a new Species of *Dithyrocaris* from the Carboniferous Limestone, &c.," by Henry Woodward, F.R.S., and Robert Etheridge, jun. (with a plate); "Glacialoid or Rearranged Glacial Drift," by G. H. Kinahan; "On some new Devonian Fossils," by Prof. H. Alleyne Nicholson (with a woodcut and plate); "Reply to Mr. Poulett-Scrope," by Robert Mallet, F.R.S.

Quarterly Journal of the Meteorological Society, January.—This number contains the following papers:—"Notes on Meteorology of Vancouver Island," by R. H. Scott, F.R.S.; "The Thunderstorm at Brighton on October 8, 1873, and its effects," by F. E. Sawyer; "Some of the Considerations suggested by the Depressions which passed over the British Islands during September 1873," by F. Gaster; "On an improved form of Aneroid for determining Heights, with a means of adjusting the Altitude Scale for various Temperatures," by Rogers Field; "On the Hurricane of August 1873, which moved in a curved track round Bermuda between the 20th and 23rd, and passed on to Nova Scotia and Cape Breton on the 24th, doing extreme damage both at sea and on land," by Capt. H. Toynbee (with a plate); "On a Mercurial Barometer for the use of Travellers, filled by the spiral cord method," by Staff-Commander C. George, R.N.; also an account of the discussion on the best form of Thermometer Stand, which took place at the meeting of November 19, 1873.

Archives des Sciences Physiques et Naturelles, Jan. 15, 1874.—The principal article in this number is an exhaustive study, by Prof. Forel, of the *seiches*, or peculiar tidal phenomena, which have long been observed on the lake of Geneva. The subject is treated in five sections, as follows: the seiches at Geneva and at Morges compared; oscillatory movement in the harbour at Morges, analogous to seiches; the movement of oscillation of seiches; experimental study (with special apparatus) of the laws of oscillation of libration; and lastly, comparisons and conclusions. Prof. Forel adheres to the theory generally accepted in explanation of the phenomenon, viz., that it is due to variations of atmospheric pressure; the pressure diminishing at one part and increasing at another, the surface of the water rises in the former case and sinks in the latter. Thus a swinging undulation is produced. Some of the larger seiches are attributed to earthquakes. The amplitude differs in different seiches; and in the same seiche it varies from one point of the lake to another. The duration of different seiches also varies in the same locality; and the duration of seiches is longer at Geneva than at Morges. These and other effects the author seeks to explain, harmonising them with physical phenomena studied in his apparatus.—In a note on the surface of waves, by M. Charles Cellerier, it is sought to show that there is no real disagreement between the laws of double refraction, as furnished by observation, and the theory based on molecular movements. It is probable, he thinks, that the ordinary ray, whether in uniaxial crystals, or in principal sections of crystals with two axes, has not quite the direction generally assigned to it; though the deviation, without disagreeing with theory, may be so small as to escape observation.—In the department of zoology, we may notice a review of recent researches by Haeckel, Bütschli, and others, on Infusoria.

Memorie della Soc. degli Spectroscopisti Italiani, September, 1873.—Prof. Tacchini contributes a paper on his observaions on the magnesium lines and 1,474 line seen bright on the sun's limb, from which it appears that the 1,474 line is always visible in a magnesium region; and further, that it frequently appears by itself where no magnesium is seen. Two beautifully-executed chromolithographs of the chromosphere on the 15th and 16th of July last accompany the paper, showing the relative intensities of the magnesium and 1,474 lines, together with their positions. The intensity of the magnesium lines seems the greater of the two, though not covering so extensive a region.—Father Secchi gives a note on the spectrum of iron, and other metals, obtained by volatilisation with fifty Bunsen's cells. He appears to find that the 1,474 line is not due to iron, and that different kinds of iron give slightly different spectra. He also gives a drawing of the carbon spectrum from the electric light, which appears similar to that of cyanogen, with the addition of five equidistant bands in the yellow and red.—The tables of Mr. E. Loomis, containing the maximum years of sun-spots, the maximum years of magnetic declination, and the maximum years of auroral display from 1778 to 1870, are given, from which, at a glance, it is seen that the maxima of all three occur in the same years with very small exceptions, and the years of minima correspond even better.

Justus Liebig's Annalen der Chemie u. Pharmacie, Band 170, Heft 3. This number contains the following papers:—"Communications from the Chemical Laboratory of the Polytechnic School at Delft: iv. Researches upon Podocarpic Acid," by A. C. Oudemans, jun. This acid is obtained from the resin of *Podocarpus cupressina var. imbricata* Blume.; a tree growing in Java. The formula assigned to the acid is $C_6H_2\left\{\begin{array}{l}OH\\COOH\\CH_3\\C_9H_{15}\end{array}\right.$ $= C_{17}H_{22}O_3$. Some of the salts are described, and also the mono- and di-nitro substitution products. A sulpho-acid, amidated, and brominated derivatives have been obtained, likewise an acetyl derivative. The author has studied exhaustively the decomposition products of the new acid, and these have led him to the constitutional formula above given.—Upon Cymene, by F. Beilstein u. A. Kupffer. The authors have examined cymenes from cumin-oil and from camphor, and find them to be identical. The same authors contribute a paper on oil of wormwood. This oil yields by distillation a terpene, absinthol ($C_{10}H_{16}O$), and a deep blue oil.—"Crystallographic researches on the calcium salts of cymene-hyphersulphonic acid," by M. Jerofejew.—"Cumic acid," by F. Beilstein u. A. Kupffer. The authors obtain the potassium salt of this acid by acting on cumin-oil with fused potash.—A lengthy paper on the salts of ethylaldehyde-sulphurous acid and the action of the sodium-sulphites upon ethylidene chloride, by Hans Bunte.—On the formula of silicates, by Prof. V. Wartha.—The concluding paper is by Otto Sigel, on the constituents of arnica water and of the essential oil of arnica.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, March 5.—Special General Meeting, G. Busk F.R.S., vice-president, in the chair. After the chairman had, in a short conciliatory address, stated the reasons which had induced the Council to summon the present meeting, he called on Mr. W. Carruthers, F.R.S., who moved "That a Committee be appointed to consider the Bye-laws and to suggest to the Council such alterations, omissions, or additions as they may think desirable." The motion having been seconded by Mr. W. S. Dallas, Major-General Strachey, F.R.S., moved as an amendment, which was seconded by Mr. C. J. Preese, "That, inasmuch as it appears that there are differences of opinion in the Society as to the legality of the alterations of the Bye-laws made at the meeting of January 15 last:—(1) This meeting, retaining complete confidence in the President and Council of the Society, requests them to obtain the opinion of some legal authority, whether these alterations are legally binding on the Society or not; (2) That if the opinion be that the said alterations are legally binding, no further steps be taken in reference to them; (3) That if the opinion be that the said alterations, or any of them, are not legally binding, the Council be requested to take the necessary proceedings for setting aside the vote of January 15."—A second amendment was moved by Mr. J. E. Harting;—"That the case having been already submitted to Council, the opinion thereon be read for the information of the meeting." After much discussion, in which Sir John Lubbock, Dr. Thos. Thomson, Dr. Trimen, Prof. Thiselton-Dyer, Mr. H. G. Seeley, and others took part, Mr. Harting's amendment was withdrawn, and the vote taken on Major-General Strachey's amendment, which was carried, and was afterwards adopted as a substantive resolution.—Sir John Lubbock, Bart, F.R.S. then moved and Mr. W. Carruthers, F.R.S. seconded a resolution expressive of the high sense entertained by the meeting of the eminent services both to

the Society and to Science rendered by the President during his long tenure of the chair, which was carried unanimously by acclamation; and the meeting closed with a vote of thanks to the chairman.

Zoological Society, March 3.—Dr. E. Hamilton, vice-president, in the chair.—The Secretary read a report on the additions that had been made to the Society's Menagerie during the month of February, 1874, and called especial attention to a Malayan Hornbill (*Buceros malayanus*) new to the Society's collection, acquired by purchase; a Python, presented by Mr. C. J. Noble, of Hong Kong, having been captured in his garden on the Chinese mainland; and a young male of an undescribed species of Deer from Northern China.—A letter was read from Sir Henry Barkly, K.C.B., Governor of the Cape Colony, announcing that he had obtained a pair of young Eared Seals (*Otaria pusilla*) for the Society's collection.—A communication was read from Mr. W. H. Hudson, of Buenos Ayres, describing the parasitical habits of the three species of *Molothrus* found in Buenos Ayres, namely, *M. bonariensis*, *M. badius*, and *M. rufo-axillaris*.—Mr. Sclater read an account of a small collection of Birds obtained by Sir Graham Briggs in the island of Barbados, West Indies.—A second paper by Mr. Sclater contained the description of an apparently new form of the family *Icteridæ*, which he proposed to call *Centropsar mirus*.—A communication was read from Dr. J. E. Gray, F.R.S., containing some remarks on *Crocodilus johnsonii* Krefft, from Northern Australia, of which he proposed to form a new genus, *Phylas*.—Mr. W. Saville Kent, F.L.S., read a paper on a huge Cephalopod or Cuttle Fish, announced by the Rev. M. Harvey as lately encountered in Conception Bay, Newfoundland, and of which a tentacle 16 feet long has been secured for the St. John's Museum (NATURE, vol. ix. p. 332). Mr. Saville Kent contributed the additional evidence of an arm 9 feet long preserved in the British Museum, in proof of the gigantic dimensions occasionally attained by certain members of this order of the Mollusca, and proposed to institute the new generic title of *Megaloteuthis* for their especial reception; he further suggested distinguishing the Newfoundland example as *Megaloteuthis harveyi*, in recognition of the service to science rendered by Mr. Harvey, in his record of and steps taken to preserve so valuable a trophy.

Geological Society, Feb. 25.—John Evans, F.R.S., president, in the chair. The following communications were read:—Geological Notes on a Journey from Algiers to the Sahara, by George Maw. The author commences by describing the details observed on his journey from Algiers to L'Aghouat, on the borders of the Sahara. The distance traversed was 285 miles, or about 210 miles in a straight line, and in a direction nearly north and south. No eruptive rocks were observed. The oldest rock is a boss of mica-schist and gneiss behind the city of Algiers; it forms a low anticlinal, with a north and south strike. The pass through the gorge of the Chiffa in the Lesser Atlas shows hard slaty rocks dipping south at a high angle; they are repeated as an anticlinal on the south side of the higher part of the Tell plateau, and are probably Mesozoic. In the plain separating the Tell from the Hauts Plateaux, and on the south side of the latter, red and yellow sandstones form anticlinals; these rocks resemble the Bunter in mineral characters, and are overlain by red marls resembling the Keuper. In the northern escarpment of the Hauts Plateaux saliferous marls are exposed, interstratified between the sandstones and below the red and grey marls. Crystals of salt and gypsum are intimately mixed with the grey marls, and the so-called "Rochers de Sel" are capped with great blocks of rock tumbled about in confusion, the position of which the author ascribes to the failure of support due to the solution of the salt in the underlying salt-marls. A thin series of bright red and green marls is seen to overlie the red sandstones in several places; and above this is an immense series of dark grey marls, interstratified with argillaceo-calcareous bands, forming a great synclinal of the Hauts Plateaux, and a contorted mass on the Tell plateau. These are probably cretaceous. At L'Aghouat they are overlain by fossiliferous beds, probably of Miocene age. Other Tertiary beds observed are soft yellow calcareous freestones on the flanks of the promontory of Algiers and of the Lesser Atlas, and some red and grey marls and ferruginous freestone capping the Tell plateau, the former at a height of 100–900 feet, and the latter of 2,500–4,000 feet above the sea-level. The plain of the Mitidja, between the Lesser Atlas and Algiers, consists of grey loam with shingle-beds, of post-tertiary age. A similar loam covers the great plain of the northern Sahara, and rises to a height of 2,700 feet. Raised beaches occur on the coast up to an elevation of 600 feet above the sea-level; and similar beaches are found inland, south of the Tell plateau, at a height of 2,000 feet. The oldest land in the line of section is the anticlinal of mica-schist near Algiers, the strike of which is nearly at right angles to that of the other rocks. The upheaval of the Mesozoic rocks was contemporaneous with the first upheaval of the Lesser Atlas; it was followed by a long period of denudation, and this by a subsidence of at least 3,000 feet in Tertiary times, during which the Miocene deposits were formed. The Tell plateau was thus elevated at least 4,000 feet, and the district north of the Lesser Atlas at least 1,000 feet, the north face of those mountains probably marking a post-tertiary line of fault of 3,000 feet. This operation was followed by a long period of denudation, and this by a post-tertiary depression, which the author terms the "Sahara Submergence," after which the land was re-elevated at least 3,000 feet, but perhaps considerably more. A gradual subsidence appears to be still taking place.—On the Trimerellidæ, a Palæozoic family of the Palliobranchs or Brachiopoda, by Thomas Davidson, F.R.S., and Prof. William King. In this memoir the authors describe in detail certain Brachiopoda, for which they propose to establish a distinct family, discuss the characters and affinities of the family, and indicate certain geological considerations which arise from their study of its numbers.—Note on the occurrence of sapphires and rubies *in situ* with Corundum, at the Culsagee Corundum Mines, Macon Co., North Carolina, by Col. C. W. Jenks. Communicated by David Forbes, F.R.S.

Chemical Society, March 5.—G. C. Foster in the chair.—A paper on the spontaneous combustion of charcoal, by Mr. A. F. Hargreaves, in which he pointed out the best wood for charcoal for the manufacture of gunpowder, and also the best method of charring it. It appears that if it is ground too soon after being burnt the charcoal is liable to take fire spontaneously.—The other communications were—Researches on the action of the copper-zinc couple on organic bodies: Part V. On the bromides of the olefines: Part VI. On ethyl bromide, by Dr. J. H. Gladstone and Mr. A. Tribe.—Researches on the preparation of organo-metallic bodies of the C_nH_{2n} series of hydrocarbons, by Dr. D. Tommasi.—Note on the action of trichloracetyl chloride on urea, by Messrs. R. Meldola and D. Tommasi; and the agglomeration of finely-divided metals by hydrogen, by Mr. A. Tribe.

Royal Microscopical Society, March 4.—Chas. Brooke, F.R.S., president, in the chair.—A paper was read by Mr. Alfred Sanders, entitled "A Contribution towards a Knowledge of the Appendicularia," in which he minutely described specimens found at Torquay and Weymouth, and illustrated the subject by diagrams. A short discussion ensued as to the best methods of observing and preserving these delicate organisms.—Two papers by Dr. Royston Pigott were afterwards read by the secretary, the first "On the Verification of Structure by means of Compressed Fluid," the second being entitled "A Note on the President's remarks on Dr. Pigott's Aplanatic Searcher."—Dr. Pigott subsequently gave an extended explanation of the contents of his papers, and also detailed a new method of determining the refractive index of covering glass.

Entomological Society, March 2.—Sir Sidney S. Saunders, president, in the chair.—Mr. M'Lachlan exhibited two male examples of an Orthopterous insect belonging to the family *Locustidæ*. They were said to be sold in the streets of Shanghai, confined in ornamental wicker cages, and bought for the sound they produced. The species appeared to be undescribed, and to pertain to a new genus allied to *Xiphidium*. Mr. M'Lachlan also exhibited a series of examples illustrating the natural history of *Oniscigaster wakefieldi*, from New Zealand, described and figured by him from the female imago in the *Entomologist's Magazine* for October 1873. The series now exhibited comprised the male imago, female sub-imago, adult nymph, and larva. The lateral wing-like horny expansions of the terminal segments of the abdomen in the imago and sub-imago are continued in the aquatic conditions on each segment of the abdomen, and in addition there are similar formations along the back of the abdomen, placed longitudinally and vertically. The adult nymph appears to possess no external gills or laminæ, but they are conspicuous in the less mature larva on each side of the ventral surface of the abdomen.—The Rev. A. E. Eaton exhibited some Arctic insects which he had brought from Spitzbergen; and also some excellent photographs illustrating the scenery of the country.—A further communication was received from Mr. Gooch

respecting the injury to the coffee-trees in Natal from the Longicorn beetle, *Anthores leuconotus* Pascoe.—Papers were communicated, "On some new Species of South African *Lycænidæ*," by Mr. Roland Trimen, and "Descriptions of new Species of *Lycænidæ*," from his own collection, by Mr. W. C. Hewitson.

Society of Biblical Archæology, March 3.—Dr. Birch, F.S.A., president, in the chair.—The following papers were read:—Translation of an Egyptian fabulous romance, "The Tale of the Doomed Prince," from the Harris Papyri, by C. W. Goodwin. The translator drew attention to the peculiar features of this ancient story, resembling in so many points the romances of the mediæval period, which may have had a common origin.—Translation of an historical narrative belonging to the reign of Thothmes III., by C. W. Goodwin.—Observations upon the Assyrian verbs *Basu* and *Qabah*, by Prof. William Wright. This paper consisted of a critical analysis of the roots of the above verbs, and their cognate analogues in other Semitic languages.

Geologists' Association, Feb. 6.—Henry Woodward, F.R.S., president, in the chair.—On the probability of finding Coal in the Eastern Counties, by John Gunn, F.G.S. Mr. Gunn gave the preference to a boring on the south of Essex, and proceeded to state the grounds on which he recommended another boring at Hunstanton, or along the outcrop of the Kimmeridge clay, in Norfolk. He detailed the several papers which he had read at the meetings of the British Association at Nottingham, Brighton, and Bradford, in proof of the existence of a forest bed in Norfolk and Suffolk, which he called the Anglo-Belgian basin, of a succession of growth of forests, and of alternate elevations and depressions which have taken place in that region, and argued thence, by analogy, the extreme probability that such existed in the carboniferous epoch. Mr. Gunn represented that if the southerly dip of the Harwich slaty rocks extended in a northerly direction it must have been reached at the Norwich boring, which was sunk considerably lower than that at Harwich, and did not pierce through the gault. Mr. Gunn dwelt especially upon this as the most serious objection to the prospect of reaching coal at Hunstanton, or rather carboniferous beds, expressed so strongly by Prof. Hall at the Brit. Ass. meeting at Brighton. Mr. Gunn also referred to the evidence of local subterranean movements in proof of the proximity of disturbances acting upon what he regarded as a thin envelope of tertiary or secondary deposits probably not exceeding 1,000 feet, and perhaps much less. He referred to the evidence of boulders, which he hoped to adduce on a future occasion.—On the Geology of Nottingham, by the Rev. A. Irving, F.G.S. Part 1.

Edinburgh

Geological Society, Feb. 26.—David Milne Home, F.G.S., vice-president, in the chair.—The following papers were read:—Notice of large striated boulder in Tynecastle Sandpit, a quarter of a mile west of Dalry Cemetery, Edinburgh, by D. Milne Home.—On glacial phenomena in the neighbourhood of Edinburgh—(1) the Pentland Hills; (2) Bruntsfield Links; (3) Blackford Hill; (4) Tynecastle—by D. J. Brown.—Notice of a section in the building excavations at Tynecastle, by Ralph Richardson.—On glacial phenomena in the Pentland Hills and neighbourhood of Edinburgh, by John Henderson.—Mr. Milne Home's paper, which was illustrated by diagrams, described the boulder as being well rounded on the sides, and its greatest length as 4½ ft., its greatest width 4 ft., its thickness about 2 ft. Its upper and under surfaces were distinctly grooved, and most deeply in the line of the longer axis, which lay N.E. by E. There were some fainter striæ oblique to that line. From a comparison of the striations, he concluded that the superior and lateral striæ had been made after the stone was laid in the bed where found. The stone, which was of greenstone, lay on a bed of compact muddy sand, containing stones which were mostly angular. Above the stone was a considerable deposit of sand, and over that a series of gravels with clayey and sandy beds, all stratified, above which was the soil—the whole deposit being a bank from 20 to 30 ft. thick. This great bed of sand and gravel, in the upper part and west side of which the boulder was found, had been originally a submarine bank. Its height above the present sea-level was about 200 ft. How much above this level the sea stood when this bank was formed was, of course, only matter of conjecture. The nearest rocks similar to the boulders were situated to the westward; most probably, therefore, it had been rafted on ice from that quarter; and, by reason of the ice stranding on this sandbank, the boulder had been deposited there. The deep striæ on the under side showed that the boulder after being deposited on the sea bottom, had been pushed forward easterly. After it had stuck fast it had been striated on the top and exposed sides, by hard and sharp rocks pushed over it, probably by icebergs. The under striæ evidently indicated that they were begun to be formed from the east side, whilst the upper striæ indicated that they had been begun to be formed by some agent passing over from the westward by the pressure of floating ice. Mr. Milne Home stated that a boulder had been recently found on Sir Thomas Hepburn's property in East Lothian which also bore evidence of having been at one time subject to the action of floating ice.

Paris

Academy of Sciences, March 2.—M. Bertrand in the chair.—The following communications were read:—On the proper nature of the principle of correspondence, by M. Chasles.—On the descending motion of solar and terrestrial cyclones, and on the formation of their opaque envelopes, by M. Faye. This is a reply to a paper by Dr. Reye, and is a defence of the cyclone theory of sun-spots.—On the acid waters which rise in the volcanoes of the Cordilleras, by M. Boussingault. The author considers the simultaneous occurrence of chlorides and sulphates in the igneous rocks the cause of the formation of hydrochloric, sulphurous and sulphuric acids in volcanic emanations, thermal waters, &c.—Meteorology of the month of January 1874 at Tougourt, by M. Ch. Sainte-Claire Deville.—Observations on solar prominences during the last quarter of the year 1873. Results furnished by the employment of diffraction gratings instead of prisms in the spectroscopic observation of the prominences, by P. A. Secchi. The author has observed the coincidence of spots with eruptions on the sun's limb on eighty-nine occasions. Eight times only were spots seen without an eruption. A remarkable case is recorded of the outburst of an eruption during the course of an observation.—On the reduction of bilinear forms, by M. G. Jordan.—On the refraction of gases, by M. Mascart.—Organogenesis compared with androgenesis in its relations to natural affinities (*class Personatæ*), by M. Ad. Chatin.—New species of the genus Dipterocarpus, by M. J. Vesque. Twelve species are described, all from Borneo.—Gnomonic projection of the terrestrial surface upon an octohedron and upon a cube circumscribing the sphere, by M. J. Thoulet.—On a new symptom of death derived from the pneumatosis of the veins of the retina, by M. E. Bouchut.—Geometrical demonstration of some theorems, by means of the consideration of an infinitely small rotation, by M. A. Mannheim.—Apparent orbit and period of revolution of the double star η Coronæ, by M. G. Flammarion.—On the mode of production of certain induction currents, by M. A. Gaiffe.—On the influence of albuminous substances upon electro-capillary phenomena, by M. Onimus.—New researches upon the physiological decomposition of beer-yeast, and remarks on a recent communication by M. Schutzenberger, by M. A. Béchamp.—On the action of chloral upon albumen, by M. H. Byasson.—Of the anæsthesia produced in man by the injection of chloral into the veins, by M. Oré.

CONTENTS

THURSDAY, MARCH 19, 1874

THE CHEMICAL SOCIETY'S JOURNAL

THE man who jokingly said that he had to give up the study of chemistry when the science became so bulky that its Handbook required a wheelbarrow for its conveyance, expressed a truth which has been painfully felt by many scientific workers. With continual fresh additions to our knowledge, anything like a comprehensive grasp of a large science must become daily more and more difficult; but while this difficulty is generally felt, it occurs with special force in the science of chemistry. Chemistry, of all sciences, has perhaps the most unlimited capacity for development. Its subject is enormous, including the whole of nature, animate as well as inanimate. Nor is the chemist satisfied with studying the properties of matter as they are exhibited in the natural operations of the world around us, even this wide and attractive field of observation does not content him; he has made the grand discovery that the elements are his servants; that he can at will take to pieces in his laboratory the compounds found in nature, and construct therefrom a multitude of new bodies. Chemistry may thus be said to produce the matter upon which it feeds; the extent to which the production of new compounds can be carried seems practically unlimited, and these become, in most cases, the starting points of fresh investigations. We have here the principal cause of the wonderful development of modern chemistry; armed with such power, it cannot but abound in valuable discoveries, and furnish, at all times, copious results. As a consequence of this rapid development of the science, it has become a matter of the greatest difficulty for the investigator, the teacher, or the manufacturer, to keep pace with the daily progress of discovery; and improvement, and ignorance of the results already obtained in any department, naturally necessitates a loss of valuable time and labour to those engaged on the subject. The bulk and variety of chemical literature are not, however, the only obstacles to the student; the difficulty is greatly increased to an Englishman by the fact that the greater part of this literature is published on the Continent, and appears in a variety of languages with which the average Englishman has but little acquaintance.

With such difficulties to encounter, the individual student has certainly little prospect of successfully keeping abreast with modern chemistry. We are therefore exceedingly glad to find that the matter has been taken up by the Chemical Society of London, and that they now publish in their monthly journal * carefully prepared abstracts of all the original papers which appear in foreign and English periodicals. The abstracts are classified for facility of reference, and are divided into Physical, Inorganic, Mineralogical, Organic, Physiological, Agricultural, Analytical, and Technical Chemistry; it is, therefore, quite easy to ascertain what has been recently done in any department of the science. When we mention that the volume for last year consists of 1,300 pages, and contains, besides the papers and lectures read before the Society, about 1,500 abstracts of chemical papers published in other journals, we shall give some idea of the magnitude of the work which the Society has undertaken.

Looking carefully through the journal we find that nearly 40 periodicals are regularly abstracted; and as many of these periodicals reprint papers from other less known publications, the extent of literature brought under contribution is very considerable. The periodicals abstracted are German, French, Italian, American, and English, the first two preponderating. The preparation of the abstracts is of course laborious, and demands considerable care. It is accomplished by a body of twenty-six abstractors, chiefly Fellows of the Society, whose initials are appended to their respective work. We are bound to say that the abstracting so far as we have had an opportunity of judging, is exceedingly well done.

A work of this kind is far too expensive to be permanently carried on by a Society destitute of endowment, unless the scientific public in our own and other countries cordially support the enterprise. We understand that the sale of the journal outside the circle of the Society is at present very small, and that the expenses of publication are largely borne by a guaranteed fund raised to give the journal a fair start, and also by a grant from the British Association. We feel sure that the enterprise needs only to be widely known to obtain the support of all lovers of Science. What the Chemical Society is now doing is indeed exactly what we most need in the present day to assist the multitude of workers who are employing scientific facts and methods. It is a kind of work which must sooner or later be carried further, and extended to all the principal sciences, if ourselves and successors are to cope with the ever-increasing accumulation of facts. While such abstracts are, from their early intelligence and their widely gathered and condensed information, an unspeakable boon even to the independent and educated philosopher, they are of still greater value to the ordinary worker, who has not the advantages of a large and costly library, or of an education embracing many languages; to him these abstracts, obtainable at moderate cost in his own language, supply as far as possible the absence of fuller means of information. The work which the Chemical Society has taken up receives, therefore, on many grounds our warmest sympathy. It would indeed be a disgrace to the intellect of our country if such a genuine effort were allowed to drop for lack of support. We would especially invite the attention of our American readers to this monthly journal; supplying, as it does, in their own language a summary of the chemical literature of Europe, we should think it would exactly meet their wants. The Germans have long had a yearly volume of abstracts treating of chemistry and its allied sciences; up to the commencement of the present publication the German *Jahresbericht für Chemie* was indeed the only available work giving a summary of recent investigations. This annual periodical has lately fallen so behind in date (the volumes for 1870 were only obtainable in the middle of last year), that it has really become a chronicle of the past, rather than of the present state of science, and can hardly compare with the new English work. The subscribers to the "Journal of the Chemical Society" possess indeed at the

* "The Journal of the Chemical Society," containing the papers read before the Society, and Abstracts of Chemical Papers published in other Journals. Edited by H. Watts, F.R.S. (J. Van Voorst, 1873.)

present time abstracts of about 4,000 papers, all of later date than those noticed in the last German *Jahresbericht*. Our German fellow-workers may therefore, with advantage to themselves, give their support to this English work.

We trust that the appreciation of all interested in chemical science for this most useful work will be so decidedly shown that the Chemical Society will soon have no further anxiety as to the success of their undertaking. The circle of readers appealed to is a very wide one; not only is it an absolute necessity for those who work at Science and those who profess it, but the medical man, the agriculturist, the manufacturer, and the geologist will all find an abundance of matter interesting to their special pursuits.

TODHUNTER'S "MATHEMATICAL THEORIES OF ATTRACTION"

A History of the Mathematical Theories of Attraction and the Figure of the Earth from the time of Newton to that of Laplace. By I. Todhunter, M.A., F.R.S. Two vols. (London: Macmillan, 1874.)

I.

THE late Prof. de Morgan, in his "References for the History of the Mathematical Sciences," divides the written histories into two classes, those which are written on the plan of Montucla, Bossut, &c., in which a general account is framed out of the writer's notes or remembrances of miscellaneous reading; or in that of Delambre, Woodhouse, &c., in which the successive writings of eminent men are examined and described one after the other, so that each chapter or section is a description of the progress of Science in the hands of some one person, and is complete in itself. This latter plan is the one he considers the most favourable to accuracy and the most interesting to students who are desirous of being the critics of the historians, and of amending their works, if need be. The admirable two volumes before us would certainly be placed under this head. As to the utility of such works, our author remarks: "A familiarity with what has been already accomplished or attempted in any subject is conducive to a wise economy of labour; for it may often prevent a writer from investigating afresh what has been already settled; or it may warn him, by the failure of his predecessors, that he should not too lightly undertake a labour of well-recognised difficulty." Mr. Todhunter is no novice in this style of writing; his "History of the Calculus of Variations" appeared in 1861, and at once placed him in the foremost rank of mathematical historians; this work was followed, in 1865, by the "History of the Theory of Probability." The principles upon which these earlier works were written have been adopted in the work under consideration. Experience has improved his already first-rate powers of analysis and of graphic representation of the contents of the works he considers; all that he wants is leisure; possibly a time may come when the University of Cambridge will appoint an historian (or historians) to fill up the painfully patent void which now exists in this department of literature. The acknowledged high merits of his published histories would suggest Mr. Todhunter as a most fitting first occupant of such a chair; the liberality of the syndics of the University Press in defraying the expenses of the printing of this last work affords evidence that the work is appreciated. In his recent volume of "Essays" (p. 151), our author mentions his taste for the history of Mathematics; we heartily hope that the union of such taste and mathematical powers will result in the begetting a numerous progeny all equally comely with, and of as good disposition as, the elder members of the family.

There is one feature in these histories that especially commends them to our own mind, and that is the writer's *candour*. We cannot better express our own views upon this point than by citing the following passage from the late Sydney Smith's writings: "There is nothing more beautiful in science than to hear any man candidly owning his ignorance. It is *so* little the habit of men who cultivate knowledge to do so—they so often have recourse to subterfuge, nonsense, or hypothesis, rather than to a plain manly declaration, either that they themselves do not understand the subject, or that the subject is not understood—that it is really quite refreshing to witness such instances of philosophical candour, and it creates an *immediate* prepossession in favour of the person in whom it is observed." * It is the absence of this candour which has been productive of so much confusion in this subject of mathematical history: the straining after completeness leads to the insertion of second- and third-hand descriptions; the right rule seems to be that of De Morgan and our author, "to give no opinion or account of any book whatever unless such as is derived from personal acquaintance with its contents." Extreme care and painstakingness are manifest throughout without any sign of flagging. Interesting as Mr. Todhunter's histories are, even to the general student, from the many "sidelights' they contain, and which are especially numerous in the present work, they are exceedingly valuable to the special student, on account of the investigations with which they abound. These are not mere reproductions, but they translate, as it were, the old and now almost obsolete language of the earlier writers into the language of modern analysis: thus in § 443 it is remarked of D'Alembert's notation, "It is not very inviting, and he leaves it to explain itself." Some idea of the extent of these investigations may be got from the fact that 475 out of the 1,632 articles are devoted to them.

The author's design is to write the history of the Mathematical Theories of Attraction and of the Figure of the Earth; for this purpose, he says, he has endeavoured to include all the memoirs and works which relate to these subjects. Such has been his diligence in his seven years' research, that we should suppose few books have escaped his notice: certainly none that would materially affect the conclusions he has arrived at. That he would have added a few to his list had he consulted the British Museum library, or had access to that bequeathed by the late Mr. Graves † to University College, we shall probably show in the course of this notice.

Mr. Todhunter shows that the subjects treated of are of no common importance and influence. Researches into both theories have been fertile in yielding new resources for mathematicians: it will suffice to instance

* "Conduct of the Understanding."

† We are informed that the liberality of a gentleman who has already been a great benefactor to the College will shortly enable students to get an accurate idea of the treasures contained in the above library.

the Transformation of Multiple Integrals, the theory of the Potential, and the functions of Laplace. A knowledge of the figure and dimensions of the earth forms the basis of all the numerical results of Astronomy. In § 25 he carefully defines the several terms made use of in the two subjects, equating in a useful way the varying terms employed by different writers.

The foundation of our subject, as all our readers know, is "great Newton's own ethereal self," Newton, "the crown and glory of his race." "The propositions on Attraction are numerous, exact, and beautiful; they reveal his ample mathematical power. The treatment of the figure of the earth is, however, still more striking, inasmuch as the successful solution of a difficult problem in natural philosophy is much rarer than profound researches in abstract mathematics. Newton's solution was not perfect; but it was a bold outline, in the main correct, which succeeding investigators have filled up but have not cancelled. Newton did not demonstrate that an *oblatum* is a possible form of relative equilibrium; but, assuming it to be such, he calculated the ratio of the axes. This assumption may be called Newton's *postulate* with respect to the figure of the earth; the defect thus existing in his process was supplied about 50 years later by Stirling and Clairaut" (§ 44). Newton appears to have arrived at his theorems in attraction in 1685; the first edition of the "Principia" made its appearance in 1687. (De Morgan, in his "Budget of Paradoxes," p. 81, discusses some of the sources of the apple story.)

Mr. Todhunter nowhere takes account of theories maintained before the time of Sir Isaac Newton; these were, for the most part, if not entirely, non-mathematical. A sketch is given in Book III. of Maclaurin's "Account of Sir Isaac Newton's Philosophical Discoveries, in Four Books."* We draw attention to this work because no reference is made to it in the *History*, whereas great part of Books III. and IV. is devoted to the subject of gravitation.

The same reason (for we cannot suppose Mr. Todhunter not to have consulted the work) has possibly induced him to pass over in silence the "Theoricæ Mediceorum Planetarum ex causis Physicis Deductæ"† of Borelli, though Libri, in his Catalogue, states that this writer "uses the principles of the law of Attraction as afterwards promulgated by Sir Isaac Newton."

Hardly a subsequent chapter but contains from one or another writer an acknowledgment of Newton's high powers; we shall here content ourselves with citing only Laplace's warm eulogy:—"Cet admirable ouvrage contient les germes de toutes les grandes découvertes qui ont été faites depuis sur le système du monde;" and further, he says, that the first step thus made by Newton in the theory must appear immense.

Huygens next appears on the scene. Our author (§§ 64, 65) clears up one or two points, more especially the rightful claim to priority of Newton over Huygens; an error which crops up in Barlow's "Mathematical Dictionary" and Svanberg's work on the Lapland Operations.

From § 48 we gather that Mr. Todhunter has not seen the *Opera reliqua*. S'Gravesande, in the preface to vol. ii. (we quote from the edition Amstel, 1728, 4to.), says, "Tractatus de lumine et dissertatio de gravitate quæ ambo scripta gallice dedit auctor, quamvis primum ut ipse in hujus præfatione monet, in linguam latinam vertere sibi proposuerat:" the second is turned into Latin with title "De causâ gravitatis." The *præfatio* occupies pp. 95, 96, *dissertatio* pp. 97-116 with an *additamentum* down to p. 136, and there is a plate: the *De vi centrifugâ* occupies pp. 107-134.

* London, 1775. 3rd edit. 8vo.
† Florentiæ, 1666. 4to.

In the *Opuscula postuma* (Lugd. Bat. 1703, 4to.) the treatise *De vi centrifugâ* (pp. 401-428) is founded, if we mistake not, on a different view of gravitation from that assigned to him by Mr. Todhunter in § 50.

Miscellaneous investigations, up to the year 1720, are then considered: Burnet's "Theory of the Earth" is glanced at, Keill's examination of the same, David Gregory's writings (which contribute nothing new), Hermann, Mairan ("Misapplied Mathematics and Misplaced Ingenuity") and the Cassinis, under whose powerful influence doubts arise as to the real shape of the earth, are more fully discussed.

We proceed to Maupertuis, a memoir* by whom is said (§ 128) to be the first example of the adoption of the principle of attraction by French mathematicians. We offer here a collation of the first editions of two of his works with the second editions which Mr. Todhunter discusses (§ 143).

The *avertissement* of 3 pp. in the 1738 edition of the *Examen désintéressé* is not reproduced in the 1741 edition: the 82 pp. of text, as also the 3 pp. of contents, at end, and the one page of errata, appear to be identical with the matter in the later edition. For the *Examen des trois*, &c., the bookseller's *avertissement* (4 pp.) is common to both: the 42 pp. of text appear to be the same; there is no list of errata; the foot-notes of the later edition appear as side-notes in the 1738 copy. The copy we consulted had the two essays bound up together, and is a duodecimo volume.

In the "Philosophical Dissertations on the Uncertainty of Human Knowledge" by the Marquis d'Argens, author of the "Jewish Spy," to which is added M. Maupertuis' "Dissertation upon Gravity,"&c.,translated from the French edition, in 2 vols. 1753, with the running title "The Impartial Philosopher," we have the following:—"After M. Maupertuis had examined the Newtonian system and after he had undergone infinite dangers and difficulties in the frozen regions of the North, in verifying a particular part of it, he concludes that we may look upon gravity as a power diffused through all parts of matter by which all its particles attract each other. The concurrence of all the force of matter which composes the earth, attracts and causes bodies to fall towards its surface, keeps the moon in her orb, and produces with regard to the other planets, and with respect to the sun, the like phenomena, always in proportion to the quantity of their force, their direction, and their distance" (pp. 255-263).

Whilst treating of Maupertuis, we think we have seen in the Graves' library the English translation of his "La figure de la terre . . . au cercle polaire," 1738: possibly the extract cited above is taken from it. In § 149 Mr. Todhunter says "Childrey seems" &c.: Joshua Childrey, 1623-1670, was of Magdalen College, Oxford, Archdeacon of Salisbury, 1663. He wrote "Britannia

* "Sur les loix de l'attraction:" cf. Bailly.

Baconica, or the Natural Rarieties of England, Scotland, and Wales, according as they are to be found in every Shire." (London, 1660. 8vo.) The passage referred to in the *Examen désintéressé* we presume was taken from the Paris edition (1667. 12mo.), under Carnarvonshire (pp. 244, 245 of the French, pp. 147, 148 of the English edition). In his dedication he writes:—"The calling I have entred into, and the capacity * wherein I have the honour to serve your Lordship, wil (I fear) offend the weake tendernesse of some, who think these deep searches into reason misbecoming a Preacher of Faith, and the contemplation of the works of Nature very impedimentall (if not destructive) to the work of Grace," &c.

Stirling (whom his rival Clairaut calls "one of the greatest geometricians I know in Europe") enunciated without demonstration approximate propositions respecting the magnitude and the direction of the attraction of an homogeneous *oblatum* at its surface and *implicitly* (§ 156) established Newton's *postulate*.

We now proceed to give an account of the original work (not seen by Mr. Todhunter) entitled "Dégré du méridien entre Paris et Amiens." (Paris, 1740.) It has 6 pp. of contents:—lvi. pp. of Part I. in nine chapters, with 3 pp. of plates. Part II. is "Mesure de la terre" par M. l'Abbé Picard, 106 pp., with 10 pp. on Aberration of fixed stars, and 5 pp. of fixed plates. On p. vi. we find, "le dégré comparé à celui que nous avons mesuré au cercle polaire, que nous avons trouvé de 57437, 9 toises donne la terre aplatie vers les pôles; et le rapport de l'Axe au diametre de l'equateur, comme 177 à 178." We had some difficulty in finding the book in the Museum from Mr. Todhunter's description; at last we found it catalogued under the heading Picard.

The Museum copy of the Essay by Celsius (§§ 198, 739, not seen by our author), entitled "De Observationibus," &c., Upsaliæ, 1738, is bound up with several other tractates on our subject, but all the rest partake of the character of the ante-Newtonian writers. Thus Nicolaus Winterberg (1596) heads his chapters—"Rotundam esse (terram) liquido apparet;" "Terram cum aquâ conjunctam σφαιροειδῆν asserimus;" and he further maintains the earth to be the centre of system of universe. We need not give an analysis of Celsius's work here; for this is undoubtedly the original from which the German translation, discussed by Mr. Todhunter, was taken. He styles Newton "vir immortalis," and, deciding against James Cassini, thus ends his ten-page tract—"Spero itaque me jam æquo et candido lectori satis superque ostendisse observationes Cassinianas, tam cœlestes quam terrestres in Gallia præcipue meridionali habitas, adeo incertas esse et inde figura telluris nullo modo deduci queat."

We have now arrived at the period when the question between the Newtonians and Cassinians was decisively settled, and the victory of the *oblates* over the *oblongs* acknowledged even by the Cassinis. This result was brought about by the expedition to Lapland in 1736-37, and won for its ruling spirit, Maupertuis, Voltaire's witty compliment of having "aplati les pôles et les Cassinis."

R. TUCKER

(*To be continued.*)

* He was chaplain to the "Rt. Hon. my most noble Lord and Master Henry Somerset Lord Herbert, &c."

OUR BOOK SHELF

Elements of Chemistry, Theoretical and Practical. By William Allen Miller, M.D., LL.D. Part II. Inorganic Chemistry. Revised by Herbert McLeod, F.C.S., Professor of Experimental Science, Indian Civil Engineering College, Cooper's Hill. 5th edit., with additions. (London: Longmans, 1874.)

IT will of course be superfluous to say anything in the way of criticism concerning this well-known manual. The death of its lamented author has necessitated the placing of the fifth edition in other hands, and it could not have fallen into better than those of its present editor. The principal changes so far have been a re-arrangement of the articles in accordance with the modern method of study and the removal of certain parts, such as those on gas analysis and the description of certain carbon compounds, to the appendix preparatory to their removal to the third part, to which they more strictly belong.

Some of the constitutional formulæ, now so much in use, have been introduced, and the kind selected have been those used by Frankland in his well-known "Lecture Notes." We are, however, glad to see that these have not been used to the exclusion of the notation adopted in former editions.

Great credit is due to Prof. McLeod for the thorough and conscientious way in which he has performed his task, and the only fault we have to find is that there is occasionally a certain amount of confusion caused by the use of different names for the same body, a fault for which, however, the science itself is largely responsible.

R. J. F.

Zones of Parallel Lines of Elevation in the Earth's Crust. By Angus Ross, sec. and mem. com. N. S. Inst. of Nat. Science. (Halifax, Nova Scotia, 1872.)

HE is a bold man who will predicate that no future discovered fact will disturb even the most widely accepted hypothesis. This being so, all hypotheses being in fact tentative only, and valuable in so far as they enable us to classify and deduce laws from such facts as we know, we ought to welcome every generalisation which groups known facts under some new aspect. In the above pamphlet we have such a generalisation. Whether it will prove to be supported by future discovery, or even whether it can be rigidly applied to explain actual facts will require much close criticism to determine. We can only say that it is ingenious and novel. The author claims to have discovered the method of distribution of the various mountain chains or lines of anticlinal elevation. These he asserts are arranged in parallel lines along certain belts or zones which girdle the earth, each zone following approximately the course of a great circle, and each having for its medial line or axis a line of volcanoes. Of these zones he describes seven, and we may extract one as a type of the rest. "Zone No. 1 on the Rocky Mountain system has its axial line in the volcanic belt extending from the middle Andes, inclusive, across Central America along the Rocky Mountains, Alaska, the Aleutian Islands, Kamtschatka, the Kurile Islands, Japan Islands, Loochoo Islands, Philippine Islands, Palawan, and Borneo. The Islands of Amsterdam and St. Paul, the Kerguelen Islands, the South Sandwich Islands, and South Georgia seem to indicate the completion of the more southerly part of the (approximately) great circle." The author, as we have said, describes seven such zones or belts which intersect one another, and argues that the points of intersection are foci of volcanic energy. He argues also that the great mountain-chains in their direction follow the course of one or other of these zones, and thus describes their arrangement:—"In each zone the proximity and elevation of the anticlinals diminish gradually from the axial line outwards, and if zone No. 1 be considered the most recent,

and the others as successively less recent in the order in which I have named them, and comparing similar parts of any two zones, the height of the anticlinals is greater, the dip less, and the difference between their axes greater in the more recent." The pamphlet is ably written and very deserving of study. HENRY H. HOWORTH

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Animal Locomotion

IN NATURE, vol. ix. p. 301, there is a letter from Mr. Wallace on a very important point connected with the Theory of Flight. The question he discusses is "whether a bird's wing during onward flight moves *downwards and backwards* or *downwards and forwards*;" and Mr. Wallace supports Mr. Pettigrew in affirming that the movement is *downwards and forwards*.

As this is a subject to which I have paid long and close attention, I desire to express my conviction that neither of the two motions thus described by Mr. Wallace is the true motion of a bird's wing in forward flight.

The true motion is one strictly vertical to the axis of the bird's body; and as that axis is ordinarily horizontal in flight, the wing-stroke is a vertical stroke, that is simply downwards, and neither "downwards and forwards" nor "downwards and backwards."

This is not a question of theory, but a question of fact, to be determined by observation. The wing-stroke of most birds is indeed so rapid that the eye cannot distinctly follow the operation. But there are birds whose wing is so large and whose flight is so slow, that the wing-stroke can be followed with the greatest distinctness. Such is the common heron—common, alas, no longer in most parts of England, but numerous on the west coast of Scotland. When at home I am in the daily habit of watching their flight; and the truly vertical character of the wing-stroke is a fact which I have verified by the eye under every possible condition which could supply the evidence.

There are indeed two slight modifications of the perfect perpendicularity of the stroke which result (1) from the attachment of the wing to the body of the bird, and (2) from the structure of the wing-feathers. The first of these two modifications consists in this—that as the wing moves upon a hinge, its extremity must move downwards, not absolutely vertically, but describing an arc. The segment of a circle, however, through which the wing thus moves, is generally a very short one: and in so far as the movement of the extremity departs from the vertical, it departs therefrom neither "backwards" nor "forwards," but (as it were) "inwards,"—that is, in the direction of a circle encompassing the axis of the bird's body as with a hoop. Pigeons, as an amusement and in play, often complete this circle—making their primary quills clash against each other over their backs, and downwards again under their breasts. But in ordinary forward flight, when birds are intent only on progression, the wings move through a very small arc indeed of the complete circle referred to.

The second modification of the perpendicularity of the stroke arises from the "set" of the wing-feathers—which curve backwards and downwards from the wing-bones. In some birds, and notably in the heron, and all the storks, the concavity thus formed is very deep, and of course a surface which is thus not a plane surface, but a concave one, however truly it may be struck downwards, cannot have a purely vertical reaction on the air.

When we observe, however, that in the case of many birds, and some of these the most powerful fliers in the world, this concavity of the wing-feathers is very slight indeed, and that the whole vane is very narrow, flat, and "taut," it is obvious that a purely vertical stroke, or one as near it as possible, is the really essential stroke for flight.

The great secret of flight is the exquisite and complicated adaptation of structure in the feathers of a bird's wing which derives from this one simple action the resultant of a force which is both sustaining and propelling. It is an adaptation which, when thoroughly grasped and understood, at once dispenses with as needless, and condemns as mechanically erroneous, all the explanations which assume either a "downward and forward" or a "downward and backward" movement.

I venture to think that Mr. Wallace is certainly in error when he ascribes to Mr. Pettigrew the merit of having been the first to show that "horizontal forward motion is a general resultant of the upward and downward action of the wings under the influence of gravitation."

In February 1865 I published in *Good Words* a paper on the mechanism of flight, in which this effect of the wing-stroke was fully explained, and elaborately illustrated. This paper subsequently appeared as chap. iii. in the "Reign of Law" published in the end of 1866. Mr. Pettigrew's lecture before the Royal Institution (in which I believe his views were first promulgated) was delivered on March 22, 1867. I had the pleasure of hearing that lecture, and the amusement of recognising parts of it (including even a poetical quotation) as taken directly from my chapter on flight. The pleasure, however, was somewhat abated by the strange mixture of much that was quite correct, with a great deal more which I believed then, and believe now, to be wholly erroneous. ARGYLL

March 11

MR. WALLACE has well said that the question, How a bird's wing moves in flight, "is a very important question." In these days, when scientific attention is being directed to the problem of aërial navigation, it is especially important. I have the less hesitation, therefore, in troubling you with some further remarks in reply to the strictures of this very accurate observer.

At the outset I must deny that I assumed either that a bird's wing is inflexible or that it is a plane. Of its flexibility I had no cause for speaking at all; but so far from regarding it as a plane, I expressly objected to Dr. Pettigrew so representing it in his supposed refutation of the orthodox view. The point in dispute is entirely concerning the down stroke; against Mr. Wallace's account of the up stroke I make no objection.

First, what may we infer *à priori* concerning the down stroke? (1) Its efficiency is independent of the velocity of the bird: this is simply a consequence of the second law of motion. We have to suppose a bird fixed in still air, and to ascertain the effect which ensues on a downward blow of the wing. The subsequent forward velocity of the bird, so far as that depends on the down stroke, is but a consequence or an accumulation of these effects. It is thus only needful to analyse the single effect itself. To this end the shape and varying flexibility of the wing must be noted. Along the exterior margin we have a rigid area, comparable to the blade of an oar, and formed for the most part of bone, in the *top side* of which the rigid tubes of the primary and secondary feathers are inserted. On the under side of this, which we may term the oar part of the wing, there is thus a considerable concavity, the direction of which when the wing is extended is decidedly backward. The area towards the middle line of the wing is flat and horizontal, approximately so at all events, when the bird is freely suspended in the air. Of the posterior, the larger, half of the wing it is true, as Dr. Pettigrew says, that the aspect is forward, more especially in heavy birds with broad and rounded wings. The flexible extremities of the feathers readily turn upwards like vanes in the manner so well shown in Fig. 80 of Dr. Pettigrew's work. We may thus roughly distinguish four areas, beginning from the front: (*a*) the oar area; (*b*) the plane or flapping area; (*c*) the kite area; (*d*) the vane area. (2) Now we may inquire what will be the effect of each when the wing is struck downward. The reaction from the oar area will be (*a*) a force directed upwards and forwards; that from the plane area (*b*) a force directed upwards simply. Against the kite area will impinge the air sent backwards and rebounding from the blow of the oar area; the effect of this (*c*) is all that corresponds to what Dr. Pettigrew calls the kite action of the wing. Lastly, the same air in escaping through the feathers, and especially in raising the tips in the vane area, will produce the forward motion (*d*) to which Mr. Wallace refers, besides contributing something (*e*) to support the bird's weight. The horizontal component of (*a*) together with (*d*) will carry the bird forward. The slighter horizontal component of (*c*)—slighter because proceeding only from the rebounding air and from a yielding surface—will tend to hinder the forward motion: hence the absence, more or less complete, of this area in quick fliers. The forces (*b*), greater part of (*c*), and (*e*) will sustain the bird against gravity.

Neither Dr. Pettigrew, nor apparently Mr. Wallace, distinguishes the motion consequent on a surface striking against the air from that of a surface gliding through it. If I incline a sheet of paper to the horizon and let it slip from my hand it will descend with a similar incline towards the ground; but if, having stiffened it, I strike it against the air at the same inclination it will tend to rise in a direction at right angles to that inclination. The *blow*

directed downwards and backwards must give an impetus upwards and forwards; the *still surface* so directed will glide downwards and forwards. I do not deny that if the down stroke of the bird's wing be directed backwards, *beyond a certain angle*, the resultant motion will be, as Mr. Wallace says, "obliquely downwards." But why? Because all the sustaining forces above enumerated are so seriously diminished—the horizontal and forward forces, with the exception of (*d*), being increased—that, to use Mr. Wallace's words, "the surplus vertical reaction of the down stroke over the up stroke is no longer able to overcome gravity," which converts the bird's wings for the nonce into kites as it comes sailing downwards, making but an occasional strike, now that the horizontal effect of the wings is so great, to increase the obliquity of its descent.

But within the limits of this angle, whatever they be, the effect of a downward and backward blow must, on mechanical grounds, be in general such as I have said. For clearness' sake it may not be superfluous to note an ambiguity in the expressions "downwards and backwards," "downwards and forwards;" they may apply either to the direction of the surface of the wing or to the direction of the anterior margin. I maintain only that the direction of the surface—in some wings, merely that of the anterior portion of the surface—is downwards and backwards. The anterior margin, by the contraction of the great pectoral muscle, is drawn downwards and forwards, in which, by the way, there is the further advantage that less air will escape from under the wing in front.

But, secondly, what can we *observe* as to the down stroke? (1) A fact, pointed out to me by an anatomical friend—that the great pectoral muscle which depresses the wing is inserted into a crest situated on the upper and forward side of the head of the humerus, so as to tilt the under surface of the wing slightly upwards, *i.e.* give it a backward direction. (2) If the flight of rooks, or still better of pigeons, be watched from a window towards sunset, the position of the shadows on the under side of the wings will be found pretty conclusive as to their direction. (3) The forward inclination of the wings of a bird about to alight, which shows that the motion of the wings in such a position retards flight. (4) The action of heavy land or water birds, that have to attain some momentum by the use of both feet and wings before they can rise; here surely a forward blow against the air is manifestly absurd. (5) "The highly-inclined position of a hovering bird," noticed by Mr. Wallace, and not of the bird only, but of his wings.

Mr. Wallace's closing remark is both true and sound:—"A bird's wing is a highly complex apparatus, subject to a variety of flexures and motions in every feather." Still it is possible, even probable, that all this variety is referrible to a few simple principles. It is with these alone that I have ventured to concern myself. JAMES WARD

Trin. Coll., Camb., March 3

With reference to Dr. Pettigrew's letter in NATURE, vol. ix. p. 362, I cannot do better than ask him to read the two papers that I refer to in my former reply, which he has evidently not done.

March 16 A. H. GARROD

The Moon's Want of Atmosphere

YOUR very suggestive review of Messrs. Nasmyth and Carpenter's work on "The Moon" leads me to propose an explanation of the absence of a lunar atmosphere, which I do not remember to have seen anywhere. The many arguments in favour of the temperature of the lunar surface being near or at the *absolute* zero, when added to the equally probable supposition that at the *absolute* zero all matter assumes the solid form, makes nothing more probable in my mind than that it is the consolidation from cold of all the previously existing gases and vapours of the Moon which has caused its atmosphere to disappear. Prof. Frankland's theory of the frozen condition of the lunar surface is evidently different from the above, and Lord Rosse's observations on lunar radiation apply only to the direct reflection of the solar rays. A. H. GARROD

On Volcanic Eruptions

A PASSAGE in Nasmyth's work on the "Moon" suggests, as a consequence, an explanation of volcanic eruptions that I have often given in lectures. The point to be explained is, why they are sudden and intermittent. Processes of cooling and expansion are gradual.

I postulate (1) that a solid crust is shrinking as it cools; (2) that the liquid interior expands on solidifying; (3) that the melting-point of lava is lowered by pressure.

Let us start with a volcanic vent in which the aperture has become partially stopped by cooled or solidified lava. In the region below, pressure sets in from the cooling and ultimate solidification of part of the liquid mass. Hence the melting-point of the rest is lowered by (3). The process continues until the pressure becomes sufficient to relieve itself through some vent, old or new; a lava rises in the vent. But this relieves the pressure, and it follows from (3) that more rock will solidify, *suddenly*, and in so doing force liquid rock *rapidly* up the vent.

A volcano is, in fact, a geyser of lava.

I do not remember to have seen this in any book; and it perhaps would have been hazardous to assert postulate (2) as certainly true previous to Nasmyth's experiments; but I have thought it probable: and if it is true, postulate (3) follows, I believe, from the laws of heat, and the explanation will be sound. I shall be glad to hear what is thought of it by authorities.

Rugby, March 13 J. M. WILSON

Remarks on Ozone

HAVING perused Dr. Moffatt's interesting communication on Ozone in the *Scottish Meteorological Journal* of October last, and also noticed the paragraph on the subject in the *Medical Times* drawing attention to it, I beg to send the following remarks respecting some points in it open to criticism from outsiders:—

1. The numbers, and special *years of records*, are not stated in the statistical tables, which might be of importance for comparison with other persons' records.

2. The occurrence of ozone with *hail*, and not with snow, may be explained by its happening in warmer weather, and not in winter, and in the warmer stratum of air through which the hail falls from the cold stratum above.

3. The larger quantity of ozone in Table II. in *winter over that in summer* is anomalous, and inconsistent apparently with the records in Tables VI. and VII., where it is stated to increase with the temperature.

4. If ozone be thought to increase in quantity with *increase of elevation* above the level of the sea, it may be asked how that is to be reconciled with the greater prevalence of it at the sea-shore than inland.

5. If there be only an apparent connection between *electrical storms* and ozone, explanation may be required to account for the production of artificial ozone by electrical action, and whether the two be identical in constitution if not in origin.

6. The paragraph—"The *air is drier* near the tropics than about the equator," might be more clearly defined by adding the "tropical circles of cancer and capricorn," as within those lines it certainly gradually gets more and more humid.

7. In one paragraph there is stated to be an intimate connection between *humidity* of the atmosphere and the manifestation of ozone, and in another this is stated to be purely accidental, which is ambiguous, while the testimony in support of it is not in accord with that in Tables IX. and X., where the adverse record is apparent.

8. That the absolute *humidity of the air* diminishes with increase of elevation may be true in the case of lofty balloon ascents, away from any terrestrial influences of mountains, but, as pointed out in a note, the *relative humidity* increases, as we may see in Westmoreland or Dartmoor, where the heights are always misty and damp.

9. The tropical or *trade winds* only chance to be land winds in some such regions as the North Indian Ocean, whereas they are generally said to be sea-breezes, as in the South Atlantic Ocean, in the ordinary acceptation of the term.

10. The connection of the production of ozone by the means of *turpentine* will bring to the mind of the tourist the freshness of the air of hills planted with pine forests.

11. Accepting the theory that ozone is connected with the equatorial winds, it may be asked how the increase of ozone in the *calm belts* is to be accounted for, where there are only Polar winds, converging to ascend into the upper regions of the air from north and south.

12. The table of *observations at sea* on board ship would require to be supplemented by a note of the period of the year and number of days on record, as the quantity of ozone is already stated to vary with the *seasons of the year* (Table II.), and

the winds, temperatures, and barometrical indications might have been added for the like reason.

13. Table XI. also requires a note of the season of the year and the number of days of observations. It may here be asked, how is the discrepancy to be reconciled between the lessening of ozone as you sail *to the Polar Regions*, and the increase of ozone as you ascend in the air, when the temperature as regularly falls in the one case as in the other.

14 The records showing the connection between *phosphorescence* and manifestation of ozone are very satisfactorily drawn out, and may probably become of much value in a new investigation.

15. The less prevalence of ozone in the higher *extratropical latitudes* may be due, as suggested in another case, to the dryness of the atmosphere impairing the *sensitiveness of the test papers*, so that for the present such deductions are under suspicion.

16. The idea that the prevalence of ozone is coincident generally with a *low barometer* seems well supported by the observations recorded, but some explanation will be required to account for its maximum occurrence with *south-east winds* in Tables IX. and XI., if one should accept the theory of its connection only with equatorial winds.

17. That its presence may be connected with *warm temperatures* of the air seems better established at sea than on land, as also its coincidence with *humidity of the air*, though this is somewhat vitiated by the conscientious suggestion that its manifestation may be due to the increased susceptibility of the test-papers when moist.

18. In the statement that ozone increases as you ascend *mountainous elevations*, it is not stated what winds were blowing at the time, which would appear to be necessary, if the idea of its prevalence with any particular wind were considered essential.

19. The key to the origin and prevalence of ozone in the atmosphere seems still undiscovered, and we do not yet appear to have determined if it belongs to aqueous vapour or a special wind, or whether it be an additional constituent of the air, like carbonic acid, or a floating entity, like a cloud.

NUBIBUS

The Limits of the Gulf Stream

As one of those engaged in the compilation of the Atlantic pilot-charts published by the Admiralty, on which are given the limits, velocity, and general features of the Gulf Stream, as well as the boundaries of the regions in which ice and icebergs may be fallen in with in the North Atlantic, I cannot allow the letter in NATURE (vol. ix. p. 343), by W. W. Kiddle, of the White Star Mail steamship *Oceanic*, to remain unchallenged.

The Gulf Stream and ice boundaries, delineated on the North Atlantic chart, referred to in that letter, are in their details transcripts from the Atlantic pilot-charts.

These details were the result of much patient investigation, and obtained from many sources probably unknown to Captain Kiddle; among the most valuable were the painstaking and sound observations made by members of the United States Coast Survey, and to be found embodied in the annual reports between 1843 and 1859; and especially from the exhaustive and learned work on currents, so well known to cultivators of nautical science, by the late Major Rennell.

If the average boundaries of the Gulf Stream cannot be laid down within reasonable limits from the authorities I have quoted, aided, too, by the many observations of ships of war, extending over the present century, I fear that Captain Kiddle's results will not assist us in a more accurate delineation.

It is, however, to be hoped that Captain Kiddle's information on the currents may be more reliable than that he has ventured upon giving with regard to the limits of iceberg-drift; here recorded facts are irresistibly against him. He has only to consult any North Atlantic memoir on the subject, and he will find that icebergs have been fallen in with so far south as 36° 10′ N., or 7° south of the high authority he quotes. I would refer him on this interesting subject, as well as how icebergs are found on the southern edge of the Gulf Stream, and why it is possible "that bergs could drift square across the heated waters of the Gulf Stream to lat. 39° N.," to a paper by the well-known W. C. Redfield, of the United States (reprinted in the *Nautical Magazine* for 1845), who gathered the facts that have simply been utilised in the Admiralty charts.

London, March 11 THOMAS A. HULL

The Great Ice-Age

MR. GREEN, reviewing Mr. J. Geikie's work on the "Great Ice-Age" (NATURE, vol. ix. p. 318), expresses the opinion that a glacial period must have been one of intense cold. This is the general opinion, and yet I think it can be shown to rest on a misconception. If the climate at any given elevation is cold enough to form glaciers, no decrease of the winter temperature will increase their magnitude; while on the other hand a low summer temperature is shown by the facts of physical geography to be eminently favourable to glaciation. This last may almost be called an identical proposition, for permanent snow means snow which lasts through the summer.

As Mr. Croll has pointed out, there have been periods where the sun's greatest and least distances were respectively greater and less than now. He thinks that a glacial period occurred when, in the course of the precession of the equinoxes, the sun's greatest distance occurred in the winter, so as to cause a *cold winter*. I think the true theory of the glacial climate is exactly the reverse of this: that is to say, it was caused by the *cold summer* which occurred when the sun's greatest distance was in the summer.

I have stated these views at greater length in the *Journal of the Geological Society of London*, 1869, p. 350.

Old Forge, Dunmurry, Co. Antrim, March 8 J. J. MURPHY

Mars

IN a most interesting article on the planet Mars, in your issue of NATURE for Feb. 19, which has just been shown to me, the Rev. T. W. Webb directs attention to the question of the colours of Mars being due to effects of contrast or not, and says—"Nor does it seem to have been noticed that no effect of contrast has been traced in the Polar snows."

Kindly permit me to inform Mr. Webb that, in a paper on Mars in the last volume of the "Monthly Notices of the Royal Astronomical Society," I expressly state that, "on May 14, 1873, the south Polar ice appeared (in an $8\frac{1}{2}$-inch silvered glass reflector, by Browning) of quite a pale sky-blue colour, evidently by contrast," and I may add that this effect I noticed also on two or three subsequent occasions.

Burton-on-Trent, March 12 EDWARD B. KNOBEL

POLARISATION OF LIGHT *

VI.

MENTION was made in the previous article of the bands produced in the spectra of polarised light. Beside the fact of the existence of these bands it has been found upon examination that the state of polarisation at different parts of the interval between two successive bands varies; and such an examination may be made by means of a quarter-undulation plate or a Fresnel's rhomb.

If we carefully examine the spectrum of light which has passed through a selenite, or other ordinary crystal, we shall find on turning the analyser that, commencing with two consecutive bands in position, the parts occupied by the bands and those midway between them are plane-polarised, for they become alternately dark and bright; while the intermediate parts, *i.e.* the parts at one-fourth of the distance from one band to the next, remain permanently bright. These are, in fact, circularly polarised. But it would be incorrect to conclude from this experiment alone that such is really the case, because the same appearance would be seen if those parts were unpolarised, *i.e.* in the condition of ordinary light. And on such a supposition we should conclude, with equal justice, that the parts on either side of the parts last mentioned (*i.e.* the parts separated by one-eighth of the interval between two bands) were partially polarised. But if we introduce a quarter-undulation plate between the selenite and analyser, with its axis inclined at 45° to that of the selenite, circular polarisation will be converted into plane and plane into circular. This being so, the parts which

* Continued from p. 326.

were originally banded ought to become bright and to remain bright, while those that were originally bright ought to become banded during the rotation of the analyser. The effect to the eye will consequently be a general shifting of the bands through one-fourth of the space which separates each pair. Further, as on the one hand plane polarisation is converted into circular right-handed or left-handed by two positions of the plate at right angles to one another; so on the other right-handed circular polarisation will be converted by the plate in a given position into plane polarisation having the vibrations in one direction, and left-handed into plane polarisation having the vibrations in a direction at right angles to the former. Hence, if the plate be turned through a right angle from the position first described, the band will be shifted in a direction opposite to that in which they were moved at first. In this we have evidence not only that the polarisation on either band is circular, but also that on the one side it is right-handed, while on the other it is left-handed.

All the phenomena hitherto described manifestly depend upon the internal structure of the crystal plate, in virtue of which it affects the vibratory movement of the ether within it differently in different directions. And seeing that most crystals, when broken, divide themselves naturally into smaller crystals having the same form, *i.e.* having their planes and edges similarly inclined, we are naturally led to conclude that the structure of these bodies may differ not so much in different parts, as along different lines or planes connected with the forms into which they break, or (as it is also described) with their planes of natural cleavage. And this suggests the question whether an uncrystalline body might not, by pressure, or strain, or other mechanical distortion, be caused to affect the motions of the ether within it in a manner dependent upon their direction, and in that way to exhibit chromatic effects with polarised light analogous to those described above. Experiment answers this question in the affirmative.

The simplest experiment in this branch of inquiry consists in taking a rectangular bar of ordinary glass; and having crossed the polariser and analyser so as to give a dark field, to strain the bar with both hands as if we were trying to bend it or to break it across. The side towards which it may be supposed to be bent is of course compressed, while the opposite is stretched out. Between these two there must be an intermediate band, more or less midway between the two, which is neither compressed nor stretched. The moment the strain is put upon the bar light will be seen to pass through the parts of the bar nearest to both sides, while a band remains dark midway between the two.

This shows that the mechanical strain has imparted to portions of the glass a structural character analogous, at all events optically, to that of a crystal. The effects may be increased and rendered more striking by placing the glass in a frame furnished with a screw, by which the rod may be firmly held and considerable pressure applied at particular points. When this is done the structural character becomes more completely developed, and the dark band is fringed with colours which appear to flow inwards or outwards according as the pressure is increased or diminished. A slightly different, but more effective, exhibition of chromatic polarisation is produced by squeezing a thick square plate of glass in a vice. In this case the pressure may be carried further without fear of fracture, and the chromatic effects heightened.

It is, however, well known that molecular forces, such as those due to heat and cooling, in many cases far transcend in intensity those which we can exert by mechanical arrangements. And, in fact, if a block of glass be unequally heated to a very moderate degree, the internal structural effects immediately reveal themselves by dark bands, which indicate the border land between strain and pressure. As the block cools, these landmarks gradually disappear, and the field becomes again uniformly dark. But by far the most splendid effects (and these are permanent) are produced by unannealed glass; that is, by glass which has been rapidly and therefore unequally cooled. When a mass of glass has been cast in a mould in the form of a thick plate, then whatever be the contour line, the outside will cool first and become a rigid framework to which the interior of the mass must accommodate itself. The nature and direction of the pressure at each point of the interior will be primarily dependent upon the form of the contour; and by adopting various forms of contour the most beautiful and varied figures with coloured compartments may be produced. The forms and colours of the figures produced by transparent bodies when submitted to polarised light have been conversely used as a means of measuring, with almost unparalleled accuracy, the mechanical pressures which such a body is undergoing.

Besides glass many other substances may be used as reflectors so as to produce polarisation; for example, leaves of trees, particularly ivy, mahogany furniture, windows, shutters, and often roofs of houses, oil paintings, &c., and last but not least the surface of water. In each of these cases when the reflected beam is examined with a Nicol the alternations of light and darkness are most strongly marked, and the colours (if a crystal plate be used) are most vivid, or in technical language the polarisation is most complete, when the light is reflected at a particular angle. In proportion as the inclination of the incident light deviates from this angle the colours become fainter, until when it deviates very greatly all trace of polarisation disappears.

It will be found very interesting to examine the polarisation of sunshine reflected from ripples on the surface of a lake, or better still from the waves of the sea, and its different degrees of completeness produced at the variously inclined portions of the waves. But without having recourse to nature on so large a scale, an artificial piece of water may be placed in our room. A tea tray will serve as well as anything else to form our little sea; and a periodic tap at one corner will cause ripple enough for the present purpose. The waves appear bright, and although brighter in some parts than others they are nowhere entirely dark. But on turning the Nicol round the contrast of light and darkness becomes much stronger than before. In parts the light is absolutely extinguished, or the polarisation is complete; in others it is incomplete in various degrees. And if a selenite or other crystal plate be introduced we have the beautiful phenomena of iris-coloured rings playing over the surface of our miniature sea.

Suppose that we now turn our attention to the sky, and on a clear bright day we sweep the heavens with a polariscope, or even with a mere Nicol's prism, we shall find traces of polarisation in many directions. But if we observe more closely we shall find that the most marked effects are produced in directions at right angles to a line drawn from our eye to the sun, when in fact we are looking across the direction of the solar beams. Thus, if the sun were just rising in the east or setting in the west, the line of most vivid effect would lie on a circle traced over the heavens from north to south. If the sun were in the zenith, or immediately overhead, the most vivid effects would be found on the horizon; while at intermediate hours the circle of strongest polarisation would shift round at the same rate as the shadow on a sun-dial, so as always to retain its direction at right angles to that of a line joining ourselves and the sun.

Now, what is it that can produce this effect, or indeed, what produces the effect of light from all parts of a clear sky? The sky is pure space with no contents, save a few miles of atmosphere of the earth, and beyond that the impalpable ether, supposed to pervade all space, and to

transmit light from the furthest limits of the stellar universe. The ether is however certainly inoperative in the diffusion of light now under consideration. But a very simple experiment will suffice to show that such a diffusion or, as it has been better called, a scattering of light, is due to the presence of small particles in the air. If a beam from an electric lamp or from the sun be allowed to pass through a room its track becomes visible by its reflection from the motes of floating bodies, in fact by the dust in the air. But if the air be cleared of dust by burning it with a spirit lamp placed underneath, the beam disappears from the parts so cleared, and the space becomes dark. If, therefore, the air were absolutely pure and devoid of matter foreign to it, the azure of the sky would no longer be seen and the heavens would appear black; the illumination of objects would be strong and glaring on one side, and on the other their shadows would be deep and unrelieved by the diffused light to which we are accustomed. Now, setting aside the dust, there are always minute particles of water floating in the atmosphere. These vary in size from the great raindrops which fall to earth on a sultry day, through intermediate forms of mist and of fine fleecy cloud, to the absolutely invisible minuteness of pure aqueous vapour which is present in the brightest of skies. It is these particles which scatter the solar rays and suffuse the heavens with light. And it is a remarkable fact, established by Prof. Tyndall, while operating with minute traces of gaseous vapours, that while coarser particles scatter rays of every colour, in other words scatter white light, finer particles scatter fewer rays from the red end of the spectrum, while the finest scatter only those from the blue end. And in accordance with this law clouds are white, clear sky is blue.

But the point which most concerns us here is the fact, also discovered by Prof. Tyndall, that light scattered laterally from fine particles is polarised. The experiment by which this is most readily shown is as follows: Allow a beam of solar or other strong light to pass through a tube about thirty inches long filled with water, with which a few drops of mastic dissolved in alcohol have been mixed. The fluid so formed holds fine particles of mastic in a state of suspension, which scatter the light laterally; and if the scattered light be examined with a Nicol traces of polarisation will be detected. But better still, instead of using the scattering particles as a polariser and the Nicol as an analyser, we may polarise the light before it enters the tube and use the particles as an analyser, and thus produce the same effect as before, not only upon the particular point of the beam to which the eye is directed, but upon the whole body of scattered light. As the Nicol is turned the light seen laterally begins to fade; and when the instrument has been turned so as to cut off all vertical vibrations, the only parts remaining visible in a horizontal direction will be those reflected from the larger impurities floating in the water independently of the mastic. The direction of vibration of the light polarised by lateral scattering is easily remembered by the fact that the vibrations must be perpendicular both to the original and to the scattered beam; if, therefore, the latter be viewed horizontally, they must be perpendicular to two horizontal straight lines at right angles to one another, *i.e.* they must be vertical.

An effect still more beautiful, and at the same time perhaps more instructive, may be produced by interposing a plate of quartz between the Nicol and the tube. The whole beam then becomes suffused with colour, the tint of which changes for a given position of the spectator with the angle through which the Nicol is turned.

And not only so, but while the Nicol remains at rest the tints are to be seen scattered in a regular and definite order in different directions about the size of the beam. But this radial distribution of colours may also be shown in a more striking manner, by using a bi-quartz, which as explained before distributes the colours in opposite directions. The beam should in every case be viewed at right angles; the more obliquely it is viewed the less decided is the polarisation.

The colours here seen are those which would be observed upon examining a clear sky in a position 90° from that of the sun; and the exact tint visible will depend upon the position in which the Nicol is held, as well as upon that of the sun. Suppose, therefore, that a Nicol and quartz plate be directed to that part of the sky which is all day long at right angles to the sun, that is, to the region about the north pole of the heavens (accurately to the north pole at the vernal and autumnal equinox), then if on the one hand the Nicol be turned round, say, in a direction opposite to that of the sun's motion, the colours will change in a definite order; if, on the other, the Nicol remain stationary while the sun moves round, the colours will change in a similar manner. And thus, in the latter case we might conclude the position of the sun, or in other words the time of the day, by the colours so shown. This is the principle of Sir Charles Wheatstone's Polar clock, which is one of the few practical applications which this branch of polarisation has yet found.

Figs. 18 and 19 represent general forms of this instrument described in the following passage by the inventor.

"At the extremity of a vertical pillar is fixed, within a brass ring, a glass disc, so inclined that its plane is perpendicular to the polar axis of the earth. On the lower half of this disc is a graduated semicircle divided into twelve parts (each of which is again sub-divided into five or ten parts), and against the divisions the hours of the day are marked, commencing and terminating with VI. Within the fixed brass ring, containing the glass dial plate, the broad end of a conical tube is so fitted that it freely moves round its own axis; this broad end is closed by another glass disc, in the centre of which is a small star or other figure, formed of thin films of selenite, exhibiting when examined with polarised light strongly contrasted colours; and a hand is painted in such a position as to be a prolongation of one of the principal sections of the crystalline films. At the smaller end of the conical tube a Nicol's prism is fixed so that either of its diagonals shall be 45° from the principal section of the selenite films. The instrument being so fixed that the axis of the conical tube shall coincide with the polar axis of the earth, and the eye of the observer being placed to the Nicol's prism, it will be remarked that the selenite star will in general be richly coloured, but as the tube is turned on its axis the colours will vary in intensity, and in two positions will entirely disappear. In one of these positions a smaller circular disc in the centre of the star will be a certain colour (red, for instance), while in the other position it will exhibit the complementary colour. This effect is obtained by placing the principal section of the small central disc $22\frac{1}{2}°$ from that of the other films of selenite which form the star. The rule to ascertain the time by this instrument is as follows:—the tube must be turned round by the hand of the observer until the colour star entirely disappears while the disc in the centre remains red; the hand will then point accurately to the hour. The accuracy with which the solar time may be indicated by this means will depend on the exactness with which the plane of polarisation can be determined; one degree of change in the plane corresponds with four minutes of solar time.

"The instrument may be furnished with a graduated quadrant for the purpose of adapting it to any latitude; but if it be intended to be fixed in any locality, it may be permanently adjusted to the proper polar elevation and the expense of the graduated quadrant be saved; a spirit-level will be useful to adjust it accurately. The instrument might be set to its proper azimuth by the sun's shadow at noon, or by means of a declination needle; but an obser-

vation with the instrument itself may be more readily employed for this purpose. Ascertain the true solar time by means of a good watch and a time equation table, set the hand of the polar clock to correspond thereto, and turn the vertical pillar on its axis until the colours of the selenite star entirely disappear. The instrument then will be properly adjusted.

"The advantages a polar clock possesses over a sun-dial are :—1st. The polar clock being constantly directed to the same point of the sky, there is no locality in which

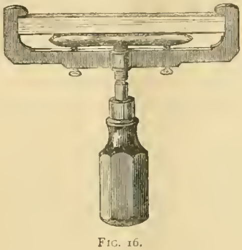


Fig. 16.

it cannot be employed, whereas, in order that the indications of a sun-dial should be observed during the whole day, no obstacle must exist at any time between the dial and the places of the sun, and it therefore cannot be applied in any confined situation. The polar clock is consequently applicable in places where a sun-dial would be of no avail ; on the north side of a mountain or of a

Fig. 17.

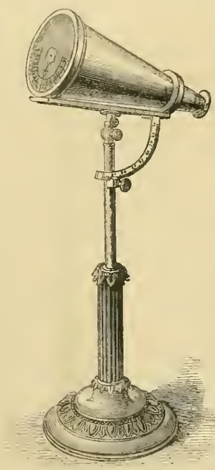


Fig. 18.—Wheatstone's Polar Clock.

lofty building for instance. 2ndly. It will continue to indicate the time after sunset and before sunrise ; in fact, so long as any portion of the rays of the sun are reflected from the atmosphere. 3rdly. It will also indicate the time, but with less accuracy, when the sky is overcast, if the clouds do not exceed a certain density.

"The plane of polarisation of the north pole of the sky moves in the opposite direction to that of the hand of a watch ; it is more convenient therefore to have the hours graduated on the lower semicircle, for the figures will then be read in their direct order, whereas they would be read backwards on an upper semicircle. In the southern hemisphere the upper semicircle should be employed, for the plane of polarisation of the south pole of the sky changes in the *same* direction as the hand of a watch. If both the upper and lower semicircles be gra-

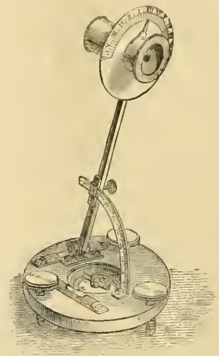


Fig. 19.—Wheatstone's Polar Clock.

duated, the same instrument will serve equally for both hemispheres."

The following is a description of one among several other forms of the polar clock which have been devised. This (Fig. 20) though much less accurate in its indications than the preceding, beautifully illustrates the principle.

"On a plate of glass twenty-five films of selenite of equal thickness are arranged at equal distances radially in a semicircle ; they are so placed that the line bisecting the principal sections of the films shall correspond with the radii respectively, and figures corresponding to the hours are painted above each film in regular order. This plate of glass is fixed in a frame so that its plane is inclined to the horizon 38° 32′, the complement of the polar elevation ; the light passing perpendicularly through this plate falls at the polarising angle 56° 45′ on a reflector of black glass, which is inclined 18° 13′ to the horizon. This ap-

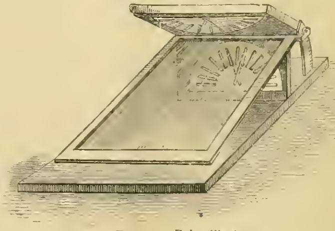


Fig. 20.—Polar Clock.

paratus being properly adjusted, that is so that the glass dial-plate shall be perpendicular to the polar axis of the earth, the following will be the effects when presented towards an unclouded sky. At all times of the day the radii will appear of various shades of two complementary colours, which we will assume to be red and green, and the hour is indicated by the figure placed opposite the radius which contains the most red ; the half-hour is indicated by the equality of two adjacent tints."

W. Spottiswoode

(*To be continued.*)

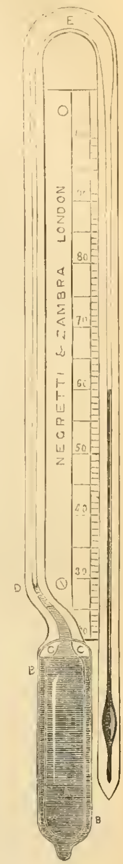
A NEW THERMOMETER

OUR readers will doubtless recollect a recent discussion in our pages relative to the priority of the invention of protected bulbs for deep-sea thermometers. The discussion has done something more than establish priority of invention, it has been the means of producing what, we believe, will prove to be a new and valuable meteorological instrument, for we have before us a paper by Messrs. Negretti and Zambra, communicated to the Royal Society by Dr. Carpenter at their last meeting, describing a new thermometer of such novel construction that it cannot fail to interest all scientific persons, meteorologists especially. We regret our inability, owing to want of space, to reproduce the paper in its entirety. The following are the main points of this communication.

In Prof. Wyville Thomson's "Depths of the Sea," p. 299, occurs the following passage :—"I ought to mention that in taking the bottom temperature with the Six's thermometer the instrument simply indicates the lowest temperature to which it has been subjected; so that if the bottom water were warmer than any other stratum through which the thermometer had passed, the observations would be erroneous."

Undoubtedly no other result could be obtained with the thermometers now in use, for unfortunately the only thermometer available for the purpose of registering temperature and bringing those indications to the surface, is that which is commonly known as the Six's thermometer—an instrument acting by means of alcohol and mercury, and having movable indices with delicate springs of human hair tied to them. This form of instrument registers both maximum and minimum temperatures, and as an ordinary out-door thermometer it is very useful ; but it is unsatisfactory for scientific purposes, and for the object for which it is now used (viz. the determination of deep-sea temperatures) it leaves much to be desired. Thus the alcohol and mercury are liable to get mixed in travelling, or even by merely holding the instrument in a horizontal position ; the indices also are liable either to slip if too free, or to stick if too tight. A sudden jerk or concussion will also cause the instrument to give erroneous readings by lowering the indices if the blow be downwards, or by raising them if the blow be upwards. It was on reading the passage in the book above referred to that it became a matter of serious consideration with Messrs. Negretti and Zambra, whether a thermometer could be constructed which could not possibly be put out of order in travelling, or by incautious handling, and which should be above suspicion and perfectly trustworthy in its indications. This was no very easy task. But the instrument submitted to the Fellows of the Royal Society seems to fulfil the above onerous conditions, being constructed on a plan different from that of any other self-registering thermometer ; and containing, as it does, nothing but mercury, neither alcohol, air, nor indices. Its construction is most novel, and may be said to overthrow our previous ideas of handling delicate instruments, inasmuch as its indications are only given by upsetting the instrument. Having said this much, it will not be very difficult to guess the action of the thermometer ; for it is by upsetting or throwing out the mercury from the indicating column into a reservoir at a particular moment and in a particular spot, that we obtain a correct reading of the temperature at that moment and in that spot.

The thermometer in shape is like a syphon with parallel legs, all in one piece, and having a continuous communication, as in the annexed figure. The scale of the thermometer is pivoted on a centre, and being attached in a perpendicular position to a simple apparatus (which will be presently described), is lowered to any depth that may be desired. In its descent the thermometer acts as an ordinary instrument, the mercury rising or falling according to the temperature of the stratum through which it passes ; but so soon as the descent ceases, and a reverse motion is given to the line, so as to pull the thermometer to the surface, the instrument turns once on its centre, first bulb uppermost, and afterwards bulb downwards. This causes the mercury, which was in the left-hand column, first to pass into the dilated siphon bend at the top, and thence into the right-hand tube, where it remains, indicating on a graduated scale the exact temperature at the time it was turned over. The woodcut shows the position of the mercury *after* the instrument has been thus turned on its centre. A is the bulb ; B the outer coating or protecting cylinder ; C is the space of rarefied air, which is reduced if the outer casing be compressed ; D is a small glass plug on the principle of Negretti and Zambra's Patent Maximum Thermometer, which cuts off, in the moment of turning, the mercury in the column from that of the bulb in the tube, thereby ensuring that none but the mercury in the tube can be transferred into the indicating column ; E is an enlargement made in the bend so as to enable the mercury to pass quickly from one tube to another in revolving ; and F is the indicating tube, or thermometer proper. In its action, as soon as the thermometer is put in motion, and immediately the tube has acquired a slightly oblique position, the mercury breaks off at the point D, runs into the curved and enlarged portion E, and eventually falls into the tube F, when this tube resumes its original perpendicular position.



The contrivance for turning the thermometer over may be described as a short length of wood or metal having attached to it a small rudder or fan ; this fan is placed on a pivot in connection with a second ; on the centre of this is fixed the thermometer. The fan or rudder points upwards in its descent through the water, and necessarily reverses its position in ascending. This simple motion or half turn of the rudder gives a whole turn to the thermometer, and has been found very effective.

Various other methods may be used for turning the thermometer, such as a simple pulley with a weight which might be released on touching the bottom, or a small vertical propeller which would revolve in passing through the water.

Messrs. Negretti and Zambra in their paper merely mention the new thermometer as being available for deep-sea temperatures ; but we believe it will prove to be of great value on land ; for with this thermometer we are at once provided with the means of making observations which will solve some of the most interesting questions connected with atmospheric temperature. At present we do not possess a *simple* instrument, in fact none at all which will automatically record *out of doors* the exact temperature at fixed periods ; we read of the temperature being so many degrees of heat or cold yesterday or last night, but we have no means of recording how cold it was (say) at midnight, or how warm at midday, except by actually watching the instrument at those hours. With the new thermometer in connection with an inexpensive time-piece, we can ascertain and re-

cord the exact temperature at any hour it may be deemed desirable, and by its means, and with experiments carried over some period of time, we may be able to determine with a degree of accuracy hitherto only approximately arrived at, which are the coldest or warmest periods of the days or nights.

ON SOME RECENT ASTRONOMICAL SPECULATIONS IN THEIR RELATION TO GEOLOGY*

I HAVE called my subject *speculations*, because in the present state of the inquiry there are so many questions that can be looked upon in no other light. At the same time it appears to me very desirable that certain facts should be examined from this new point of view, if only to lead to researches which otherwise would not have claimed attention. What I then propose is to consider the bearing on certain geological questions of the new views of Mr. Lockyer respecting the constitution of matter, as indicated by a comparison of the spectra of the various classes of stars, and the probable effects of a change in the constitution of our sun.†

Sir W. Thomson has contended that the sun cannot have continued to give out heat and light for so long a period as has been assumed by many geologists, and has concluded that it was "on the whole most probable that it has not illuminated the earth for 100 millions of years, and almost certain that it has not done so for 500 millions."‡ Prof. Huxley made this question the subject of his address to the Geological Society in 1869, but the argument on both sides was on the supposition that the constitution of matter is such that from the earliest epoch the heat and light given off had been derived mainly, if not entirely, from the simple cooling of a heated body. If, however, Mr. Lockyer's views be true, the sun at the earliest period must have consisted of matter in a more dissociated condition than at present, and, as he points out, in combining so as to give rise to other so-called elementary substances, probably a large extra amount of heat and light would be set free. The result of this appears to me to be that when the general temperature was that at which such a dissociation occurs, the sun's energy would continue nearly the same for a period which in the present state of our knowledge cannot be determined, but which would probably be of vast duration; and not only so, but the cooling would be more uniform from the first, and not subject to so great a variation as would occur in the case of an intensely-heated body cooling without any physical change in its constituents. If this be so, the length of time during which our globe may have been receiving such an amount of heat and light as would be compatible with the existence of animals and plants may well have been as great as that demanded by any of the supporters of evolutionary theories.

Though there would be such an approximate uniformity for a vast period, yet still at the earliest epoch, the physical state of the sun would not have been the same as now, and it becomes important to consider what effect this may have produced on life on the globe. According to Mr. Lockyer's views the sun at an early period had much the same physical constitution as the stars of the type of Sirius, giving off light of a whiter or bluer character, *i.e.* the rays at the blue end of the spectrum were relatively stronger than at present, whilst in future ages they would become more feeble, and the sun pass into the condition of stars of the red type. What then would be the effect of the greater intensity of the rays at the blue end of the spectrum on animals and plants at early geological epochs? This question clearly indicates the importance of future experimental inquiries, directed to this particular subject, but at the same time it may be well to consider the bearing of what is already known. In the present state of our knowledge no facts seem more likely to help towards a conclusion than those connected with the distribution in plants of the more important of the coloured substances which absorb different rays of light. I have found that there is an intimate relation between their optical and chemical characters, and that these are also related to the development of the individual plants, and to the structural development of mature plants of different classes. Taken as a whole, in advancing from a more rudimentary condition, there is in each case a farther and farther departure from such colouring-matters as can be formed artificially, and a relatively greater and greater production of those which are more and more easily decomposed by light, when not protected by the constructive energy of the living plants. This destructive action is due relatively more to the rays at the blue end of the spectrum, whilst, at all events in the case of chlorophyll, the production depends more upon the yellow rays. Hence, by relatively increasing the intensity of the blue rays the destructive force would be relatively increased, and the constructive force relatively diminished. We may, perhaps, therefore conclude that bluer light would be relatively more favourable to the higher classes of plants when in the early stage of their growth, and to the lower than to the higher classes when in the mature condition requisite to insure permanent reproduction. The former conclusion is borne out by Mr. Robert Hunt's experiments, which showed that whilst the rays at the blue end of the spectrum quicken the germination of the higher classes of plants, it is the rays at the extreme red end which facilitate their flowering and the perfecting of the reproductive organs.* The effect of differently coloured light on the growth of the cryptogamia has not, I believe, been examined; but, if the principles involved in the above arguments be correct, they would lead us to conclude that at an early epoch in the history of our globe the bluer light of the sun would be relatively more favourable to the growth of larger cryptogams than to that of phænogams. The arguments I have used do, however, involve so many new and imperfectly-tried general principles, that it would be very premature to say that the characteristic peculiarities of the vegetation of the earlier geological periods depended on this cause, and all that I contend is that the question deserves to be examined from this new point of view, since it may at all events assist in arriving at a true explanation.

* An abstract of a paper read before the Sheffield Literary and Philosophical Society, Feb 3, 1874, by H. C. Sorby, F.R.S.
† *Comptes Rendus*, Dec. 8, 1873.
‡ Brit. Ass. Report, 1861, p. 28.

* Brit. Ass. Report, 1843, p. 35.

THE "CHALLENGER" EXPEDITION†

II.

FERNANDO NORONHA

THIS group of islands was visited by the *Challenger* on September 1 and 2, 1873. They consist of a principal island, about four miles long, and three-and-a-half broad, stretching about N.E. and S.W., and several smaller ones at the eastern extremity, known as Platform Island, Booby Island, St. Michael's Mount, Egg Island, and Rat Island. They are situated in the Atlantic, in lat. 30° 50', about 200 miles from the nearest point of the South American coast, their entire length being about seven miles. The principal island is generally of a volcanic character, and hilly, the highest hill being about 600 feet. On its northern coast rises to a height of 1,000 feet what is known as the Peak. It is a peculiar-looking

† These Notes are founded on letters sent home by Mr. H. N. Mosely.

mass of bare rock, the summit of which is entirely devoid of vegetation, and quite inaccessible. The cliffs are composed of columnar basalt. At the eastern end of the island are some sand rocks, like that of Bermuda, and dunes of calcareous sand also occur. St. Michael's Mount is a cone 300 feet high, composed of a mass of phonolith. The remaining islands are flat, composed of sandstone, with volcanic particles.

It was in the dry season, which extends from July to December, that the *Challenger* visited these islands; this season, however, is not one of absolute drought, parching up everything, but there are occasional heavy rains. Trees abound on the higher parts of the island, where the land has not been cleared for cultivation, or where the convicts have not felled them for making their fishing-boats or rafts, the largest trees, it is said, having all disappeared for this purpose. Numerous creepers cluster together in the branches of the trees. At the western extremity of the island the vegetation is thickest and richest, and apparently of a virgin character. *Jatropha gossypifolia* L., a large shrubby plant, common in the West Indies, and also growing in Bahia, Mexico, and New Granada, was very abundant; it was in full flower, but its only foliage were tufts of young leaves just beneath the inflorescence, so that its bare stems were conspicuous among the green creepers. The plant was also found on St. Michael's Mount and Rat Island. Another euphorbiaceous-looking plant, with stout thorns, was found on the principal island, but not on any of the others. A thorny acacia also grew on the shore; and climbing round almost every tree was *Abrus precatorius* L., one of the commonest of tropical plants, and so well known for its pretty brilliant scarlet and black seeds, which are used everywhere for necklaces, and other ornamental purposes, and in India as a standard weight. This plant, however, grew only on the main island. *Ipomœa pes-capræ* Sw. is abundant on the sand hills, and upon it and most of the other low-growing plants, *Cuscuta americana* L., spreads amazingly. A species of *Cereus* was abundant on the cliffs, but only one grass (*Oplismenus colonus* H.B.) was found on the main island.

Trees, bushes, and creepers cover the upper part of St. Michael's Mount, which is, to a certain extent, inaccessible, and, moreover, being so small, offers no room for cultivation; therefore there is no reason to suspect that the plants found upon it are attributable to any other than a natural origin. *Capparis cynophallophora* L. grows in abundance on the summit of the mount. It is a tree with a stem 8 or 9 inches in diameter, and dark green oval lanceolate leaves. A species of Ficus with aerial roots grows in favourable spots, and there forms a tree of considerable size; one is mentioned as having a trunk 30 feet high, and 18 inches in diameter. On Rat Island the same species of Ficus was also found down near the sea level, where, instead of forming a tree, it becomes a low spreading bush, not more than 5 or 6 feet high. From the natural exposure of this island to the full force of the wind, all the plants growing here, which are mostly leguminous and euphorbiaceous, mingled with cucurbitaceous creepers, are stunted in their growth. Although shady moist places occur about St. Michael's Mount, neither on this nor on the main island were any ferns, mosses, or hepaticæ found. Lichens also are very scarce.

Among the principal cultivated fruits are bananas and melons, the latter being very plentiful, and of a peculiarly fine flavour. Grapes grow well, but are not cultivated at the present time. Sugar-cane, cassava, maize, sweet potatoes, &c. are also grown in large quantities.

Animal life is singularly scarce, two lizards being the only animals recorded from Fernando Noronha, one of which is peculiar to the island, the other being found also in North America.

NOTES

The following intelligence with regard to the late Dr. Livingstone, sent by Dr. Kirk, appears in the *Times* of Tuesday:—"Lieut. Murphy, in a note addressed to me from M'pwapwa, a place about ten days' journey from the coast, and dated the 20th of January last, says that he was then accompanying the body, and expected to reach Bagamoio, a seaport, on or about the 14th ult. Capt. Sheffe, of the Austrian ship-of-war *Heligoland*, had proceeded to the coast, and would at once convey the body and Lieut. Murphy's party to Zanzibar on their arrival. Lieut. Cameron had set out for Ujiji to recover papers left there by Dr. Livingstone. Lieut. Murphy had been in communication with him subsequent to the death of Dr. Dillon, and was sorry to find that great difficulties impeded his onward progress, owing to the antagonism of native chiefs and the desertion of many of his followers on the road from Unyanyembe to Ujiji. Chuma, who for eight years accompanied the Doctor in his wanderings, I learn had been into Zanzibar. He seems to place the position of Dr. Livingstone's death at the north of Lake Bangweolo, on or about the 4th of May, 1873. He was probably on his way westward. A reply to the official telegram, regarding the disposal of the body on arrival, was anxiously expected."

We learn that Mrs. Arnott, the widow of the late Dr. Neil Arnott, has written to Dr. Lyon Playfair, the member for the University of Edinburgh, offering 1,000*l.* for the promotion of Natural Philosophy in that University.

The trustees of the late Dr. Andrew Bell, the founder of the Madras School, St. Andrews, have placed at the disposal of the Senatus of the University of St. Andrews, his native city, a considerable sum towards the endowment of an Education Chair during the present session. The Senatus has had under consideration the subject of a teacher's degree, and a programme relating to its institution has been laid before the Education Department of the Government.

At a meeting of the Sedgwick Memorial Committee held at Cambridge on the 11th inst., Prof. Humphry in the chair, it was stated by the Treasurer that the subscriptions exceeded 10,000*l.*, and that more than 7,000*l.* had been paid into the account of the fund at the several banks. The question of the site of the new Geological Museum, which is to constitute the memorial, was discussed, and the feeling of the committee was in favour of the space in front of the New Museum and Pembroke Street.

The Italian Government has determined to send out four expeditions for the observation of the Transit of Venus, the main instrument of inquiry depended upon being the spectroscope. On the other hand, for reasons not far to seek, no spectroscopes are to be employed by the English parties. Truly "they manage these things better in France," and not only in France, but in America and Italy.

To-night (Thursday) Mr. Dewar's lecture On Dissociation will be given before the Chemical Society.

At the annual meeting of the trustees of the Museum of Comparative Zoology, Cambridge, U.S., held in January, a committee reported that to carry out the plan inaugurated by Prof. Agassiz, a considerably larger endowment will be necessary, and that the funds now on hand are not sufficient to conduct operations on the present scale later than April 1, after which, unless an additional income of 15,000 dols. can be secured, it will be necessary to greatly reduce the scale of work. 30,000 dols. per annum is estimated as being the least sum on which the establishment can be maintained on a satisfactory scale. Efforts are now being made to secure an endowment of 300,000 dols., of which about 65,000 had been contributed at a recent date.

THE Duke and Duchess of Edinburgh, on their visit to the Zoological Gardens on Sunday last, desired to have their attention specially directed to a deer sent from Manilla by his Royal Highness as a present. When it arrived in this country, in May 1870, Mr. Sclater, F.R.S., the Secretary to the Society, immediately recognised that it belonged to a species hitherto quite unknown, and he accordingly named it *Cervus alfredi* or Prince Alfred's Deer. It is a very interesting fact that this specimen, and one of the opposite sex subsequently purchased by the Zoological Society, together with a young one born in the Gardens, are the only examples that have at any time been obtained of this particularly well-marked species of deer.

THERE will be an election at Worcester College, Oxford, in June, to three Scholarships, one of which will be in Natural Science. Particulars can be had on application to the senior tutor. At the same time there will be an election at Magdalen College to not less than four Demyships and one Exhibition. Of the Demyships, one at least will be Mathematical, and one at least in Natural Science; the Exhibition will be in Mathematics. The stipend of the Demyships is 95*l.* per annum, and of the Exhibition 75*l.*, tenable for five years. For particulars apply to the senior tutor.

THE Board of Trade have been informed by the Meteorological Committee that they are now prepared to re-introduce the use of Admiral Fitzroy's signals (cones and drum) with slightly modified significations, and that the change will take effect on and after March 15, 1874. The signals to be used will consist of:—1°. Cone, point downwards for southerly gales: S.E. round by S. to N.W. 2°. Cone, point upwards for northerly gales: N.W. round by N. to S.E. 3°. Drum *with cone*, to indicate the probable approach of a *very heavy gale* from the direction indicated by the cone. The drum will not be used without the cone. The signals are to be kept hoisted *during the daylight only*, until 48 hours have elapsed from the time *the telegram was despatched*, unless countermanded. At night lanterns may be used wherever the local authorities deem it advisable to do so, as pointed out in an explanatory pamphlet, copies of which are supplied for gratuitous distribution. It will be seen from the pamphlet in question, that the meaning of the signals is that an atmospherical disturbance exists (which will be explained in the telegram) and will probably, but not *necessarily*, cause a gale at the place warned *from the direction* indicated by the signal. The Meteorological Office will supply the canvas shapes and lanterns to such places as require them, on loan; but in all cases the local authorities must undertake the charges incidental to the hoisting of the signal, such as flagstaff and gear, oil, &c., and also to the keeping of the apparatus in repair, painting, &c.

M. G. TISSANDIER, the editor of *La Nature*, is completing a series of observations for calculating the amount of atmospheric dust falling each day. The mean found is said to be several pounds in twelve hours for a surface not larger than the Champ de Mars, rather less than a half a square mile.

THIRTY-SEVEN small planets have been discovered in the years 1872 and 1873, or 18½ for each year, making 1,850 per century. From the days of Hipparchus to the present time we may reckon 2,000 years; had astronomers worked with the same zeal and success during these 2,000 years, the number of small planets known would have amounted to 37,000, only three times the number given by Arago of stars up to the 7th magnitude, and a very small proportion of the stars of the 10th magnitude. Although very minute, the latter are generally much brighter than small planets as seen at the time of opposition.

PROF. O. C. MARSH has made out some interesting points in connection with the remains of equine forms in the North American tertiaries. Following up the genealogy of the horse, as traced by Prof. Huxley in the European remains, he has been able to show that the American deposits present even a more complete series of intermediate forms. Between *Orohippus agilis* of the Eocene, which was about the size of a fox, and had four toes on the fore foot, with three behind, and *Equus fraternus* of the Pleistocene, which is not osteologically distinguishable from the existing *Equus caballus*, the following genera form the connecting links in form, size, and antiquity, viz. *Miohippus* and *Anchitherium* of the Miocene, and *Anchippus*, *Hipparion*, *Protohippus* and *Pliohippus* of the Pliocene. "Considering the remarkable development of the group through the entire Tertiary period, and its existence even later, it seems very strange that none of the species should have survived, and that we are indebted for our present horse to the old world."

IN continuation of his exquisite researches on the phenomenon of flight (*Comptes Rendus*, January 12, 1874), M. Marey has made a series of observations which prove how important a part the onward movement of a bird plays in increasing the efficiency of each wing stroke. For supposing that in its descent the wing did not continually come in contact with a fresh volume of air, it would act at a disadvantage, because the downward impulse which, at the commencement of each stroke, it gives to the air below it, would make that air so much less efficient a resisting medium; whilst, by continually coming in contact with a fresh body of air, the wing is always acting on it to the best advantage. For this reason, when a bird commences its flight, it turns towards the wind if possible, to make up for its lack of motion on starting.

THE extension of the Cinchona cultivation in Darjeeling continues. Every year additional land is brought under Cinchona culture, and it is calculated that 2,000 acres more will be cleared and planted within the next four years. With regard to Ipecacuanha, upwards of 20,000 plants and cuttings are now in hand, all of which promise well. Another interesting fact relating to the introduction of useful plants into India, is that of the success in the Terai of the Cacao (*Theobroma cacao* L.). The plants that were planted out about a year ago, were sent from Kew at the suggestion of Dr. Hooker, and they are now in a most healthy and satisfactory condition.

THE French Academy has at last published the list of candidates for the seat rendered vacant by the death of the late Dr. Nelaton. The issue is quite uncertain. M. Broca, the celebrated anatomist, has obtained only a second rank, and M. Marey is placed in the third.

FATHER SECCHI is preparing, at Gauthier Villars, a second edition of his work on the Sun, on an enlarged scale. He has quoted so largely from Mr. Lockyer's "Solar Physics" that an intended translation of this work is abandoned for the present.

QUITE a sensation was produced in the last sitting of the Academie des Sciences, by the exhibition of photographs of Spitzbergen scenery, sent by Prof. Nordenskiöld. One of these represented a meteorite nearly 18 tons in weight.

A BELGIAN paper describes an immense petrified trunk of a conifer discovered in the province of Lineburg in perfect preservation. Its length is about 33 feet, and its diameter about 20 inches.

THE *Annuaire* of the Bureau des longitudes for 1874 has been recently published. Although sold at 1½ fr., it contains chromolithographs showing solar protuberances, and an essay by M. Faye on questions relating to the sun.

THE widow of General Poncelet, one of the most distinguished French military engineers, has written to the French Institute, announcing that the whole of the works of her late husband will soon be in the hands of the public. The last volume, the sixth of the series, containing the lectures delivered at the Metz School of Artillery and the École Polytechnique, will be issued shortly. It is edited by M. Krœtz, Chief Engineer of the National Manufactures, one of the General's pupils. General Poncelet was a member of the French Institute for more than twenty years. He died in 1864.

A MEMOIR upon the embryology of *Terebratulina*, by Prof. Morse, has just been published by the Boston (U.S.) Society of Natural History, this being the result of a thorough investigation in regard to the development of this genus of the brachiopod shells found so abundantly on the coast of Maine. Prof. Morse's labours were mainly prosecuted at Eastport, and extended through a period of several years. He found that the species spawns throughout the entire summer season (at least from April to August), but that investigations in the earlier part of the season were preferable, since, with the increasing warmth, the development is more rapid than is convenient to the observer.

THE "Fenland Meteorological Circular and Weather Report" is the name of a monthly periodical, two numbers of which, for February and March, have just reached us. It is edited by Mr. S. H. Miller, F.R.A.S. The circular is intended to be "a medium for local meteorologists, an abiding record of the climate of the Fenland, and a register of the changes of the weather, to which the agriculturist, horticulturist, and naturalist may easily refer." It is intended besides, we believe, that the "Circular" should fill to some extent an educational function, and induce agriculturists to take an interest in the sciences with which their art is so intimately connected. This purpose is to be served by the publication of readable articles on scientific subjects, the first of which is by Mr. S. B. J. Skertchly, F.G.S., on the "Practical Bearings of Meteorology." The two numbers sent us contain well-constructed tabular and graphic reports of the meteorology of Wisbech for January and February, besides district reports, and a number of notes and short articles on subjects more or less intimately connected with the department to which the "Circular" belongs; the paper and typography are all that can be desired, and the price is only 2*d*. per month. The enterprise is highly creditable to its originators, and we sincerely hope it will be a great success and attain a wide circulation in the important district for whose benefit it has been started; and we hope the example thus set will be followed by other districts in the kingdom. The publishers of the "Circular" are Leach and Son, Wisbech.

A BILL has been introduced into the U.S. Congress proposing an appropriation of 7,000 dols. to enable the Department of Agriculture to make a collection of all the species of trees growing throughout the United States, and for their exhibition in suitable cases. The collection itself, when completed, is to be exhibited at the Philadelphia Centennial Exposition, but to belong to the Agricultural Department, and to be returned to it.

AT the meeting of the French Academy of March 2, M. Charles Sainte-Claire Deville, gave an account of his meteorological mission to Biskra and Tuggurt. At each of these stations an observatory has been established similar to that at Montsouris. Captain Roget superintends the observatory of Biskra, and Dr. Audet that of Tuggurt; the latter, according to M. Deville, is in an almost perfect situation, surrounded by a sufficient quantity of vegetation, and preserved from the effects of radiation. The results comprehend already observations continued during the month of January, and M. Deville sees in them the promise of important discoveries.

WE have received a useful work lately published by the Smithsonian Institution, prepared by Prof. F. W. Clark, of Howard University, Washington. This is the first part of a series entitled the "Constants of Nature," and gives in tabular form the specific gravities, the boiling and melting points, and the chemical formulæ of a large number of substances, with indications of the authorities whence the facts are derived. The volume contains about 250 pages, and is well provided with the necessary indices.

LIEUTENANT G. M. WHEELER (United States Engineers) and party are in Washington, and are engaged in elaborating the results of their explorations in 1873. Already about 76,000 square miles of territory have been carefully gone over and topographed with a view to their representation in the new series of index maps now nearly ready for publication. Much valuable information in regard to the geology of the country, its mining facilities, and the probabilities of successful irrigation, has been obtained, and will be duly published. In the line of natural history the collections have been very large, embracing at least 1,200 skins of birds, besides many hundreds of reptiles, fish, insects, &c. The botanical collection is said to be the finest and largest ever procured by a Government expedition. The results of the work of the expedition for the years 1871, 1872, and 1873 are, we understand, shortly to be published, comprising seven large quarto volumes, which will prove a valuable addition to the scientific history of the great West.

WE are glad to see, from Part IV. of the Transactions of the Clifton College Scientific Society, that that Society is exceedingly prosperous, so far as number and attendance of members is concerned, though we very much regret to learn that, like not a few other similar Societies, it contains but a small number of real workers. We hope that the patrons and office-bearers of the Society will do their best to devise some means to remedy this very serious defect, for serious the defect is, seeing that one of the main objects of such a Society is to train its members to methodical work, careful observation, and independent thinking. The only paper in this part, by a student member of the Society, is a long and elaborate one on Potteries, by C. C. Stevenson.

A THICK supplementary number of Petermann's *Mittheilungen* has been published containing a vast number of statistics relating to the population of the globe, with two excellent illustrative maps.

AT the meeting of the Adelaide Philosophical Society held on Nov. 25, 1873, Dr. Schomburgk read the second part of a long paper on poisonous plants. The plants noticed were those of the genus *Strychnos nux vomica*, *Datura stramonium* (the thorn-apple), *Solanum nigrum*, and *Taxus baccata* (the yew tree).

ACCORDING to the "Report of the Mining Surveyors and Registrars" of Victoria for the quarter ending September 30, 1873, the total yield of gold from alluvium and quartz reefs during the quarter was 291,861 ozs. 7 dwts. Appended to the Report is the continuation of Baron von Müller's description of New Vegetable Fossils of Victoria; the following are described and illustrated :—*Odontocaryon magregorii*, *Conchotheca rotundata*, and *Phytidotheca pleioclinis*.

THE additions to the Zoological Society's Gardens during the past week include a Finsch's Amazon (*Chrysotis finschi*) from W. Mexico, presented by Mr. C. Chivers; a Virginian Deer (*Cervus virginianus*) from N. America, presented by Mr. N. M. Bateson; a Cornish Chough (*Fregilus graculus*), British, presented by Mr. J. T. Hewes; a Common Otter (*Lutra vulgaris*), British, presented by Dr. Stafford; a Blue and Yellow Macaw (*Ara ararauna*) from S. America, presented by Miss J. Staines.

*THE GASEOUS, LIQUID, AND SOLID STATES OF WATER-SUBSTANCE**

IN two communications made by me to the British Association at its meetings at Edinburgh in 1871, and at Brighton in 1872, and printed as abstracts in the Transactions of the Sections for those years, considerations were adduced on relations between the gaseous, the liquid, and the solid states of matter. The new subject of the present paper constitutes a further development of some of those previous considerations, and a brief sketch of these is necessary here as an introduction for rendering intelligible what is to follow.

Taking into consideration any substance which we can have in the three states, gaseous, liquid, and solid, we may observe that when any two of these states are present in contact together, the pressure and temperature are dependent each on the other, so that when one is given the other is fixed. Then if we denote geometrically all possible points of temperature and pressure jointly by points spread continuously in a plane surface, each point in the plane being referred to two axes of rectangular co-ordinates, so that one of its ordinates shall represent the temperature and the other the pressure denoted by that point, we may notice that there will be three curves, one expressing the relation between temperature and pressure for gas with liquid, another expressing that for gas with solid, and another expressing that for liquid with solid. These three curves, it appears, must all meet or cross each other in one point of pressure and temperature jointly, which may be called the triple-point. The triple-point, considered in respect to its temperature, is in fact what would often be called the freezing point *in vacuo*; that is, the freezing temperature of water in contact with no gas except its own aqueous vapour or steam; and the pressure at the triple point is just the pressure of that aqueous gas or steam.

The curve between gas and liquid, which may be called the *boiling-line*, will be a separating boundary between the regions of the plane corresponding to the ordinary liquid and those corresponding to the ordinary gaseous state. But by consideration of Dr. Andrews's experimental results ("Phil. Trans.," 1869) we may see that this separating boundary comes to an end at a point of temperature and pressure which, in conformity with his language, may be called the *critical point* of pressure and temperature jointly; and we may see that, from any liquid state to any gaseous state, the transition may be gradually effected by an infinite variety of courses passing round the extreme end of the boiling-line.

The accompanying figure serves to illustrate these considerations in reference to transitions between the three states, the gaseous, the liquid, and the solid. The figure is intended only as a sketch to illustrate principles, and is not drawn according to measurements for any particular substance, though the main features of the curves shown in it are meant to relate in a general way to the substance of water, steam, and ice. A X and A Y are the axes of coordinates for the temperatures and pressures respectively; A, the origin, being taken as the zero for pressures and as the zero for temperatures on the Centigrade scale. The curve L represents the *boiling-line* terminating in the critical point E. The line T M represents the line between liquid and solid. It is drawn showing in an exaggerated degree the lowering of the freezing temperature of water by pressure; the exaggeration being necessary to allow small changes of temperature to be perceptible in the diagram. The line T N represents the line between the gaseous and the solid states of water-substance. The line L T N appears to have been generally (in the discussion of experimental results on the pressure of aqueous vapour above and below the freezing-point) regarded as one continuous curve; but it was part of my object in the two British-Association papers referred to, to show that it ought to be considered as two distinct curves (L T P and N T Q) crossing each other in the triple-point T.

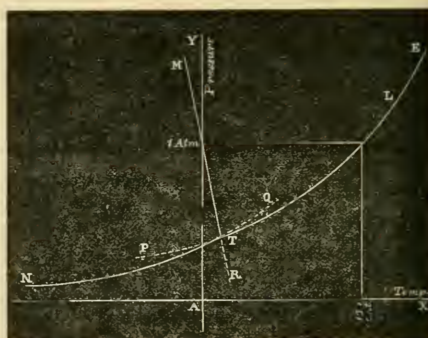
In the second of the two British-Association papers already referred to (the one read at the Brighton meeting, 1872), I gave demonstrations showing that these two curves L T and N T should meet, as shown in the accompanying figure, with a re-entrant angle at T, not with a salient angle such as is exemplified in the vertex of a pointed arch; and offered in conclusion the suggestion that the reasoning which had been adduced might be followed up by a quantitative calculation founded on experimental data, by which calculation the difference of the pressures of steam with water, and steam with ice for any given temperature very near the triple point, may be found with a very close approximation to the truth.

In the month of October 1872 I explained to my brother, Sir William Thomson, the nature of that contemplated quantitative calculation: I mentioned to him the method which I had prepared for carrying out the intended investigation, and inquired of him for some of the experimental data, or data already deduced by theory from experiments, which I was seeking to obtain. On his attention being thus turned to the matter, he noticed that the desired quantitative relation could be obtained very directly and easily from a simple formula which he had given in his paper on the Dynamical Theory of Heat, "Transactions of the Royal Society of Edinburgh," March 17, 1851, § 21 (3), to express the second law of thermodynamics for a body of uniform temperature throughout, exposed to pressure equal in all directions.

That formula is

$$\frac{dp}{dt} = C\,M$$

in which p denotes the amount of the pressure, and $\frac{dp}{dt}$ its rate of increase per unit increase of temperature, the volume being kept constant; C denotes Carnot's function; and M denotes the rate of absorption at which heat must be supplied to



the substance per unit augmentation of volume, to let it expand without varying in temperature. The body may be either homogeneous throughout, as a continuous solid, or liquid, or gas; or it may be heterogeneous, as a mass of water and aqueous vapour (*i.e.* steam), or ice and water, or ice and aqueous vapour (*i.e.* steam).

Now apply that formula, 1st, to steam with water, and 2nd, to steam with ice, the temperature of the heterogeneous body in each case being that of the triple-point, or we may for the present purpose say 0° C., which is almost exactly the same. It is to be observed that while in the general application of the formula the rate of increase of the pressure with increase of temperature, *when the volume is kept constant*, has been denoted by $\frac{dp}{dt}$, yet in each of the two particular cases now brought under consideration it is a matter of indifference whether the volume be kept constant or not; because the pressure of steam in contact either with water or with ice, for any given temperature, is independent of the volume of the whole heterogeneous body; so that the change of pressure for change of temperature is independent of whether there be change of volume or not. As C is a function of the temperature which has the same value for all substances at the same temperature, it has the same value for the two cases now under consideration. Hence, retaining for the first case (that, namely, of steam with water) the same notation as before, but modifying it by the use of an accent where distinction is necessary in the second case (that of steam with ice), and thus using $\frac{dp}{dt}$ to denote the rate of increase of the pressure per unit increase of temperature for steam with wate

* "A Quantitative Investigation of certain Relations between the Gaseous, the Liquid, and the Solid States of Water-Substance." By Prof. James Thomson, LL.D., lately of Queen's College, Belfast, now of the University of Glasgow. Communicated to the Royal Society by Sir William Thomson, LL.D., F.R.S. Abridged for NATURE by the Author.

at the triple-point (0° C. nearly), and M to denote the rate of absorption at which heat must be supplied to a body consisting of steam and water at the triple point, per unit augmentation of volume of that whole heterogeneous body, to let it expand without varying in temperature, and using $\frac{dp'}{dt}$ and M′ to denote the corresponding rates for steam with ice at the triple point, we have

$$\frac{\frac{dp}{dt}}{\frac{dp'}{dt}} = \frac{M}{M'}$$

The latent heat of evaporation of one pound of water at the freezing-point (or at the triple point) into steam at the same temperature, as determined by Regnault, is 606·5 thermic units, the thermic unit being here taken as the heat which would raise the temperature of 1 lb. of water 1° C., and the latent heat of fusion of ice is about 78 or 79 of the same thermic units. Hence, though M and M′ belong each to a cubic foot of steam at the triple point, not to a pound mass of it, still the ratio $\frac{M}{M'}$, is = $\frac{606}{79 + 606}$

Hence

$$\frac{\frac{dp}{dt}}{\frac{dp'}{dt}} = \frac{606}{79 + 606} = \frac{1}{1 \cdot 13}$$

This shows that for any small descent in temperature from the triple point (where the pressure of steam with ice is the same as that of steam with water), the pressure of steam with ice falls off 1·13 times as much as does the pressure of steam with water.

In submitting the quantitative calculation now given, I have preferred to adopt the method proposed and developed by my brother rather than that which I had myself previously devised, because his method is simpler, and brings out the results more briefly by established principles from existing experimental data. I may say, however, that the method devised by myself was also a true method, and that I have since worked it out to its numerical results, and have found that these are quite in accordance with those brought out by my brother. The two indeed may be regarded as being essentially of the same nature; and I think it unnecessary to occupy space by giving any details of the method I planned and have carried out. Its general character may be sufficiently gathered from the concluding passages of the British Association 1872 paper, as printed in the Transactions of the Sections, Brighton Meeting.

In order to discover whether the feature now developed by theoretical considerations is to be found showing itself in any degree in the experimental results of Regnault on the pressures of steam at different temperatures *, I have made careful examinations of his engraved curve (Plate viii. of his Memoir), and of his empirical formulæ adapted to fit very closely to the results exhibited in that curve, and of his final tables of results at the close of his Memoir; and by every mode of scrutiny which I have brought to bear on the subject—in fact by each of some seven or eight varied modes—I have met with clear indication of the existence of the expected feature; and by some of them I have found that it can readily be brought prominently into notice. The engraved curve drawn on the copperplate by Regnault himself is offered by him as the definitive expression of his experiments, as being an expression which satisfies as well as possible the aggregate of his observations; subject, however, to a very slight alteration, which he has pointed out as a requisite amendment in the part of the curve immediately below the freezing-point, a part with which the investigations in the present paper are specially concerned.

After telling (p. 581 of his Memoir) of the great care with which he had marked the curve on the copperplate and got it engraved, he says:—"Je n'ai pas pu éviter cependant quelques petites irrégularités dans les courbes; mais une seule de ces irrégularités me paraît assez importante pour devoir être signalée. Elle se présente pour les basses températures comprises entre 0° et − 16°, la courbe creuse trop vers l'axe des températures, elle laisse, notablement au-dessus d'elle, toutes les déterminations expérimentales qui ont été faites entre 0° et − 10°. Ainsi les valeurs, que cette petite portion de la courbe donne pour les forces élastiques, sont un peu trop faibles, et j'ai eu soin de les augmenter, de la quantité convenable, dans les nombres que je donnerai plus loin." Whether we are now to think that this bend downwards* of the curve towards the axis of temperatures involving what Regnault regarded as a small faulty departure of his drawn curve from his actual experiments, was introduced merely by a casual want of accuracy in drawing, or whether we may suppose that possibly there may have been some experimental observations which attracted the curve downwards, but were afterwards rejected on a supposition of their being untrustworthy, it appears that such a bend is a feature which the curve really ought to possess, and is one which, even after being partially smoothed off by way of correction, is not obliterated, but still remains clearly discoverable in the final numerical tables of results.

This is best brought to light by means of the empirical formulæ devised and employed by Regnault for the collating of his results. He proceeded evidently under the idea of the curve being continuous in its nature, so that a single formula might represent the pressures of aqueous vapour throughout the whole of his experiments; but before seeking for such a formula he proceeded to calculate several local formulæ of which each should represent very exactly his experiments between limits of temperature not wide apart; and afterwards he worked out several general formulæ, each adapted singly for the whole range of his experiments.

Now in the paper communicated to the Royal Society, and printed in the Proceedings for December 11, 1873, from which the present paper is an abridgment, the details of a scrutiny of the chief of these formulæ are given (the formulæ, especially, which were adopted by Regnault for deducing his final general table extending from − 32° C. to + 230° C.), from which it appears that they present clear indications that at and very close to the freezing-point (or rather the triple-point) the rate of increase of pressure for increase of temperature is decidedly less in the case of steam with water than in that of steam with ice; or, in other words, that at and very close to the triple-point the steepness of the curve for steam with water is decidedly less than that of the curve for steam with ice; or, to state the same a little more fully, that while the steepness is increasing as we ascend from temperatures below the triple-point up to the triple-point, with ice in contact with steam, there is a sudden abatement of the steepness in passing the triple-point, where the change occurs from steam with ice to steam with water, after which, with continued rise of temperature, the steepness goes on again increasing. In fact the result comes out that these formulæ, expressing an aggregate of experimental results of Regnault, would indicate for $\frac{\frac{dp}{dt}}{\frac{dp'}{dt}}$ at the freezing-point, or the triple-point, not the value 1 (as would be the case if a curve continuous past the triple-point would express the pressure of steam or aqueous vapour, for different temperatures, in contact with ice below the triple-point and with water above it), but 1·09 or 1·10, which makes a near approach to the result 1·13 found by my brother's quantitative calculation already here cited. The decimal fractions in excess of unity, here represent the quantitative relation between the greatness of the feature under consideration as brought out by the theoretical investigation on the one hand, and as deduced from Regnault's results on the other hand: and thus we may say that this feature can be brought to view as existing in Regnault's principal results in a degree about $\frac{9}{13}$ or $\frac{10}{13}$ of that in which the theoretical investigation shows that it must really exist, and ought to be found experimentally, if the experiments had a sufficiently minute exactitude to detect it and to measure it.

Regnault also gives, in the same Memoir, another statement of results deduced from his experiments, and put in the form of a table intended chiefly for meteorological purposes; which table shows the pressures of aqueous vapour for temperatures ranging below and above the freezing-point at very small intervals of temperature, $\frac{1}{10}$th of a degree centigrade each. In this table, the numbers inserted as representing the pressures below the freezing-point are slightly different from the corresponding ones in his general table, which, with the formulæ used in making it, has just now been referred to; and he mentions that this slight

* Regnault, "Des forces elastiques de la vapeur d'eau aux différentes températures," Mémoires de l'Académie des Sciences, 1847.

* In M. Regnault's curve the temperatures are measured horizontally across the sheet and pressures are measured upwards.

discrepance has resulted from the fact that the two tables were formed at different periods, and were not calculated by the same formula; but he remarks that the differences are insignificant, as they scarcely amount to ·02 millimetre of mercury in the pressures which the two tables respectively show. Here, too, as in the general table, the feature expected shows itself, though in a diminished degree. By careful examination of the minute changes of pressure for small changes of temperature, close to the freezing-point, both above and below it, as they are shown in this table, I find that the experimental results as here offered would indicate the existence of the feature in a degree about $\frac{5}{13}$ or $\frac{6}{13}$ of that in which the theoretical investigation now shows that it ought to be met with, if experiments could be made on pressures of aqueous vapour, above and below the freezing-point, with sufficiently minute exactitude.

It is indeed a great credit to the accuracy of Regnault's experiments, and to the exactitude of his results, that the results contain the clear indications they do of this feature, which only comes to view through comparison of differences of pressure represented by very minute fractions of a millimetre of mercury; and which, unless a very high order of accuracy were maintained, might have given no perceptible indication of its existence, or might readily have been made to disappear totally from the final results, through the application of the ordinary methods for clearing off small errors of observation.

SCIENTIFIC SERIALS

American Journal of Science and Arts, February 1874.—This number commences with a paper by Mr. Langley (accompanied with plate), describing studies on the minute structure of the solar photosphere, made at the Alleghany Observatory. The equatorial used had an aperture of 13 inches. The author finds that the ultimate visible constituents of the photosphere are not the "rice grains," but small *granules* composing them, and not more than 0″·3 in size. Comparing the total area covered by them with that of the whole sun, he estimates that the greater part of the solar light comes from an area of not over one-fifth of its visible surface, and which may be indefinitely less. Hence the received estimates of the intensity of the action to which solar light is due must, he thinks, be greatly increased. In the penumbra there are not only numerous small cyclones, and even right- and left-handed whirls in the same spot, but probably currents ascending nearly vertically. The action of superposed approximately horizontal currents is a prominent feature. The outer penumbral edge seems to be formed by rupture. Mr. Langley accepts M. Faye's theory as the most probable.—Prof. Pickering communicates some measurements of the polarisation of light reflected by the sky, and by one or more plates of glass. One remarkable result arrived at was, that the polarisation (from the sky) is the same, for a given solar distance, for any meridian distance; in other words, that the polarisation is the same for all points equally distant from the sun.—In a translated paper on the dissipation of electricity in gases, by a Russian physicist, M. Boboulieff, the author concludes from his experiments, that the dissipation in air (and other gases) diminishes with diminution of the pressure; and that the dissipation in hydrogen is less than in air (at the same pressure).—Mr. Verrill continues his notes on results of recent dredging expeditions on the coast of New England.—In the "Scientific Intelligence" we find a summary of a recent important memoir by Prof. Morse on the systematic position of the Brachiopoda. His avowed object is to show that in every point of their structure the Brachiopoda are true worms, with possibly some affinities to the Crustacea, and that they have no relations to the Mollusca, save what many other worms may possess in common with them.—The organisation of an American Metrological Society is announced; the design being to originate and promote measures for improving the system of weights, measures, and moneys, and bring these into relations of simple commensurability with each other.

In the number of the *Bulletin Mensuel de la Société d'Acclimatation de Paris* issued in January one of the principal papers is an article by M. Mérice on Agriculture in Brazil. This country is by nature fitted to be one of the most prolific agricultural tracts of earth in the world, so varied and abundant are its productions, and so fruitful its soil. Improved implements are necessary, and increased skill would give greatly increased results. Great strides are being taken in the "education" of various kinds of silkworms, and under the directions given in the *Bulletin* the different varieties may be properly reared on the most approved principles.—M. Carbonnier, to whom the honour is due of introducing the "Paradise fish" from China, has been successful in importing some live specimens of another species of *Macropodus*, the "rainbow-fish" of India: specimens of the *Pesca-re*, or "king-fish" of South America have also been brought to Paris from Buenos Ayres. M. E. Perris' paper on birds and insects is continued.—The recent transmission of salmon ova to New Zealand, the cultivation of lobsters in the United States, the introduction of the *Eucalyptus* in various parts of Europe, are all, amid a mass of other matter, referred to at length. The number for January, just received, gives an interesting account of the year's work at the *Jardin d'Acclimatation.* In the Bois de Boulogne experiments have been made in the cultivation of various vegetables and other useful plants, on the results of which the future utilisation of new importations greatly depends.—The notes on the cultivation of the vine and on the use of mineral manures will be found very valuable.—The question of fish culture, which has assumed such large proportions in England and America, is being taken up by the Society, and an interesting paper on the subject is contributed by M. de la Blancheu.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti: Dec. 18, 173. In this number Prof. Lombroso furnishes exact measurements of the crania of 66 Italian criminals (from various museum collections) along with an interesting analysis of those data. With reference to capacity as measured by apparent circumference, while there were a few of pretty large circumference (1 of 580, 1 of 550, 2 of 560, 2 of 540, out of 65), and a moderate number of ordinary size (8 of 530, 13 of 520), a large proportion were quasi-microcephalic (39 out of 65); and precisely 19 of 510, 8 of 490, and 12 of 500. Of 40 crania examined the mean capacity, in cubic centimetres, was 1,389; two were of more than ordinary capacity (1,610 and 1,633), 3 were of ordinary (1,500 and more), 12 had a capacity of 1,400 and more, 19 were of much inferior capacity (1,300 and more), while 4 were truly microcephalic, with a capacity of 1,100 to 1,200. Of the last, 2 were crania of assassins, 1 that of a thief, and 1 that of an incendiary (with intent to rob). Prof. Cantoni gives the concluding portion of a valuable paper in experimental physics, on the polarisation of non-conductors. He here takes up several objections urged by Prof. Righi to his opinion as to the possibility of polarising a non-conductor durably.—M. Corradi continues an historical sketch of the study and teaching of anatomy in Italy in the Middle Ages.—We also note short papers on primitive tumours of the dura mater (by M. Bizzozero), and on a remarkable appearance of the zodiacal light, and a shower of falling stars observed in some parts of Italy on December 12 last.

Bulletin de l'Academie Royale des Sciences (*de Belgique*). No. 12. In this number are given a series of papers or lectures of a somewhat popular nature, read at the public seance in December. The first is by M. Gluge, who advocates the teaching of biology in the Belgian schools.—M. d'Omalius d'Halloy follows with an argument for the hypothesis of transformation by generations of forms from a first creation, as against that of successive creations on the one hand, and that of evolution from matter on the other.—The next lecture, by M. van Beneden, is entitled "A Word on the Social Life of the Inferior Animals," and gives some curious facts in natural history, relating especially to parasites.—And lastly, we have an able lecture by M. Schwann, on the commencement and the end of the world, according to the mechanical theory of heat. The author gives a lucid exposition of the two fundamental principles of conservation and dissipation of energy, explaining, with special fulness, the doctrine enunciated by Clausius and the considerations leading to it.—The *Bulletin* further contains reports by members of the Academy on various prize-competitions. One subject proposed was the relation of heat to development of phanerogamic plants, with special reference to the periodic phenomena of vegetation. The Committee give lengthy analyses of the memoir received, to which, while of some scientific merit, the prize is not awarded. In a lecture by M. Morren on the subject, the law is elucidated, that, other things being equal, the quantity of carbon fixed by a vegetation is greater in proportion as its height is less, inasmuch as this supposes a less expenditure of movement.—Another question called for a description of the coal system of the Liége Valley. From a memoir on which the committee report favourably, it appears that instead of having twenty-five beds of coal, as had been thought since the labours

of Dumont, the district referred to contains scarcely half that number.—Several mathematical notes are given, and there is a description of three additions to the synopsis of Calopterygines, by M. Longchamps.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 12.—"Contributions to the Developmental History of the Mollusca, Sections I., II., III., IV." By E. Ray Lankester, M.A., Fellow of Exeter College, Oxford. Communicated by G. Rolleston, F.R.S., Linacre Professor of Anatomy and Physiology in the University of Oxford.

The points of greatest interest to which the author draws attention in the present memoir are :—

1. The explanation of the basket-work structure of the surface of the ovarian egg, by the plication of the inner egg-capsule.
2. The increase of the yelk by the inception of cells proliferated from the inner egg-capsule.
3. The homogeneous condition of the egg at fertilisation.
4. The limitation of yelk-cleavage to the cleavage-patch.
5. The occurrence of independently-formed corpuscles (the autoplasts) which take part in the formation of the blastoderm.
6. The primitive eye-chamber formed by the rising up of an oval wall, and its growing together so as to form a roof to the chamber.
7. The origin of the otocysts by invagination.
8. The rythmic contractility of a part of the wall of the yelk-sac.
9. The disappearance of the primitive mouth, and the development of a secondary mouth.
10. The development of a pair of large nerve-ganglia by invagination of the epiblast immediately below the primitive eye-chambers.

"The Localisation of Function in the Brain," by David Ferrier, M.A., M.R.C.P., Professor of Forensic Medicine, King's College, London. Communicated by J. Burdon Sanderson, F.R.S., Professor of Practical Physiology in University College.

The chief contents of this paper are the results of an experimental investigation tending to prove that there is a localisation of function in special regions of the cerebral hemispheres.

Anthropological Institute, March 10.—Prof. George Busk, F.R.S., president, in the chair. A paper, by Dr. A. P. Reid, was read, "On the mixed or half-breed Races of North-Western Canada." The mixed races were nine in number, viz. the progeny of (1) the Anglo-Saxon father and Indian mother, (2) the French and French-Canadian father and Indian mother, (3) the Anglo-Saxon father and mixed Anglo-Saxon and Indian mother, (4) the French father and mixed French and Indian mother, (5) the "half-breed" Anglo-Saxon and Indian as father and mother, (6) the "half-breed" French and Indian as father and mother, (7) the descendants proceeding from intermarriage of 5th class, (8) the descendants proceeding from intermarriage of 6th class, (9) the mixed or "half-breed" father and Indian mother. Those nine divisions included the principal mass of the mixed peoples of Manitoba. The French and Anglo-Saxons and their descendants rarely intermarried. The author pointed out the marked change in physique, which was common to all the classes he had enumerated, that quickly followed the removal of Europeans to American soil. The complexion becomes swarthier and more nearly resembling the type of native Americans than one would suppose. That change was due to climatic influences, to different food, and to altered customs. On the whole, there was a tendency, in all the mixed races, to the Indian rather than to the European type. They could not be said to possess any objectionable peculiarities; they were not more inclined to the abuse of alcohol or to other irregularities than the pure whites; and it would be difficult to find a people who have fewer faults. Some of the families of the pure white and pure Indian were often very numerous, sometimes reaching the number of fifteen; but four to six was the average.—A paper, by the Rev. George Taplin was read, "On the mixed races of Australia and their migrations." The author's deductions were made chiefly from linguistic data. He however recorded the fact of having met with some individuals of the Narrinyeri tribe who had light complexions and straight hair. He found also that among the Narrinyeri there were superstitions and customs identical, even in name, with those obtaining among the Samoans.—Commander Telfer, R.N., communicated notes on the discovery of burial grounds near Tiflis in Georgia. In one of the graves were found parts of a body that had undoubtedly been interred in a sitting posture. The skull of an adult was remarkably distorted, and bore a striking resemblance to the longest form of the Titicacan skulls of South America.—A paper by Miss A. W. Buckland "On the Serpent, in connection with primitive metallurgy," was also read.

Royal Horticultural Society, March 4.—General Meeting. —Lieut.-Gen. Hon. Sir A. H. Gordon, K.C.B., in the chair.— The Rev. M. J. Berkeley commented on some of the plants shown. They included *Encholirion corallinum*, a curious Bromeliaceous plant from Brazil, a fine species of Medinilla probably new, and the beautiful *Iris reticulata*, which, though a native of Persia, proved quite hardy in this country.

Scientific Committee.—Dr. Hooker, C.B., P.R.S., in the chair.—The Rev. M. J. Berkeley called attention to the following communication made by Prof. Panceri to the Institut Egyptien at its meeting on December 13, on Cryptogamic vegetation found within the egg of an ostrich, which was interesting in connection with what he had himself brought before the committee on March 5 and 19, 1873. The egg had been given Prof. Panceri at Cairo, and was still fresh, the air space having not even been formed. He soon, however, noticed the appearance of dark blotches within the shell, and having broken it open to ascertain the cause, he found that they were produced by the growth of minute fungi. Instances of a similar kind had already been studied by him, and he had communicated the results to the Botanical Congress held at Lugano in 1859. The Rev. M. J. Berkeley had found *Cladosporium herbarum* in the interior of a fowl's egg.— Dr. Masters brought shoots of *Picea nobilis*, in which the primary shoot was dead and swollen beneath the apex. In many instances he had found similar excrescences to contain the larva of an insect. In other cases the primary cause of injury appeared to be frost or cutting east winds.—Dr. Masters exhibited some peas which had been attacked by a beetle (*Bruchus pisi*) which fed on the cotyledonary portion, but left the plumule, so that the seeds still germinated.—Dr. Masters reported on the monstrous Cyclamen which had been referred to him at the last meeting. The apparent corolline whorl in the Primulaceæ is now regarded as an outgrowth from the andrœcium. In the present case there appeared to be a supplementary staminal whorl alternating with the normal one, and therefore with its members opposite to the sepals. These members, however, had become partially petaloid, and were rolled up, so that the whole flower had a superficial resemblance to a case of lateral prolification.—Mr. Grote stated that Mr. F. Moore, of the Indian Museum, agrees with Prof. Westwood, and refers the Assam Tea-bug to the genus *Helopeltis* of the Capsidæ. A Ceylon species of this bug is figured by Signoret in the *Ann. Soc. Entom. de France*, 3rd series, pl. 12, fig. 2. Two other species are known from the Indian Archipelago. The Indian species described by Mr. Peal, differs from the Ceylon species in its habit of feeding on the juice of the tea-plant; and Mr. Moore proposes to call it *H. theivora*.—Prof. Thiselton Dyer read the following extract from a letter from Mr. James Caldwell, Port Louis, Mauritius:—"I would specially call your attention to a case in which the ribbon cane has sported into a green cane and a red cane from the same head. I have at least 200 instances of it in the same plantation, and the fact has completely upset all our preconceived ideas of the difference of colour being permanent. The conversion of a striped cane into a green cane was not uncommon, but the change into a red cane universally disbelieved, and that both events should occur in the same plant incredible. I find, however, in Fleischman's 'Report on Sugar Cultivation in Louisiana for 1848,' published by the American Patent Office, the circumstance mentioned, but he says he never saw it himself."—In the report of the meeting for Feb. 11 (NATURE, vol. ix. p. 354) the word "gabsy" in line 12 should be omitted.

Mathematical Society, March 12.—Dr. Hirst, F.R.S., president, in the chair.—The following papers were read:—On certain constructions for bicircular quantics, and On a geometrical interpretation of the equations obtained by equating to zero the resultant and the discriminant of two binary quantics, by Prof. Cayley.—On the Cartesian equation of the circle which cuts three given circles at given angles, by J. Griffiths.—On another system of poristic equations, by Prof. Wolstenholme.

EDINBURGH

Royal Physical Society, Feb. 25.—Dr. John Alex. Smith, president, in the chair.—On a New Mode of Esti-

mating the Amount of Colour in Water, by Mr. J. Falconer King. Mr. King's process consists in adding to chemically pure water a standard coloured solution contained in an accurately graduated instrument until the pure water equals in colour the specimen of water under examination. The result of an estimation of colour in a water can thus be accurately recorded and preserved for future reference.—Occurrence of the Deal Fish (*Trachypterus arcticus*), near Montrose, by James C. Howden, M.D., Sunnyside.—Notes of the American Bittern (*Botaurus lentiginosus*), and some other of our rarer birds recently shot in the South of Scotland, by John Alex. Smith, M.D.—Note on a New Fossil from the Silurian Rocks in the Pentland Hills, by Mr. D. J. Brown. Mr. Brown described a section through the rocks in which the fossil occurred. The fossil he believed to be a seaweed, of which it appeared to be a frond. This is the third specimen of seaweed that has been found in these rocks.—Note on Bryozoa, from the carboniferous limestone at Longniddry Station, by Mr. D. J. Brown. Mr. Brown exhibited a fine series of Bryozoa from the lower carboniferous limestone group of Longniddry quarry, Haddingtonshire. This series of Bryozoa consisted principally of fragments of the genera *Fenestrella* and *Polypora*, the whole facies being eminently that of the carboniferous limestone, although amongst them was one fragment apparently referable to the Permian genus *Thamniscus*.—On some Peculiarities in the Geographical Distribution of the Mammalia of Greenland, as explanatory of the origin of the flora and fauna of that country, by Dr. Robert Brown, secretary. Dr. Brown considered that a great portion of the Greenland fauna and the bulk of its flora had been derived from Europe when Greenland was united, probably during or shortly after the time the Miocene beds were laid down to the European continent, by continuous land or a chain of islands, of which it is possible that Iceland, Bear Island, and perhaps even the Orkneys and Shetlands, are only fragments.

MANCHESTER

Literary and Philosophical Society, Feb. 24.—Rev. William Gaskell, vice-president, in the chair.—On the Effect of Acid on the Interior of Iron Wire, by Prof. Osborne Reynolds. It will be remembered that at a previous meeting of this Society Mr. Johnson exhibited some iron and steel wire in which he had observed some very singular effects produced by the action of sulphuric acid. In the first place the nature of the wire was changed in a marked manner, for although it was soft charcoal wire it had become short and brittle; the weight of the wire was increased; and what was the most remarkable effect of all was that when the wire was broken and the face of the fracture wetted with the mouth it frothed up as if the water had acted as a powerful acid. These effects, however, all passed off if the wire were allowed to remain exposed to the air for some days, and if it were warmed before the fire they passed off in a few hours. Prof. Reynolds subjected one of the pieces of wire to a farther examination, and from the result of that examination was led to what appears to be a complete explanation of the phenomena. He was led, from certain observations, to conclude that the effect was due to hydrogen, and not to acid, as Mr. Johnson appeared to think, having entered into combination with the iron during its immersion in the acid, which hydrogen gradually passed off when the iron was exposed. This conclusion he tested and proved to be correct by further experiments. The question appears to the author one of very considerable importance, both philosophically and in connection with the use of iron in the construction of ships and boilers. If, as is probable, the saturation of iron with hydrogen takes place whenever oxidation goes on in water, then the iron of boilers and ships may at times be changed in character and rendered brittle in the same manner as Mr. Johnson's wire, and this, whether it can be prevented or not, is at least an important point to know, and would repay a further investigation of the subject.—Dr. Ransome demonstrated the movements of the chest in respiration, showing the remarkable mobility of its several parts, and the consequent facility with which its cavity can be inflated.

BALTIMORE

Maryland Academy of Sciences, Feb. 2.—A paper was read from Prof. D. S. Martin upon the economical resources of Cornwall, embracing one of the most remarkble deposits of iron ore in America, and forming three large banks. Reference was made in the paper to the immense development of the magnetic oxide of iron in these mines, and to the fact that some of the ore exhibits marked magnetic polarity (native lode-stone). The yield is 175,000 tons annually, but the capacity is double. The minerals of unusual interest found here, with the magnetite, are lodes and coatings of cuprite, chrysocolla, azurite, malachite, and brochantite, the last named being found in no other locality in Eastern North America.

PARIS

Academy of Sciences, March 9.—M. Bertrand in the chair.—M. H. Resal communicated a paper on the theory of the "ground swell" (*houle*).—On a new spiral regulating chronometers and watches, by M. Phillips. The results of experiments made to test the isochronism of chronometers provided with the new spiral.—Researches on crystalline dissociation; estimation and division of the work done in saline solutions, by MM. P. A. Favre and C. A. Valson. A continuation of former communications on this subject.—On a particular arrangement of micrometer with movable wires proposed for the telescopes to be used for the observation of the Transit of Venus, by M. Ph. Hatt. Communicated by M. Fizeau.—New note on waves of variable height and velocity, by M. L. E. Bertin.—On the dispersion of gases, by M. Mascart. The author has determined the dispersion of air, nitrogen, hydrogen, N_2O, CO, CO_2, and CN. The dispersion of these gases bears no direct relation to their refractive power nor to their density.—On the wave-lengths and characters of the violet and ultra-violet rays of the solar spectrum, given by a photograph taken by means of a diffraction grating, by M. H. Draper. An abstract of this paper and the accompanying Alberttype print have already appeared in this journal.—Note on hydrogenised palladium, by MM. L. Troost and P. Hautefeuille. By studying the tension of the gas in the metal at various temperatures the authors come to the conclusion that hydrogenised palladium is a definite compound of hydrogen and palladium with an excess of hydrogen dissolved in it. The tension of the hydrogen is constant from the time the amount of contained gas is equal to 600 volumes; this amount corresponding to the formula Pa_2H. The authors announce a future communication on hydrides of potassium and sodium (K_2H and Na_2H). No allusion is made to the results recently obtained by Wright and Roberts by the determination of the specific heat of hydrogenised palladium.—New apparatus for determining the tannin contained in the different astringent materials employed in tanning, by M. A. Terreil. The process used depends upon the absorption of oxygen by tannin in presence of alkaline liquids.—Organogenesis compared with androgenesis in its relations with natural affinities (Classes *Selaginaceæ* and *Verbenaceæ*), by M. A. Chatin.—Reply to a reclammation of priority of M. Béchamp, by M. P. Schutzenberger.—Probable character of the first fortnight of March, by M. de Tastes. A weather prognostication.—Researches on the origin of the lithological elements of the tertiary and quaternary soils of the neighbourhood of Oran, by M. Daubrée. The author concludes from his researches that the Middle Tertiary epoch was especially an age of eruptions of a trachytic nature. M. A. Nordenskiöld presented to the Academy some photographs taken in Spitzbergen in 1872–73. Among the photographs was one of the largest known mass of meteoric iron. It was discovered in Greenland (Ovifak) in 1870. This mass weighs 21,000 kilogrs. and is about to be brought to Stockholm for the Royal Museum.

CONTENTS

THURSDAY, MARCH 26, 1874

THE SCIENCE COMMISSION'S MUSEUM REPORT

THE Royal Commission on Scientific Instruction and the Advancement of Science have just issued their fourth Report, which is mainly concerned with the principal public Scientific Museums and Collections of the Metropolis, touching also briefly on the Scientific Museums and Botanic Gardens of Edinburgh and Dublin, and at some length upon provincial Local Museums generally, and upon the means by which these last might be made widely beneficial for scientific instruction. The Report also deals with the subject of Public Lectures in connection with Museums.

The Metropolitan Museums dealt with in the Report are the British Museum, the Museum of the Royal College of Surgeons, the National Botanical Collections and Gardens, the Museum of Practical Geology, and the South Kensington Museum, with its branch at Bethnal Green. The Report of the Commission is founded upon a thorough investigation into the growth and present condition of these institutions, and the opinions of a large number of men competent to speak on the subject as to the best means of systematising the various institutions, and of enabling them to discharge efficiently the objects for which they exist. The following are the principal recommendations of the Commissioners, which we prefer to give in the words of the Report.

With regard to the Natural History Collections of the British Museum, it is recommended :—

"That a Director be appointed by the Crown, and should have the entire administration of the establishment, under the control of a Minister of State, to whom he should be immediately responsible. That the appointments of keepers and other scientific officers should be made by the Minister, after communication with the Director and with the Board of Visitors.

"That a Board of Visitors be constituted, to be nominated in part by the Crown, in part by the Royal and certain other Scientific Societies of the metropolis, and, in the first instance, in part also by the Board of Trustees ; the members to be appointed for a limited period, but to be re-eligible ; and that the Board of Visitors should make annual reports to the Minister, to be laid before Parliament, on the condition, management, and requirements of the Museum, and should be empowered to give him advice on any points affecting its administration."

With regard to the National Botanical Collections and Gardens, the Commission recommend :—

"That the collections at the British Museum be maintained and arranged with special reference to the geographical distribution of plants and to palæontology ; and that the collections at Kew be maintained and arranged with special reference to systematic botany.

"That all collections of recent plants made by Government expeditions be, in the first instance, sent to Kew, to be there worked out and distributed, a set being reserved for the British Museum ; and that all collections of fossil plants made by Government expeditions be sent to the British Museum.

"That opportunities for the pursuit of investigations in physiological botany should be afforded in the Royal Gardens at Kew."

With regard to the Museum of the Royal College of Surgeons, it is recommended :—

"That, should the fund at the disposal of the College prove inadequate for the efficient maintenance and continued extension of the Museum, it should receive support from the State, as an institution intimately connected with the progress of biological science in this country."

With regard to the Scientific Collections of the South Kensington Museum, the Commissioners recommend :—

"The formation of a collection of physical and mechanical instruments ; and they submit for consideration whether it may not be expedient that this collection, the collection of the Patent Museum, and that of the scientific and educational department of the South Kensington Museum, should be united and placed under the authority of a Minister of State."

With regard to Provincial Museums, the Commissioners recommend :—

"That, in connection with the Science and Art Section of the Education Department, qualified naturalists be appointed to direct the collection of specimens in order to supply whatever deficiencies exist in the more important provincial museums ; and also in order to organise typical Museums, to be sent by the Department of Science and Art into the provinces to such Science Schools as may be reported to be likely to make them efficient instruments of scientific instruction.

"That a system of inspection of provincial museums be organised with a view of reporting on their condition, and on the extent to which they are usefully employed, and whether the conditions of the loan or grant from the Department of Science and Art have been fulfilled."

The final recommendations are on the subject of Lectures, and are : —

"That courses of lectures be given in connection with the collection of physical and mechanical instruments, the object of these lectures being to illustrate the progress of scientific and mechanical discovery and invention.

"That the establishment of lectures on Science, accessible to all classes on the payment of a small fee, should be promoted by the Government in the great centres of population.

"That, in the first instance with the view of carrying out the preceding recommendation, the system of instruction of this kind, which has already been established by the Government in the metropolis, should be developed by the institution of courses of lectures on the principal branches of Experimental and Natural Science.

"That the proposed lectures be of two kinds (1) lectures of an elementary character on the general principles and most important facts of Science ; (2) lectures specially intended for the working classes on the application of Science to the arts and industries of the country."

Until this Report was issued no general survey had ever been taken of our Museum system, if that can be called a system the growth of which has been almost entirely the result of accident. Both in the metropolis and in the provinces there exists a large number of museums and of collections of various kinds—to a large extent, however, connected with Natural History, and in local museums with Antiquities—but in almost every case, when the history of any of these institutions is traced, it will be found that it had its origin in quite an accidental way, and that no well-defined and intelligent system has been followed in the establishment of those institutions meant for public instruction. Some of the consequences of this capricious birth and untrained growth of the institutions referred to are that, especially in the metropolis, we have a heterogeneous collection of museums that have no relation

whatever to each other, each pursuing the even tenor of its way without any regard to its neighbours ; the collections in these museums often overlap each other, thus wasting means that might be expended to better purpose in developing some well-organised common system of aid to scientific research and instruction, and consequently some departments of Science are represented and endowed almost to excess, while others of at least equal importance are not represented at all ; and although all of them have ostensibly the same objects in view, viz. to afford facilities for scientific research and for the scientific instruction of the public, some are directly under the control of a Minister of State, others are not.

If the recommendation of the Commission, that the government of the British and Patent Museums be transferred to a department of State with a responsible Minister at its head, is adopted by the Government, no doubt some of these anomalies will be abolished ; the institutions will be made to fit into each other, and their government will be reorganised on some common and intelligent system, such as that recommended by the Commission.

One of the most glaring of these anomalies is the almost exclusive representation and endowment in our public museums of the Natural Sciences ; Botany, *e.g.*, being twice endowed, in the British Museum and at Kew—while the Physical Sciences, as if they were the illegitimate offspring of man and nature, are left to pick up a living as best they may, so that had it not been for their inherent vitality they would long ago have been starved out of existence.

In our Museums and Gardens, and elsewhere, aid to research in connection with the Biological Sciences is well provided for, while students of Botany, of Zoology, and of Geology in its various departments, have abundant facilities afforded them for the practical study of these sciences. The result is that there is nothing to check the career of these sciences ; they have been rapidly extending their domain, and may go on extending it still further without much anxiety as to where the sinews of war are to come from; all this with the very best results to our country. Our readers need no reminding of the immense strides recently made by Physical Science in its various departments, departments increasing in number and complication, and of the vistas of possible discovery of the most stupendous character which have been opened up, but for which private enterprise is utterly inadequate, and which must remain shrouded in mystery unless assistance similar to that which has been so amply accorded to the favourite Natural History Sciences be also given to the hitherto neglected Physical Sciences. Physical Science, though she sees many a glorious world that she longs to conquer, and whose conquest would be fruitful of the best results, can only in sadness let her hands dangle idly by her side, because unaided she cannot reach these fields of battle. No one competent to pronounce an opinion would venture to say that Physical Science has done less for the material prosperity of this country than Natural Science ; indeed within the last few years our rapid advance has been almost entirely owing to the practical application of physical discoveries. Yet what encouragement is held out to those who are able and willing to devote themselves to research which brings no profit to the researcher, but which is fraught with ultimate benefit to the race ?

The public, as we have shown, is made familiar in our museums with the results which have been reached in the Natural History Sciences, as well as with their *matériel*, but looks in vain for any exhibition of the instruments, the methods, and equally valuable results which belong to Physical Science ; hence, no doubt, partly the reason why the latter has been hitherto almost entirely left out in the cold; it is not known, and has but little opportunity of letting the public know its history and achievements, though it has something to show of at least equal value with the umbrella or the boomerang of a conquered savage. In chemistry, heat, light, sound, electricity, astronomy in its various branches—if a student wishes to have something more than a mere book knowledge of the methods of work and of the results obtained (and there are many such students), where can he obtain it in the same way as students of Zoology, Botany, Geology, Comparative Anatomy, and Physiology can carry on the practical study of these sciences? And yet no one, we dare say, would venture to give any better reason for this state of things than that Chance, which has hitherto governed the growth of our museums, has ordered it so.

There can be now, however, no possible excuse for the continuance of this anomalous system, seeing that the Report of the Commission has thoroughly exposed it, and suggested methods whereby to some extent its glaring defects and anomalies may be remedied. If Government wish to find a model for their guidance in reorganising and supplying the deficiencies of our public museums and institutions intended for the researches of students and for popular instruction, let them turn to Appendix III. of the Report of the Commission, containing the Report of the Secretary on the Aid given by the State to Science in France. In a previous article (vol. ix. p. 217) we referred to the disgraceful condition of our Patent Museum, and contrasted it with the magnificent Conservatoire des Arts et Métiers of Paris, extracts from the long and complete catalogue of which, as well as syllabus of its well-organised courses of lectures, will be found in the Appendix referred to.

"Evil is wrought by want of thought,
As well as by want of heart."

Government can no longer plead the excuse implied in Hood's lines for neglecting to remedy the evils so forcibly brought under their notice by the Report of the Commission. If means are not forthwith taken to organise our public museums and institutions for scientific research and instruction on some intelligent system, to supplement their lamentable deficiencies, and make them as widely beneficial to the advancement of Science in all its departments and conducive to the highest instruction of the public as they are calculated to be, it can no longer be set down to ignorance, but to an utter disregard to the highest welfare of the country. In this direction the new Government have a chance of distinguishing themselves and winning for themselves an enduring and worthy popularity; let them lose no time in showing their wisdom by appointing a responsible Minister of Education whose duty it will be to keep all our public scientific and educational institutions up to the highest pitch of efficiency, to re-organise them upon some common basis, and to see that the progress of research in all branches of Science is not hampered by the want

of adequate means for its pursuit. By such means will our rulers show themselves to be the real well-wishers and benefactors of their country.

TODHUNTER'S "MATHEMATICAL THEORIES OF ATTRACTION" *

A History of the Mathematical Theories of Attraction and the Figure of the Earth from the time of Newton to that of Laplace. By I. Todhunter, M.A., F.R.S. Two vols. (London: Macmillan, 1874.)

II.

OF the great Scotch mathematician, Maclaurin, we read—"The importance of his investigations may be seen by observing how great has been his influence on succeeding writers. Clairaut, D'Alembert, Lagrange, Legendre, Gauss, Ivory, and Chasles show by reference, explicit or implicit, their obligations to the creator of the theory of the attraction of ellipsoids.

Maclaurin well deserves the memorable association of his name with that of the great master in the inscription which records that he was appointed Professor of Mathematics at Edinburgh, "*ipso Newtono suadente*." His main contribution to the theory of the figure of the earth was an exact demonstration of Newton's postulate, of which only approximate solutions had previously been given. We may note on § 260 that we have seen the French version of his "Treatise on Fluxions," "traduit de l'Anglois, par le R. P. Pezenas, Paris, 1749; 2 vols." The first volume has li. pp. of Introduction; v.-viii. *Avertissement par le traducteur* ix.-li., Translation of Author's Preface and Introduction with *Table des Matières;* then 344 pp. of text, plates, and 4 pp. of errata. The second volume has viii. pp. of contents, 322 pp. of text, plates, with 6 pp. at end (4 pp. of errata), for errata, *approbation*, and *privilége*.

The next noteworthy name is again that of an English writer, Thomas Simpson. His contributions are of eminent importance. The analysis he employed, Mr. Todhunter observes, "would not have been unworthy of Laplace himself." There is here an interesting biographical note of a kind which the writer so well knows how to introduce, and which adds a charm to the more general details. In writing our notice we have especially dwelt upon the English contributors to our subject; on the whole it can hardly be denied "that Newton's countrymen have left to foreigners the glory of continuing and extending his empire." Singularly enough Mr. Todhunter gives no account of Simpson's work, "A New Treatise of Fluxions . . . with a variety of new and curious problems." London, 1737. 8vo. This is six years earlier than the "Mathematical Dissertations." Problems XXI. to XXIII. (§§ 201-206) deal with attractions of a circular plate on a point on the axis; of a cylinder on a point on its axis; of a sphere on a particle on its surface, or any distance above it, for law varying as inverse of (distance)^2 and for (distance)^n. They correspond to Problems II., IV., V., VI. of 1823 edition of the "Doctrine and Application of Fluxions."

The great work of Clairaut, "Théorie de la figure de la terre," &c., appeared in 1743. In this branch "no other person has accomplished so much as Clairaut; and the subject remains at present substantially as he left it, though the form is different. The splendid analysis which Laplace supplied adorned but did not really alter the theory which started from the creative hands of Clairaut." Laplace, too, places it "au rang des plus belles productions mathématiques."

The expedition to Peru gave rise to much paper warfare, and Mr. Todhunter has collected together, in a useful form, the titles of the original pamphlets. We think he has overlooked the following, "Nouveau projet d'une mesure invariable propre à devenir universelle, extrait d'un memoire lû . . . le 24 avril, 1748, par M. de la Condamine," viii. pp. A copy we have consulted of No. xx. (p. 236) is dated "Plombières, juin 30, 1754." (Consult Lalande, p. 455.)

D'Alembert need not long detain us. Laplace points out that his writings want "clarté." Mr. Todhunter says of him, "The errors of D'Alembert are certainly surprising; they seem to me to indicate that he was little in the habit of enlarging his own views by comparing them with those of others. His criticisms of Clairaut prove that he had not really mastered the greatest work which had been written on the subject he was constantly studying. His readiness to publish unsound demonstrations and absolute errors is abundantly shown in the course of our criticism. On the whole the blunders revealed in the history of the 'Mathematical Theory of Probability,' and in the present history, constitute an extraordinary shade on a fame so bright as that of D'Alembert."

Here we must give an account of a work not mentioned in the History. The "Considerazioni sopra la Figura della Terra"* of Tommaso Narducci appeared about the year 1747. It comprises two Lemmas (in modern geometrical conics they would be for the ellipse (1), GN equal $\frac{CB^2\, CN}{CA^2}$, (2) radius of curvature equal $\frac{PG^3\, CA^2}{CB^4}$), and nine problems. The first problem is "Dati due gradi di meridiano e loro latidudine, trovare la ragione degl' assi, e gl' assi stessi;" the last is "Data la ragione de' due assi, che sia di 1 ad m, trovare nel meridiano un grado, che sia eguale al grado dell' equatore." It is an interesting piece of geometrical work.

In his § 490 Mr. Todhunter considers it curious that the (Cambridge) University library does not possess a complete copy of the famous work of Stay and Boscovich. His surprise will probably be increased when we state that, if we are not mistaken, neither do the libraries of the British Museum or that of the late Mr. Graves; at any rate, we do not remember to have met with Boscovich's commentary on the poem. "These writings furnish elementary accounts of the most important results which had been obtained up to their date, and reveal apparently great knowledge and judgment in Natural Philosophy." A copy of Boscovich's "Dissertatio de telluris figurâ, habita in seminario romano Soc. Jesu nunc primum aucta et illustrata ab ipsomet auctore, P. R. J. Boscovich," forms pp. 161-218 of vol. ii. of Giuliani's memoirs (cited at the foot, date 1744). In p. 184 he speaks of Maclaurin's "Fluxions" as "Newtono ipso dignissima;" there is a noteworthy passage, pp. 217, 218, and also a notice on p. xii.

* Continued from p. 380.

* It occupies pp. 225-266 of vol. iii. of the "Memoria sopra la Fisica e Istoria Naturale di diversi valentuomini," edited by Carl Antonio Giuliani, in 4 vols. (1743-1747).

of the introduction of the volume.* The date on the copy of Frisi's dissertation (not seen by Mr. Todhunter) we consulted was 1751; it contains 8 pp. of *antecessio*; 86 pp. of text, 3 plates of figures, and 2 pp. of dedication. It consists of ten chapters, and may possibly, as Mr. Todhunter suggests, have been incorporated by Frisi in his "Cosmographia" (§ 532), though it certainly was not transferred bodily; on p. 65 he gets "axis terræ ad diametrum sibi normalem erit ut 229 : 230."

We have seen one of the works alluded to in § 551, viz., that of Bouguer; it is entitled, "Opérations faites par ordre de l'Académie . . . pour la vérification du dégré du méridien compris entre Paris et Amiens." Paris, 1757. 8vo. It consists of 28 pp., including two for title, and was read March 23, 1757.

In § 717 reference is made to the account of a measurement of an arc of the meridian in Lombardy by Beccaria, published at Turin "in 1744." We know of no work by Beccaria on this subject, except the "Gradus Taurinensis." The two copies of this which we have seen are dated 1774 and 1775; possibly from its position in the book the former of these dates is intended by Mr. Todhunter. It is a scarce work.

Mr. Todhunter has in § 725 devoted more attention to a supposed work by Newton than perhaps it really deserves. At any rate, De Morgan ("Budget of Paradoxes," p. 83) greatly doubts that Newton wrote it. He remarks that it has been treated with singular silence, and the name of the editor has never been given.

Lagrange contributes a memoir, in which he arrives by analysis at the point Maclaurin had reached by geometrical methods.

The operations carried on at Schehallien for ascertaining the density of the earth are next noticed, and with the conclusion of vol. i. the history of the two subjects during the century which followed the appearance of the "Principia" is nearly completed.

Some works mentioned as not having been seen (in § 738) may here be described.

The title of D'Anville's book is incorrectly given by Lalande.† For "*la* circonférence," read *sa*; for "*de l'équateur*," read *sur les parallèles*. There are 8 pp. of dedication (to Duc de Chartres), 20 pp. of *avertissement*, 3 pp. of *privilége*, &c, 11 pp. of observations, and 147 pp. of text, with a plate.

Lalande describes very accurately the contents of the "Anecdotes physiques et morales."

Mayer's "Basis Palatina" has 6 pp. of dedication, 14 pp. *lectori astronomo*; 23 pp. are taken up with "Series et ordo triangulorum quæ ex propriis suis observationibus, anno 1763 habitis, deduxit et correxit C. M.; 2 pp. of *conspectus totius operis*.

Hennert's work (Utrecht, 1778) contains five dissertations, of which the fourth is—"Sur le mouvement que prend un corps, quand il est parvenu au centre d'attraction, et sur l'attraction considerée comme principe universel." It takes up pp. 125-166. On p. 166 he says—

"Concluons de nos recherches qu'on n'a pas assès de preuves pour admettre l'attraction comme principe universel de tous les changemens qui arrivent dans le monde matériel. Nous avons vu que la cohésion des corps ne se déduit pas sans difficulté de l'attraction. . . . . Je sens bien, qu'il reste d'autres recherches à faire sur cette matière. J'en ai ebauché quelques unes que je pourrai publier si elles me paroissoient pouvoir contribuer au progrés des sciences physico-mathèmatiques."

His fifth dissertation is "Sur la figure de la terre relativement à la parallaxe de la lune et à la navigation." It occupies pp. 167-214. In § 18 we read, "Après avoir cherché inutilement de concilier les observations avec les hypothèses, dont les astronomes ont fait usage jusqu'aujourdhui, tachons de tirer un meilleur parti de notre formule générale," &c. And in § 25, "Il résulte de nos calcules que l'hypothèse de M. Bouguer et la notre donnent plus exactement le degré de longitude que l'hypothèse elliptique qui s'écarte considérablement de l'expérience." There are 4 pp. of dedication, 11 pp. of preface (interesting and amusing), 3 pp. of contents, 214 pp. of text, 2 pp. of errata, and 3 plates.

We may here describe a volume containing "Dissertationes de uniformitate motus diurni," by Hennert and Frisius, "præmio coronatæ," Petropoli, October 10, 1783. That by Hennert contains 42 pp., and *additamenta* making up 70 pp. in all; that by Frisius goes on to p. 112, and then 40 pp. more. They treat of attraction, but are not, apparently, of much importance.

Frisius it was who first introduced the ellipsoid as distinguished from the oblatum and the oblongum; from § 669, we learn, also, that he has no hesitation in adopting the truth as to the earth's motion.

Hube's work is in 87 pp. 8vo., with 1 page of plates. Its value may be seen from the following extract § 43:—

"Demonstravimus itaque tellurem nostram omnino esse homogeneam, vel potius densitatem variam illius partium, ratione universæ massæ, nullius fere momenti esse . . . probavimus porro, pendulorum experimentis, differentiam gravitatis sub polo et æquatore, tantam esse, ut terræ forma elliptica omnino esse nequeat . . . ad finem itaque meum pervenisse mihi videor, qui tantum fuit, ut experimentorum hucusque factorum ope, summâ qua fieri potuit evidentiâ, telluris formam certo definirem ac omnia dubia, quæ in hac re jure moveri possent, tollerem; neque adeo immorabor in consectariis variis nostræ theoriæ explicandis, quoniam vera telluris forma semel certo stabilita, haud difficile est, eo colligere atque perspicere, quæ inde necessario efficiuntur."

Further particulars concerning Thomas Williams (§ 988) are given in the "Budget of Paradoxes," p. 102.

The work referred to in § 1,000, is a 4to. volume, and contains 1 page of *avertissement*, 13 pp. of introduction, 1 page of table, 94 pp. of text, and 1 page of errata (in this Houslowheat is corrected to Hounslowheat). We think we have somewhere seen the preface ascribed to Legendre; it is clear, however, from the introduction (from the words "deux de mes confrères de l'Académie M.M. Mechain et Legendre, p. xiv.) that it is due to Cassini, as Lalande correctly states. With the copy we examined was bound up "Descriptions des moyens employés pour mesurer la base de Hounslow Heath dans la province de Middlesex, publiée dans le vol. lxxv. des 'Trans. Phil.' par le Major-Général William Roy, traduite de l'Anglais par M. de Prony," Paris, 1787. There is a *discours préliminaire du traducteur* 18 pp. There is a notice of 1 page, a page of errata: the translation occupies 80 pp., there are 3 tables, and 5 planches. Mr

* We have also seen another work, the "De centro Gravitatis, editio altera, accedit disquisitio in centrum magnitudinis" (Rome, 1751), but it does not, if we remember, bear upon our subject.

† There is a very valuable copy of this work ("Bibliographie Astronomique") in the Graves' Library, containing Lalande's autograph notes, and many other interesting features.

Todhunter gives no account of this work: it is apparently a translation of the work described in § 984.

The following work by Delambre and Legendre (will this throw light on § 1,146?) does not seem to be described: it is "Methodes analytiques pour la détermination d'un arc du méridien précédées d'un memoire sur le même sujet," par A. M. Legendre. Paris, 1799. 4to.) In note ii. to "Methode pour determiner la longueur exacte du quart du meridien," par A. M. L. occurs *Legendre's Theorem.* There are 176 pp., 16 pp. of tables at the end, 5 pp. of "Observations sur quelques endroits du mémoire du cit. Delambre," par A. M. Legendre; 2 plates, 7 pp. of *avertissement*, and 4 pp. of contents.

We now close our notes with a few remarks on §§ 531, 682, and 1,584. The memoir, which neither Playfair nor Mr. Todhunter have been able to procure a sight of, is to be met with in vol. i. of the Giuliani memoirs cited above, consequently its date is antecedent to 1743. It occupies pp. 65-88, and is entitled "Problema mecanicum de solido maximæ attractionis solutum, a P. Rogerio Josepho Boscovich." The problem is, "Data quantitate materiæ punctum attrahentis, in quacunque lege distantiarum invenire solidum ipsum continens, quod maximè omnium attrahat ipsum punctum positum in axe solidi producto ad datam distantiam ob ipsius solido vertice propiore." The author gives a geometrical and an analytical solution of the problem, and concludes, "Solutio geometrica in eo huic posteriori præstat quod ibi determinatur solidum maximæ attractionis etiam inter solida omnia irregularia, hic tantum inter solida genita rotatione curvæ circa axem."

The greater part of this second volume is taken up with the important writings of Laplace, Poisson, Gauss, Ivory, and Plana.

In the case of Laplace, who was, like some other writers, not in the habit of acknowledging his indebtedness to preceding authors, the result of the investigations is to restore his reputation to its proper eminence. "In the present history, and in that of Probability, I have gone over a third part of the collected mathematical works of Laplace; and to that extent the evidence of his great powers and achievements is, I hope, fully and fairly manifested."

Our work is now nearly done; were we to make use of all our notes, we might easily double and treble what we have written.* We have noted upwards of fifty articles which are interesting as sidelights: thus, § 227, Bouguer's remarks on what we now call the "personal equation;" § 710, transformation of variables in a triple integral, and many others. The value of the index would have been enhanced had reference been made to these; as it is, the index is much fuller than in the earlier volumes, and we have detected but few errors. This is no new feature, for all Mr. Todhunter's books are most carefully got up in this respect, and we have not met with a single important error in the mathematical work; the few mistakes we have come across are easily corrected.

There are indications here and there throughout the volumes that, should the writer be able to secure the requisite leisure, he will not want for subjects to exercise his special gifts upon. We sincerely hope that he will do so at an early date, and that it may be our lot to read the results. In the course of the preparation of the present work Mr. Todhunter has published, in the Royal and other Societies' proceedings, various papers which have grown out of his investigations in the history of our two subjects.*

R. TUCKER

* In our remarks we have preferred to treat the subjects from an historical rather than from a mathematical point of view.

* Possibly some further memoirs of use might be found in the "Librorum in Bibliothecâ Speculæ Pulcovensis, anno 1858, exeunte contentorum catalogus systematicus," by Otto Struve. Petropoli, 1860.

TRAINING

Training in Theory and Practice. By Archibald Maclaren. Second Edition. (Macmillan & Co., 1874.)

WHEREVER we go, "The Boat Race" is the topic of the hour. Opinions are freely expressed as to the relative merits of the rival crews; and the risks and dangers incurred during the process of training, sturdily insisted on by some, are as obstinately denied by others. The respective values of the slow and quick stroke—the American fashion of "sliding-seats," and a variety of kindred questions, are eagerly debated, occasionally by men who really understand what they are talking about, but more frequently in order to make conversation, or, as the phrase goes, "for the sake of something to say."

In such a state of the public mind, it has by a happy chance been so ordered that the second edition of Mr. Maclaren's well-known work on Training should appear, at a moment when all will take unusual interest in its contents.

From a perusal of this treatise everyone may gather information calculated to be of service to him, not only for the time being but for the future. The man who likes to know a little of everthing, may with advantage indulge his curiosity about a subject which has perhaps hitherto been out of his line; while the father with a son in "the eight," and whose mind has been disturbed by letters in the papers, hinting at dire mischief as the outcome of training, may find substantial comfort in its pages. All those who, either from necessity or for amusement, undergo much physical exertion, will do well to imbue themselves with the author's teaching; and the "man of ease" or of sedentary occupation will find hints for health or sanitary lessons of a description which, if honestly carried out, would cause the ruin of half the doctors in London.

Mr. Maclaren uses "rowing" as the peg on which to hang his theme, and the reason he gives for so doing is as follows:—

"It is the exercise most susceptible of being influenced by a judicious system of bodily preparation, being at once an act of considerable intricacy, demanding long and assiduous practice, and an exercise of considerable difficulty, involving the possession, although not in an equal degree, of both muscular and respiratory power, to promote which is the object of all training."

The question, what is training? and what is it meant to do? he answers thus:—"It is, to put the body with extreme and exceptional care under the influence of all the agents which promote its health and strength, in order to enable it to meet the extreme and exceptional demands upon its energies." There can be no doubt that the essence of this paragraph is contained in the words "extreme and exceptional care;"—for without such care,

instances are furnished to alarmists of men "fainting by the way," and a highly valuable art is in danger of being brought into disrepute. We have no fear for the men engaged in a great race like that which takes place on Saturday—they have been carefully instructed in the proper method of training—all that experience has taught has been lavished on them, and the result is, as Dr. Morgan's statistics show, that they live as long as other portions of the civil community.

But on the other hand we do fear for the many persons who assert that they are in training for some race or other physical feat, but from whom on inquiry we learn that their notions and practice are so desultory, and so deficient in anything like scientific detail, that it is an abuse of the word training to apply it to their misdirected proceedings. They forget, or at least do not sufficiently consider, that the feat they are about to attempt will require of them, at some critical moment, a supreme effort; and that in the making of this effort, a lasting injury may be inflicted upon a frame that is only imperfectly prepared.

To them we say, "if a thing is worth doing at all it is worth doing well." Train thoroughly or not at all—you have no right to jeopardise your future by "extreme carelessness" when all bad results may be avoided by "extreme care."

In former times Diet was looked upon as of paramount importance among the agents of health in training; Mr. Maclaren, however, places exercises in the front rank, and justifies himself for doing so in the following logical and telling words:—"So long as men believe that the qualities which they covet are to be obtained from mere dietary regulations, they will neglect the real agencies which can alone bestow them; exercise, the one agent which gives, which can give, these qualities, both from its own nature and from the influence which it exerts upon all other agents of health, is, in a measure, neglected, nay, avoided, and to the imaginary virtues of diet men look for the longed-for acquisitions; they have yet to learn, they have yet to know, and to themselves realise, that power of muscle in trunk and limb, that freedom and capacity of heart and lung, that energy, stamina, strength and endurance, are not to be obtained from what they *eat*, but from what they *do*."

To each of these subjects, Exercise and Diet, a separate chapter is devoted; and each is treated in a masterly and exhaustive manner. Our space will not, however, permit of more than an allusion to them. Mr. Maclaren deprecates the error of confining the attention to any one form of exercise, on the ground that it must be insufficient to produce the desired result, that is to say, the increased action, and thereby the fuller development, of all the muscles of the body. He illustrates his meaning by the example of the man who, having one favourite author or favourite object of study, fails to cultivate or employ his *whole* mind. On the subject of Diet he is much less stringent and exclusive than is customary, and we think rightly so, recognising the fact that each one must be a law to himself; whence the truth of the trite saying, "What is one man's meat is another man's poison." His views on this point may be summed up in his own words: "I would only advocate the rational system of not suddenly breaking in upon a man's fixed habits, at the time you are asking for an effective display of his greatest bodily energies."

Another moot point, the question of the amount of sleep required by different persons under the same circumstances, is next discussed. No hard and fast rule is laid down, but the breadth of view that is one of the great charms of the book is again apparent. The opinion is expressed that the time to be devoted to the purpose should vary not only with the individual, but with the same individual at successive periods of life, and that the wants of the system, in this respect, are influenced by various causes, and by the action of the other agents of health, especially by exercise. With reference to this matter, we have frequently observed that tall persons require a longer period of recumbency than short, whose hearts are called upon for less powerful exertion, by reason of the smaller height of the column of blood that they have to sustain and propel.

The chapters next in order deal with the important but still subsidiary questions of air, bathing, and clothing. We cannot at present enter into detail with regard to any of these subjects, but we would add to Mr. Maclaren's observations on bathing, that one great secret of using a cold bath in the dressing-room without discomfort or injury, is to sit down in the water in the first instance, and to wash the upper part of the body, thus somewhat raising the temperature of the water before the feet are immersed.

The concluding portion of the book is devoted to very clear and practical directions for self-training for aquatic purposes, and in this, as in all other parts, it will be found a complete and trustworthy guide by those for whose use it is intended.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Herbert Spencer versus Thomson and Tait

A FRIEND has lent me a copy of a pamphlet recently published by Mr. Herbert Spencer, in which certain statements of mine are most unsparingly dealt with, especially in the way of attempted contrast with others made by Sir W. Thomson and myself. I am too busy at the present season to do more than request you to reprint one of the passages objected to (leaving it to your readers to divine to what possible objections it is open), and to illustrate by a brief record of my college days something closely akin to the mental attitude of the objector.

"Natural philosophy is an experimental, and not an intuitive science. No *à priori* reasoning can conduct us demonstratively to a single physical truth" (Tait, *Thermodynamics*, § 1).

One of my most intimate friends in Cambridge, who had been an ardent disciple of the late Sir W. Hamilton, Bart., and had adopted the preposterous notions about mathematics inculcated by that master, was consequently in great danger of being plucked. His college tutor took much interest in him, and for a long time gave him private instruction in elementary algebra in addition to the college lectures. After hard labour on the part of each, some success seemed to have been obtained, as my friend had at last for once been enabled to follow the steps of the solution of a question involving a simple equation. A flush of joy mantled his cheek, he felt his degree assured, and he warmly thanked his devoted instructor. Alas, this happy phase had but a brief duration; my friend's early mental bias too soon recovered its sway, and he cried in an agony of doubt and despair, "But what if x should turn out, after all, *not* to be the unknown quantity?"

Compare this with the following extract from Mr. Spencer's pamphlet:—

"... if I examine the nature of this proposition that 'the properties of matter *might have been*' other than they are. Does it express an experimentally-ascertained truth? If so, I invite Prof. Tait to describe the experiments!" P. G. TAIT

Animal Locomotion

MY former letter on this subject was merely to show that, mechanically, Dr. Pettigrew's view of the forward motion or inclination of a bird's wing during the down stroke was less absurd than had been supposed, and even seemed necessary to flight. I did not profess to have made accurate observation or experiment on the point. I accept, therefore, the observation of the Duke of Argyll as to the vertical motion of the heron's wing; but as he expressly refers to its great concavity, that would give a vertical down stroke the effect of a somewhat forward stroke of a flatter wing. The proper inference would therefore seem to be, that in birds with less concave wings the stroke is slightly directed forwards. As to the last two paragraphs of his Grace's letter, he will see, if he refers again to mine, that he has quoted words I never used. I impute to Dr. Pettigrew the "merit of showing" that the "*slight upward angle* of the mean position of the wing plane is essential to secure horizontal forward motion *as* a general resultant," &c., and this is exactly what the Duke denies.

Mr. James Ward's elaborate analysis of the down stroke of a bird's wing simply shows (if correct) that in the position he ascribes to it (moving downward and backward) it would send the bird horizontally forward. Of course it would. But then what becomes of the bird during the up stroke in an opposite direction? The bird is then falling, and by the downward reaction of all the solid surface of the anterior margin of the wing, and of all the feathers, however obliquely turned, it is driven farther downwards; and as this takes place between every two down strokes, and approximately during an equal space of time, how is a horizontal average motion to be produced unless the down stroke alone produces, not a horizontal, but a highly-inclined upward motion? Mr. Ward's whole argument appears to me to ignore the great downward reaction, added to gravitation, during every up stroke, which requires that the down stroke should not merely support the bird, but raise it up vertically just as much as during the up stroke it has fallen vertically. The matter, however, is not to be settled by discussing theoretically, but by observation and experiment. I simply maintain that the results of Dr. Pettigrew's observations and experiments are not, as supposed, inconsistent with mechanical principles; and nothing in your correspondent's letter induces me to alter that opinion.

ALFRED R. WALLACE

The Newfoundland Cuttle-Fish (*Megaloteuthis harveyi* S. Kent)

MY right being questioned, through an anonymous paragraph in the *Globe* of the 11th inst., to institute a new generic title for the gigantic Cephalopod encountered off Newfoundland, and of which I communicated an account to the Zoological Society's meeting of March 3, I would briefly reply to my criticiser in these columns.

In the first place, it is a somewhat anomalous proceeding to raise objections on such a question before details of the grounds upon which it has been deemed advisable to establish such a title have appeared, as in the ordinary course of events they will, in the "Proceedings" of the Society. In these it will be found that ample reasons are given for the course that has been taken, as also due notice of both Prof. Steenstrup's and Prof. Verrill's researches in a similar direction. Had my assailant placed himself more thoroughly *au courant* with the details of the case, he would possibly have held back his emphatic assertion that Prof. Verrill had "actually identified the species from Newfoundland with those described by Steenstrup as belonging to his genus *Architeuthis*." This identification in Prof. Verrill's own language is entirely problematical, and must unfortunately remain so, since a beak only, an organ of no value in generic discrimination, has been preserved of the typical species *A. dux*. Respecting the second form, *A. monachus*, we have still less knowledge, the title being provisionally instituted by Prof. Steenstrup for the reception of two gigantic Cephalopods cast on the shores of Jutland in the years 1639 and 1790, and of which popular record alone remains.

In reference to the "imperfect evidence" asserted by my critic to be at my command, I may state that I received accounts of the examples, upon which I have proposed to base my new title of *Megaloteuthis*, direct from America as long ago as in the beginning of December last, supplemented by numerous fuller details since.

W. SAVILLE-KENT

Lord Lindsay's Expedition

THE expedition of Lord Lindsay for observation of the Transit of Venus at Mauritius (why will people still call it *the* Mauritius?) will afford a good opportunity for re-measuring the base line of Abbé de la Caille, made in 1753, and which, to the best of my belief, has never been since verified.

The small conical cairns which mark its extremities should still be found *in situ*. I saw one only of them in November 1864, when I had not time to search for the other. The base measured was 1,828 toises in length, and, I imagine, on the meridian. It was on a level plain at the south-west extremity of the island, close under the western slopes of the precipitous and noble "Morne du Brahant," which rises nearly 1,700 feet above the sea-level. By road the distance of this spot from Port Louis must be at least 30 miles, but it is much more easily reached direct by boat; or, as December is a bad time of year for boating outside the reefs, the best route would be from Black River by water inside the isle Bénitier. It is a glorious district, all that part of the island, and contains the finest scenery, including the Chamaral Falls.

S. P. OLIVER

Buncrana, near Londonderry, March 14

QUETELET

ON February 17 last Jacques-Adolphe-Lambert Quetelet died at Brussels, in the seventy-eighth year of his age, having been born on February 22, 1796, at Ghent. At the early age of 18 he was appointed Professor of Mathematics in the College of his native town. In July, 1819, the degree of Doctor of Science was conferred on him by the University of Ghent, then recently founded by King William. His dissertation on this occasion was so well received that he was shortly thereafter appointed to the Chair of Mathematics at the Royal Athenæum of Brussels; and in February following was elected a member of the Academy of Sciences and Belles-Lettres.

At this time he applied himself with ardour to the cultivation of literature and pure mathematics, thus laying a sure foundation for the world-wide fame he afterwards achieved as an exact investigator in many departments of physics, as an original thinker in applying methods of scientific treatment to the discussion of problems previously considered as belonging exclusively to moralists and divines, and as a clear and eloquent expounder of the truths he had demonstrated. The many-sidedness and fertility of his mind may be seen from his scientific memoirs enumerated in the Royal Society's Catalogue of Scientific papers, amounting at the close of 1863 to 220. He continued to write almost to the last, notwithstanding the mental malady, consisting in loss of memory, with which he was afflicted many years before his death, and it is noteworthy that even to the last his handwriting retained much of the rare grace and elegance for which it had been so remarkable.

The earliest of Quetelet's published memoirs, begun in 1820, were on geometrical subjects. The non-appreciation of these by the public determined him to devote himself to physical science and astronomy. On these subjects he lectured publicly with great success.

In 1823 he was sent on a mission to Paris with the view of preparing a report on the observatory of that city for the guidance of the Belgian Government in founding a similar observatory at Brussels. After some delay, the observatory was established, with Quetelet as director, and in 1833 began the long series of observations on astronomy, meteorology, and other physical inquiries, for which this observatory is so well known. The most important of his astronomical observations was the prepara-

tion of a catalogue, begun in 1857, of stars which seem to have appreciable motion. He also began, so early as 1836, systematically to observe and record the occurrence of meteors and shooting-stars. These observations came to be of great value thirty years later, when the true nature of these bodies was satisfactorily established.

The meteorological observations at this observatory have been particularly full and valuable, embracing hourly and bi-hourly observations, published annually *in extenso*, of atmospheric pressure, temperature, humidity, rain, cloud, &c. These have been exhaustively discussed by Quetelet in "La météorologie de la Belgique comparée à celle du globe," published in 1867. In this admirable treatise we have what must still be regarded as the fullest and best account of the meteorology of any single locality on the globe—the yearly, monthly, daily, and hourly march of the various meteorological elements being given. In the same volume are given *résumés* of the observations made at the other stations which began to be established at Alost, Ghent, Liége, &c., in 1835.

He was elected perpetual secretary of the Academy of Sciences and Belles-Lettres in November 1834, and was chiefly instrumental in adding a section on the Fine Arts in 1845. It is scarcely necessary to refer to the scientific contributions he made to the Fine Arts, by his extensive and minute investigations regarding the proportions of the human body, the results of which are given in his "Anthropométrie." In matters relating to the higher education, to the census, and other national questions, the Belgian Government wisely availed itself repeatedly of his wide knowledge and great experience.

His first paper on the subject of statistics was published in 1826; in 1835 appeared his "Physique sociale," and ten years later his "Lettres sur la théorie des probabilités appliquées aux sciences morales et politiques." In 1841 a Central Commission of Statistics was established by royal decree, of which Quetelet was made president, and of which he continued to be president to his death. He originated the idea of convening an International Congress of Statistics. The first was held in Brussels in 1853, and others have since been held at Paris, London, Berlin, Florence, the Hague, and St Petersburg. It is in the field of statistics that Quetelet appears as a great discoverer, and his success in this department must be attributed to the clearness with which he saw that statistics occupy the ground in the development of the social and political sciences which observational data do in the development of such sciences as astronomy and meteorology, to the patient industry with which through long years he gathered together his facts, and to the mathematical skill he brought to bear on the discussion of the results. He was truly, as expressed by the Academy of Berlin in their congratulatory letter on the occasion of the centenary of the Belgian Academy, "the founder of a new science which proceeds from the firm basis of observation and calculation to discover and unfold those immutable laws which govern the phenomena, apparently the most accidental, of the life of man, down even to his most trivial actions."

SCIENTIFIC RESULTS OF THE "POLARIS" ARCTIC EXPEDITION

WE have received advanced sheets of the Report of the Secretary of the United States Navy, of the examination of those of the crew of the *Polaris* who were in the ship when she broke loose from the floe to which she was anchored, on October 15, 1872, leaving the nineteen persons on the sheet of ice which was their floating home, until picked up about six months after off the coast of Labrador (NATURE, vol. viii., p. 217). This report confirms the opinion we have already expressed that no Arctic expedition can be adequately conducted unless carried out under naval discipline. It was only on account of the good intentions and good nature of the crew, especially after their noble and enthusiastic captain's death, that things went on as smoothly as they did. Captain Buddington seems to have had no heart in the object of the expedition, and we cannot help thinking that had he not been with it much more would have been gained. It was in deference to his opinion that Captain Hall refrained from trying to push beyond his furthest point (82° 16′ N.) with the ship; all the other officers, though they do not seem to have been very well assorted, being of opinion that an attempt should be made to get further north, or at least not to lose ground by wintering further south.

We have already (vol. viii., p. 435) given details as to the rescue of those who were left in the *Polaris*, and of their being landed in Scotland by the *Arctic* and *Eric* whalers. The present report affords some idea of the scientific results of the expedition, a detailed account of which will no doubt by and by be published, although we regret to see that many of the records of the scientific results were lost in the confusion incident to the parting of the ship from the floe. Still much that is valuable has been brought home, from which many additions to a scientific knowledge of that part of the Arctic region will be obtained. Notwithstanding the want of perfect harmony among the officers, the scientific work of the expedition seems to have been diligently carried on, and the evidence of Dr. Bessels especially contains a great deal of value to Science. Geographers will be able to correct and extend their maps of the regions visited, and we hope that very soon the complete material for enabling them to do so will be in their hands. Constant and careful tidal observations were carried on, with the very valuable result of ascertaining that the tide of Thank-God Harbour, 81° 38′ N. is not produced by the Atlantic but by the Pacific tidal wave. "It was found," Dr. Bessels says, "that the co-tidal hour is about $16^h\ 20^m$. Rensselaer Harbour, being the northermost station, has its co-tidal hour at $18^h\ 04^m$, consequently the tide comes from the north, the rise and fall at spring-tides amounting to about 5 ft.; at neap tides $2\frac{3}{10}$. Most likely the two tidal waves meet somewhere in Smith Sound, near Cape Frazier. Kane and Hayes have both found a ridge of hummocks near Cape Frazier, and in drifting down we experienced that during some time, being abreast of Cape Frazier; we hardly made any headway, but we drifted both north and south."

The results of the expedition may be summed up briefly as follows:—(1) the *Polaris* reached 82° 16′ N., a higher latitude than has been attained by any other ship; (2) the navigability of Kennedy Channel has been proved beyond a doubt; (3) upwards of 700 miles of coast-line have been discovered and surveyed; (4) the insularity of Greenland has been proven; and (5) numerous observations have been made relating to astronomy, magnetism, force of gravity, ocean physics, meteorology, zoology, ethnology, botany, and geology, the records of which were kept in accordance with the instructions supplied by the National Academy, and some of the results of which we propose briefly to enumerate.

ASTRONOMY.—Great care was taken in determining a reliable meridian at Thank-God Harbour. Soon after entering winter-quarters an observatory was erected on the shore, thirty-four feet above mean sea-level, and the transit instrument stationed there. The longitude of this station was determined by the observation of 300 lunar distances; a number of moon culminations; a great number of star transits; a number of star occultations; a great number of altitudes of the sun on or near the prime vertical. Its latitude, by the observation of a great number of circummeridian altitudes of the sun, and a number of altitudes of stars. All of these observations were lost, but a number of the results have been preserved which are sufficient to establish the position of his station.

The instruments used in the above observations were a Würdemann transit and Gambey sextants divided to 10". The expedition carried six box chronometers made by Negus, three of which indicated sidereal time, and four pocket chronometers by different English makers. These time-pieces were compared every day at precisely the same time, and the result entered in the chronometer-journal.

Besides the above-mentioned observations, twenty sets of pendulum experiments were made, which are saved, but the observations for time belonging to them are lost.

MAGNETISM.—The magnetic observations obtained were more complete than any others ever before made in the Arctic regions. The instruments supplied were:—one unifilar declinometer; one dip circle, with Lloyd's needles; one theodolite; and several prismatic compasses.

The observations on variation of declination were registered at Göttingen time, and were continued for five months: readings taken hourly. Besides that, three term days were observed every month, according to the Göttingen regulations, one of these term days corresponding with the day accepted by all the magnetic stations. Further, a number of observations were taken either with the theodolite or the prismatic compass. Whenever possible, the dip was observed, and several sets of observations on relative and absolute intensity and of the moment of inertia were obtained.

OCEAN PHYSICS.—Unfortunately there was not much opportunity for taking soundings. About twelve were obtained along the coast of Grinnell Land, which prove that the hundred-fathom line follows the coast at a distance of about 15 miles in Smith's Sound. One of these soundings (90 fathoms) proved highly interesting, containing an organism of lower type than the *Bathybius* discovered by the English dredging expedition. It was named *Protobathybius robesonii*.

A number of deep-sea temperatures were taken with corresponding observations on the density of the water. Following the coast of West Greenland the limits of the Gulf Stream were ascertained. Specimens of water from different depths were preserved in bottles, but were, unfortunately, lost.

As soon as the vessel was fairly frozen in, a tide-gauge was erected over a square hole cut in the ice-floe, and kept open continually; the pulley and rope were supported by a tripod of oars. A rope, to which a wooden scale, divided into feet and inches, was fastened, was carried through a block attached to the tripod. One end of the rope was anchored at the bottom by means of two thirty-two pound shot, and a counterpoise was attached to the other end to keep the rope properly stretched. This apparatus was tested by a series of scale readings with corresponding soundings, and proved to work very satisfactorily. The observations comprise eight lunations, the readings being taken hourly, half-hourly, and in some instances every ten minutes, in order to determine the precise moment of the turn of the tide.

METEOROLOGY.—After having entered winter-quarters meteorological observations, which up to this time had been made three-hourly, were made every hour, Washington time. The register contained observations on the temperature of the air, atmospheric pressure, psychrometrical observation, direction and force of wind, appearance of the sky, state of weather, and both solar and terrestrial radiation. Besides, all extraordinary meteorological phenomena were carefully noted.

For the registration of the temperature of the air mercurial thermometers were used for temperatures down to $-35°$ F.; for lower ranges spirit instruments being compared at intervals of 10°. As circumstances would permit, mercurial or aneroid barometers were used. As it was not supposed that psychrometrical observations could be favourably conducted at very low temperatures, the expedition was not supplied with the suitable instruments. For that reason two uncoloured spirit thermometers were selected and used, the readings of which agreed. As check observations the dew-point was determined by means of Regnault's apparatus. To measure the velocity of the wind, Robinson's anemometer usually served. The distance travelled by the wind was noted hourly, at the same intervals of time. The velocity of the wind was determined either by the same instrument or by means of Casella's current-meter. These observations on the winds, combined with those on moisture of the atmosphere, will form a valuable contribution to physical geography.

It was not thought essential to procure photographs of the clouds, as they do not differ in their general character from those in more southerly latitudes. The only remarkable fact to be noticed is that sometimes cirri could be observed at very low altitudes among stratus clouds, which, however, is not surprising if their mode of formation is taken into account.

Special attention was devoted to the aurora borealis, which occurred frequently, but rarely showed brilliant colours, never bright enough to produce a spectrum. Whenever necessary one observer was stationed at the magnetometer and the other out-doors, the former observing the motions of the magnets, while the other was watching the changes in the phenomenon and taking sketches. Although an electroscope and electrometer were set up, and the electrical condition of the atmosphere frequently tested, in no instance could the least amount of electricity be detected. The amount of precipitation was measured as carefully as the violent gales would permit, by means of a rain-gauge supplied with a funnel. In February, as soon as the sun re-appeared, observations on solar radiation were commenced, and continued throughout the entire summer. The instruments employed were a common black-bulb thermometer, and one *in vacuo*; both exposed on white cotton.

ZOOLOGY AND BOTANY.—The collections of natural history are almost entirely lost. With the exception of two small cases containing animals, minerals, and one package of plants, nothing could be rescued. The character of the fauna is North American, as indicated by the occurrence of the lemming and the musk ox. Nine species of mammals were found, four of which are seals. The birds are represented by twenty-one species. The number of species of insects is about fifteen, viz.: one beetle, four butterflies, six diptera, one bumble-bee, and several ichneumons, parasites in caterpillars. Further, two species of spiders and several mites were found. The animals of lower grade are not ready yet for examination.

The flora is richer than could be expected, as not less than seventeen phanerogamic plants were collected, besides three mosses, three lichens, and five fresh-water algæ.

GEOLOGY.—Although the formation of the Upper Silurian limestone, which seems to constitute the whole west coast north of Humboldt Glacier, is very uniform, some highly interesting and important observations have been made. It was found that the land is rising, as indicated, for instance, by the occurrence of marine animals in a fresh-water lake more than 30 feet above the sea-level and far out of reach of the spring-tides. Wherever the locality was favourable the land is covered by drift, sometimes containing very characteristic lithological specimens, the identification of which with rocks in South Greenland was a very easily accomplished task. For instance, garnets of unusually large size were found in latitude 81° 30′, having marked mineralogical characteristics by which the identity with some garnets from Fiskernaes was established. Drawing a conclusion from such observations it became evident that the main line of the drift, indicating the direction of its motion, runs from south to north.

THE COMMON FROG*

XII.

So much for the circulation of the frog in its adult condition. Its larval, or tadpole stage, presents us with a series of changes which, though more familiar, are not less wonderful.

In the first place, however, it may be well to describe shortly the condition of the circulation in fishes, where the purification of the blood is effected, not by means of the exposure of the blood to the action of air taken into respiratory cavities of the body, but by its subjection in little plates of membrane, the gills, to the influence of air mechanically mixed up with and dissolved in the water in which those gills are bathed.

In fishes, moreover, unlike all air-breathing animals, none of the oxygenated blood is returned to the heart for propulsion, but is collected directly into the great dorsal aorta, whence it is distributed to the whole body, only being returned to the heart after such distribution, so that venous blood alone enters that organ.

This venous blood is sent out from the heart through a bulbous aorta, whence arise on each side a series of arteries which ascend the branchial arches, one on the outer side of each such arch, decreasing in size as it ascends.

Each branchial artery gives off small gill arteries, which run along one edge of each little membranous leaflet or gill, and supply it with minute branches ending in capillaries, in which the blood is purified. There the purified blood is taken up by minute veins which open into gill veins, one of which runs along the opposite edge of each gill to that occupied by the gill artery.

The gill veins pour their contents into branchial veins, one of which ascends the outer side of each branchial arch, increasing in size as it ascends. The branchial veins open into the great dorsal aorta, whence the blood is distributed over the body. Generally the branchial arteries are only connected with the branchial veins by the intervention of the capillary vessels of the gills. Sometimes, however (as *e.g.* in the mud-fish, *Lepidosiren*), the branchial veins are directly continuous with the branchial arteries.

In the tadpole, while the gills remain fully developed, a condition exists quite similar to that of fishes. Minute vessels, however, directly connect together, at the root of each gill, the branchial artery and branchial vein of each gill. Such a connecting vessel is termed a *ductus botalli.*

A minute vessel given off from the third branchial artery, is the incipient pulmonary artery.

As development proceeds, as the gills diminish by absorption, and as their respective arteries and veins decrease in size and importance, each *ductus botalli* increases until at last we have established the six great continuous vessels of the adult frog.

We have, then, in the life-history of the frog, a complete transition from the condition of the fish to that of a true air-breathing vertebrate, as regards its circulation. The various conditions herein referred to have, however, an important bearing on the question of the first origin of such structure.

All higher animals, even the very highest, have the great arteries, when they first appear, arranged substantially as in fishes.

From the common aortic bulb five vessels ascend each side of the neck, and more or fewer of these arteries abound in different classes, the permanent adult condition being arrived at by this circuitous route.

This argument has commonly been adduced as an argument in favour of the descent of air-breathing animals from more ancient gill-bearing forms, and it is not without weight.

* Continued from p. 369

Nevertheless it must be borne in mind that the primitive condition in Fishes is that of direct continuity between the branchial arteries and veins such as we have seen exists permanently in *Lepidosiren*. It is only as development proceeds that each primitive continuous arch

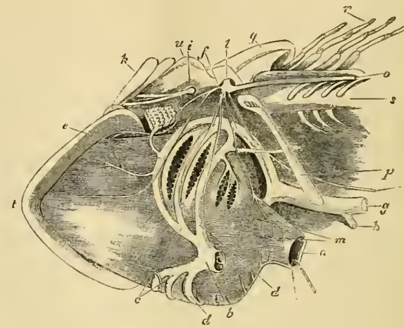


FIG. 78.—Infero-lateral view of Head and Aortic Arches of Lepidosiren (after Hyrtl). *a*, œsophagus; *b*, anterior end of bulbus aortæ; *c*, common roots of the first aortic arches; *d*, third aortic arch; *e*, first aortic arch; *f*, dorsal union of the first three aortic arches; *g*, aorta; *h*, cœliac artery; *i*, exit of the fifth nerve; *k*, part of operculum; *l*, exit of the nervus vagus from the skull; *m*, branches to œsophagus; *n*, nerve going to the rectus abdominis; *o*, nervus lateralis; *p*, first and hypertrophied rib; *q*, posterior part of the skull; *r*, segmented neural spines; *s*, chorda dorsalis; *t*, mandible; *u*, quadrate.

becomes broken up into an artery and a vein connected by a net-work of capillaries.

Now we can understand the series of unbroken arches in higher animals as the relics of ancestral vessels which divided for gill circulation and were therefore once of extreme functional importance and utility. But how can we understand the primitive unbroken series of arches in Fishes? Their utility was yet to come!

The frog when adult has, besides its skin, no breathing organs but the lungs. As has been said before, other members of the Frog's class retain gills and aquatic respiration during the whole of life, as for example *Menobranchus.*

Every one kind, however, whether provided permanently with gills or not, develops lungs, and it might easily be imagined that similarly every gilled-creature which has lungs is also a Batrachian.

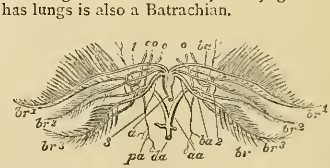


FIG. 79.—The Circulation of a Tadpole in its primitive stage, when nearly all the blood is distributed to the gills; the pulmonary arteries being quite rudimentary, and the vessel (or ductus botalli) connecting together the branchial artery and vein at the root of each gill being minute. *a*, bulbus aortæ; *b*, branchial arteries; *br1*, *br2*, *br3*, the three gills (or branchiæ of each side); *bv*, the branchial veins which bring back the blood from the gills—the hindermost pair of branchial veins on each side unite to form an aortic arch (*aa*), which again unites with its fellow of the opposite side to form *da*, the descending (or dorsal) aorta. The branchial veins of the foremost gills give rise to the carotid arteries, *cc*. *o*, artery going to the orbit; *pa*, pulmonary artery; 1, 2, 3, anastomosing branches connecting together the adjacent branchial arteries and veins.

This, however, would be a mistake.

The Mud-fish or *Lepidosiren*, already referred to more than once, is furnished with both gills and lungs throughout the whole of life. On this account it has been reckoned by some naturalists to be a Fish and not a Batrachian. Its fish-nature, however, has now been tho-

roughly established, and thus the probability of the existence of lungs within the class of fishes is also established.

But what is a lung?

A lung is a sac-like structure capable of being distended with air, supplied with venous blood direct from the heart and sending arterial blood directly to it. Generally the whole of the blood from the lungs goes back to the heart directly, but in one Batrachian—the celebrated *Proteus*—a portion of the blood from the lungs finds its way not

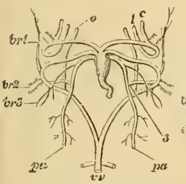


FIG. 80.

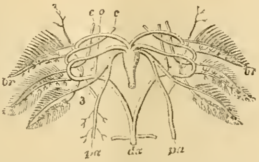


FIG. 81.

FIG. 80.—The Circulation in a Tadpole at a more advanced stage, when the gills have begun to be absorbed, the pulmonary arteries to increase, as also the connecting branches (at the root of the gills) between the branchial arteries and branchial veins.

FIG. 81.—The Circulation in a young Frog. Here the gills have been absorbed, and the blood passes directly from the heart to the head, the dorsal aorta, the lungs, and the skin,

into the heart but into vessels of the general circulation. When there is an air-sac which does not both receive blood directly from and return it directly to the heart—*i.e.* when there is no true *pulmonary* circulation—such an air-sac (whether single or double) is termed a *swim-bladder* and a structure of the kind is found in very many fishes. The swim-bladder of ordinary fishes neither receives blood directly from the heart by an artery like the pulmonary artery of higher animals, nor does it return blood directly to the heart.

The transition, however, from a lung to a swim-bladder is a graduated one. We have just seen that in *Proteus*,

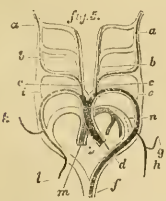


FIG. 82.

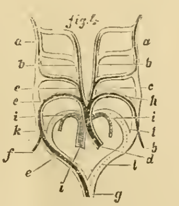


FIG. 83.

FIG. 82.—Diagram representing the main arteries of a Bird (fowl) with the changes induced on the primitive condition (after H. Rathke). *a*, *a*, internal carotids; *b*, *b*, external carotids; *c*, *c*, common carotids; *d*, root of main aortic arch (here right); *e*, arch of the same; *f*, right subclavian (which arises from the anastomosis of the first two right primitive aortic arches); *g*, commencement of the descending aorta; *h*, *h*, left subclavian; *i*, *i*, *i*, pulmonary arteries; *k*, right, and *l*, left, rudiments of the primitive aortic arches.

FIG. 83.—Diagram representing the main arteries of a Mammal with the changes induced in the primitive condition (after H. Rathke). *a*, *b*, *c*, carotids, as before; *d*, root of main aortic arch (here left); *e*, arch of the same; *f*, commencement of descending aorta; *g*, left vertebral artery; *h*, left subclavian; *i*, right subclavian; *k*. right vertebral artery; *l*, continuation of right subclavian; *m*, pulmonary artery; *n*, remnant of left primitive aortic arch.

though blood is returned from the lungs direct to the heart, yet that not all the blood is so returned. On the other hand in another animal, *Ceratodus*, though blood is not brought to its air-sac directly (which is therefore a swim-bladder and not a lung), yet for all that blood is sent *from* it direct to the heart.

Ceratodus (or as it is locally called "flat-head") is a fish of Queensland, closely allied to *Lepidosiren*, and is a very noteworthy animal apart from and in addition to its peculiarly transitional structure as regards its air-sac.

It is, indeed, the last of an ancient race, a species of the same genus (known almost exclusively by its teeth) being found fossil in strata of oolitic and triassic date. It was discovered by the Hon. W. Foster, M.C.A. Mr. Gerard Krefft, F.L.S., Curator and Secretary of the Sydney Museum, first described and figured the animal in 1870,* and at once correctly referred it to the genus *Ceratodus*, which up to that time was supposed to be entirely extinct. Its further determination was effected by Dr. Günther.† He has conclusively shown that *Ceratodus* and *Lepidosiren* are closely allied, and thus finally brought the latter definitively within the class of Fishes, for that *Ceratodus* is a fish no one questions. It is an animal, however, of somewhat amphibious habits, as at night it leaves the brackish streams it inhabits, and wanders amongst the reeds and rushes of the adjacent flats. Vegetable substances constitute its principal food.

Ceratodus and *Lepidosiren* together afford the most remarkable evidence of the persistence of the same type of structure in the Vertebrate sub-kingdom. The group to which they both belong reaches back into the very earliest epoch, which has yet afforded us any evidence whatever of the existence of fishes; while the genus *Ceratodus* seems to have persisted unchanged from the period of the deposition of the triassic strata.

Summary.

Taking a rapid retrospect of the course we have pursued, we find that in seeking to decide as to "What is a Frog?" our inquiry into its absolute structure has made known to us an animal of peculiarly specialised and perfect organisation. This has been shown to us pre-eminently by the study of its skeleton. We have especially noted its skull, its wonderfully short vertebral column, its utterly anomalous pelvis, and its scarcely less anomalous foot. The flesh which clothes that skeleton has been seen to exhibit distinct muscles wonderfully like our own, those of the foot, indeed, exceeding ours in number, and being a very marvel of complexity. We have met with a nervous system ministered to by delicate organs of sense, and noted for the ready response to stimuli, made by even separated parts of it as evidenced by strikingly co-ordinated complex movements. We have found the circulation to be carried on by a heart which, at first sight, seems too structurally imperfect to distribute the venous and arterial blood in their respectively appropriate channels. Nevertheless, further examination has shown us that this heart is provided with a special arrangement of parts so delicately co-adjusted as to be able to act thus as efficaciously as does the heart of animals much higher in the scale. Respiration, too, we have seen provided for partly by an effective throat air-pump, partly by a peculiar activity of the cutaneous structures.

We have, moreover, found that this complex adult condition is arrived at by means of a rapid metamorphosis from an immature condition wonderfully different, indeed, but no less perfectly adapted to the life conditions of the tadpole state.

It remains now "to sum up the results" of our investigations through "a series of wider and wider comparisons" to answer, finally, as far as may be, the initial question of this little treatise.

We have, in the first place, seen that the frog belongs to an order far more distinct from cognate ordinal groups than is man's order from other orders of his class mammalia. We have also seen that the frog belongs to an order which is singularly homogeneous, and yet that the class which includes it is remarkably heterogeneous.

Again, we have found that the subordinate groups of the frog's order, families and genera, have very definite

* See "Proc. Zool." Soc 1870, p. 22.

† See "Phil. Trans." 1871, p. 511; Plates xxx. to xlii.

relations to *space*, and that the order, as a whole, is, as far as yet known, remarkably restricted as regards geological *time*.

The comparisons instituted in our survey of the frog's anatomy will enable us now to sum up resemblances; first, as regards the orders of its class, and secondly, as regards the class itself.

1. Its own order, *Anoura*, has been seen to present singular resemblances to the *Chelonia* amongst reptiles. Such are the bony plates of the back of some forms, the bony covering of the temporal fossa in others, the mode of inspiration in the adult, the armature of the jaws in the young. On the other hand, the peculiar elongated tarsus has reminded us of certain mammals, and the median Eustachian opening of *Pipa* and *Dactylethra* has suggested an affinity to crocodiles and birds. It has been plain, however, that these several likenesses, however singular and striking, are not evidences of genetic affinity.

2. The order *Urodela* may well recall to mind the *Lacertilia* amongst reptiles, with which animals the *Urodela* were actually classed by Linneus. Moreover in both groups we find a series of different species, longer and longer in body and shorter and shorter in limb. We have also seen that in both these groups an analogous complication obtains in the muscles of the legs.

3. The order *Ophiomorpha*, as has been before observed, present a general resemblance to serpents, and a special resemblance to certain short-tailed ones; though it is rather to the Amphisbenian Saurians that they may most advantageously be compared. Here, again, however, we meet with the resemblances which, though striking, do not allow themselves to be interpreted as indices of any special relationship by descent.

4. The order *Labyrinthodonta* recalls to mind, as has been said earlier, the Crocodilia amongst reptiles, of which they may be deemed as the prophetic precursors, so to speak, though certainly not the direct ancestors.

Thus the class *Batrachia*, as a whole, presents a very interesting analogy and parallelism with the class *Reptilia*. It is a parallelism, moreover, which reminds us of that which exists between the various orders of Placental mammals and the great subdivisions of the pouched or Marsupial order of mammals. We have carnivorous, insectivorous, arboreal, aquatic, herbivorous, marsupial beasts, as we have carnivorous, insectivorous, arboreal, aquatic and herbivorous placental beasts. The harmonious variations of the placental and marsupial groups thus present us with excellent instances of affinities independently evolved and not due to hereditary influence.

In a similar way it seems probable that the subdivisions (orders) of the class Batrachia, mimic, as it were quite independently, the subdivisions (orders) of the class Reptilia.

The Frogs' class, as a whole, shows as many striking affinities to some or other fishes. It does so in the possession of gills and of a branchial apparatus during one time of life at the least; a large parasphenoid in the skull; the often persistently unsegmented terminal part of the notochord; the single ventricular cavity of the heart; the presence of a *bulbus aortæ*; the development of a *nervus lateralis;* the communication between the urinary canal and the oviduct, and certain other characters of less importance.

The class *Batrachia* agrees both with fishes and reptiles in having the blood cold, more than one aortic arch, and (except in crocodiles) in not having the distinct ventricles.

The class agrees with fishes, reptiles, and birds, in having no complete diaphragm, and no corpus callosum* in the brain, and no single aorta arching over the left bronchus.

We have now arrived at the end of those considerations seemingly best suited to enable us to answer the initial question, "What is a Frog?" The requisite definition might, of course, have been given much earlier, but these inquiries have seemed necessary to enable the reader to understand the technical terms of such definition—to give them, in his eyes, a real meaning.

The Frog is a tailless, lung-breathing, branchiate vertebrate, with four limbs typically differentiated, undergoing a complete metamorphosis, and provided with teeth along margins of the upper jaw.

The course of our inquiry into the nature and affinities of the Frog has not alone served to answer the question with which this memoir opened. Incidental bearings upon deep biological problems have come before us more than once in its course, nor have all the conclusions which seem to have forced themselves upon us been totally negative.

Thus we have met with several instances of the independent origin of remarkably similar structures, such as a shielded temporal fossa and elongated tarsus, which, together with structures like the tooth of the Labyrinthodon, seem to be characters for the existence of which neither the destructive agencies of nature acting on minute oscillations of structure, nor any sexual phenomena, will account.

Again, in the life-history of the Frog, considered even purely by itself, we find a remarkable example of spontaneous transformations due to innate powers and tendencies.

When, however, this process is considered in the light derived from the curious phenomena of transformation so enigmatically presented to us by the axolotl, we have very strongly brought before us the powerful action of internal tendencies lying dormant and latent till made manifest, through the advent of conditions so obscure that as yet they have evaded the most careful and anxious scrutiny of practised adepts.

It would seem to be a negligence not here to point out, that if new forms of life—new species—arise from time to time through congenital variation, not a few of the facts herein quoted point to the probability that such forms have arisen through the evolutions of implanted potentialities definite in nature, in other words, by "specific genesis."

Again, a general survey of the different kinds of relations which the Frog has brought before us, is well calculated to impress us with the overwhelming richness and fulness of nature.

Although, from our ignorance, the natural history of many other animals well known to us may appear less replete with interest than that of the common Frog may now be, yet it cannot be doubted but that the progress of science is capable of revealing to us facts as full of instruction and of as profound a significance in the life history of almost any kind of animal whatever.

Ever fresh, ever fertile, natural history offers to our faculties a pursuit practically inexhaustible. We are not, indeed, denied the gratification of successfully exploring and satisfactorily explaining mystery after mystery, but each secret wrested by our efforts brings before us other ever new enigmas, so that though refreshed by success we need never be wearied by monotony. While we need not regard any problem as absolutely hopeless, no dread of coming to the end of our inquiries need ever chill the warmth of our zeal in the scientific cause. Some may consider such reflections justified by the phenomena presented to them by the natural history of the Common Frog.

St. George Mivart

* As to this structure see Lesson in "Elementary Anatomy," pp. 367, 375.

THE HABITS OF BEES AND WASPS*

SIR JOHN LUBBOCK, in a paper on the Social Hymenoptera (Bees, Wasps, and Ants), especially with reference to their habits, senses, and power of communication with one another, pointed out with regard to the latter, that the observations on record scarcely justify the conclusions which have been drawn from them.

* Being the substance of a paper by Sir John Lubbock, Bart., F.R.S., read before the Linnean Society on the 19th March, 1874.

Thus Messrs. Kirby and Spence say that ants have a language "not confined merely to giving intelligence of the approach or absence of danger, but co-extensive with all their other occasions for communicating their ideas to each other." The observations, however, on which this statement is based, scarcely seemed to him to be conclusive. The two Hubers, indeed, had clearly shown that ants and bees could make one another cognizant of their state of feeling, could communicate anger, danger, &c., but that was very different from the possession of a true language.

In support of the opinion that Ants and Bees possess a true language, it is usually stated that if one bee discovers a store of honey, the others are soon aware of the fact. Thus Huber says, "Wasps are also acquainted with the mode of imparting information to their companions. When a single wasp discovers a stronghold of sugar, honey, or other article of food, it returns to its nest, and brings off, in a short time, a hundred other wasps; but we are yet ignorant, if it be by visible or palpable signs, they are mutually informed of this discovery."*

This, however, does not necessarily imply the possession of any power of describing localities, or anything which could correctly be called a language. If the bees or wasps merely follow their fortunate companions, the matter is simple enough. If, on the contrary, the others are sent, the case would be very different. In order to test this, Sir John proposed to keep honey in a given place for some time, in order to satisfy himself that it would not readily be found by the bees, and then after bringing a bee to the honey, to watch whether it brought others or sent them,—the latter, of course, implying a much higher order of intelligence and power of communication.

In the first place, then, he kept some honey for some days at an open window in his sitting-room, and no bees came to it. He then brought a bee up from his hives in the garden in his hand, choosing one which was in the act of leaving the hive. He found it frightened the bees less to be brought in the hand than in a bottle, probably on account of the darkness. The bee thus brought up was then fed with honey, which it sucked with evident enjoyment for a few minutes, and then flew quietly away. But though it had given no symptom of alarm or annoyance, it did not return, nor did any other bee come to the honey. This experiment he repeated eight times, with a like result. He therefore procured one of Marriott's observatory hives, which he placed in his sitting-room. The bees had free access to the open air, but there was also a small side, or postern door, which could be opened at pleasure, and which led into the room.

This enabled him to feed and mark any particular bees, and he recounted a number of experiments from which it appeared that comparatively few bees found their own way through the postern, while of those which did so, the great majority flew to the window, and scarcely any found the honey for themselves.

Those, on the contrary, which were taken to the honey, passed backwards and forwards between it and the hive, making, on an average, five journeys in the hour. In these cases it is obvious that the bees which had found the honey did not communicate their discovery to the others; and the postern being small and on one side, few of the bees found it out for themselves. If the honey had been in an open place, no doubt the sight of their companions feasting would have attracted other bees, but in this case the honey was rather out of sight, being behind the hive entrance; and was, moreover, only accessible by the narrow and winding exit through the little postern door.

Sir John had, also, in a similar manner, watched a number of marked wasps with very similar results.

No doubt when one wasp has discovered and is visiting a supply of syrup, others are apt to come too, but he believed that they merely follow one another. He argued that if they communicated the fact, considerable numbers would at once make their appearance, but he has never found this to be the case. The frequent and regular visits which his wasps paid to the honey put out for them proves that it was very much to their taste. Yet they did not bring their companions with them. For instance, on September 19, when a marked wasp paid more than forty visits to some honey, only one other specimen came to the honey during the whole day. Both these wasps returned on the 20th, but not one other. The 21st was a hot day, and there were many wasps about the house; his honey was regularly visited by the marked wasps, but during the whole day only five others came to it.

From these and other observations of the same tendency he concludes that even if bees and wasps have the power of informing one another when they discover a store of good food, at any rate they do not habitually do so, and this seemed to him a strong reason for concluding that they are not in the habit of communicating facts. If they do not, he argues, discuss among themselves the incidents of the day, their adventures in search of food, their success and fortunes in hunting, is it not a fair inference that they have no power of doing so?

Without in any way regarding the facts now recorded as sufficient or conclusive, he thought they indicated that their communications were confined to the feelings, and that there was no power of transmitting information as to matters of fact.

When once wasps had made themselves thoroughly acquainted with their way, their movements were most regular. They spent three minutes supplying themselves with honey, and then flew straight to the nest, returning after an interval of about ten minutes, and thus making, like the bees, about five journeys an hour. During September they began in the morning at about 6 o'clock, and later when the mornings began to get cold, and continued to work without intermission till dusk. They made therefore rather more than 50 journeys in the day. In fact they were just as industrious as bees, and kept longer hours, as they began earlier in the morning. He believed that the wasps which seemed to be idling in our rooms had simply lost their way. He gave also a number of observations tending to show the difficulty which bees have in finding their way. For instance, he put a bee into a bell glass 18 inches long with a mouth $6\frac{1}{2}$ inches in diameter, turning the closed end to the window. The bee buzzed about for an hour, when, as there seemed no chance of her getting out, he released her.

Although, as everyone knows, wasps are easily startled and very much on the alert, still they are very courageous.

On one occasion one of his marked wasps had smeared herself with honey and could not fly. When this happened to a bee it was only necessary to carry her to the alighting-board, when she was soon cleaned by her comrades. But he did not know where this wasp's nest was, and could not, therefore, pursue a similar course with her. At first he was afraid she was doomed. He thought, however, that he could wash her, fully expecting, indeed, to terrify her so much that she would not return again. He therefore caught her, put her in a bottle half full of water, and shook her up and down well till the honey was washed off. He then transferred her to a dry bottle and put her in the sun. When she was dry he let her out, and she at once flew to her nest. To his surprise, in thirteen minutes she returned as if nothing had happened and continued her visits to the honey all the afternoon. The next morning she was the first to arrive.

He also had made some experiments on the behaviour of bees introduced into strange hives, which seemed to contradict the ordinary statement that strange bees are always recognised and attacked.

Another point as to which very different opinions have

* Huber, "Nat. Hist. of Ants," p. 374

been established is the use of the antennæ. Some entomologists have regarded them as olfactory organs, some as ears; the weight of authority being perhaps in favour of the latter opinion. In experimenting on his wasps and bees Sir John, to his surprise, could obtain no evidence that they heard at all. He tried them with a shrill pipe, with a whistle, with the violin, with all the sounds of which his voice was capable, doing so, moreover, within a few inches of their head, but they continued to feed without the slightest appearance of consciousness.

Lastly he recounted some observations to show that bees have the power of distinguishing colours. The relations of insects to flowers imply that the former can distinguish colour, but there had been as yet but few direct observations on the point.

THE CAVENDISH LABORATORY

THIS Laboratory, in which every facility is furnished for the prosecution of physical research, is the munificent gift of William Cavendish, Duke of Devonshire, K.G., Chancellor of the University, who has intimated his intention of presenting it complete to the University.

The building, which is now finished, was erected from the designs of W. M. Fawcett, M.A., of Jesus College, at an expense of about 10,000*l*.

The ground-floor contains a set of rooms for operations requiring great steadiness, such as the measurements of length, time, and mass, and of heat, electricity, and magnetism. A store-room, a workshop, and a battery-room are also provided on the ground-floor.

The first floor contains a spacious lecture-room with a preparation-room, a large apparatus-room, a private room for the professor, and a large working laboratory, fitted with tables standing on beams of their own, so as to be independent of the vibrations of the floor. All the tables in the building are supported in the same way, and there are in every floor small trap-doors, by means of which bodies may be suspended over the tables in the room beneath, and through which electric and other communications may be made.

The upper rooms are intended for acoustics, radiant heat, optics, electricity, and the graphic reduction of observations. There is also a dark room for photographic preparations. The air in the electric room will be kept dry by a contrivance due to Mr. Latimer Clark, and the electric machine worked in this room may be made to furnish electricity for experiments in the lecture-room.

In the tower will be erected an iron tube, which may be filled with mercury so as to measure the greater pressures to which gases and vapours are subjected in the heat-room on the ground-floor. There is also an arrangement by which the electric potential of the air at the top of the tower may be measured either in the lecture-room or in the electric-room.

The laboratory is open daily from 10 A.M. till 6 P.M. under the superintendence of the Professor of Experimental Physics, for the use of any member of the University who may desire to acquire a knowledge of experimental methods, or to take part in physical researches.

NOTES

A REUTER'S telegram from Aden, of March 23, states that the steamer *Calcutta* arrived there from Zanzibar on the previous day with the body of the late Dr. Livingstone. We fear this must be regarded as final, and as shutting out any further hope; we can only now do all possible honour to those remains which the doctor's faithful servants have so religiously preserved. A letter recently received from Zanzibar, by Mr. R. A. Laing, states that the body, after having been exposed to the sun for a month to dry, and then packed in a hollowed tree, was wrapped round with cloth, and the natives carrying it supposed it a bale of cloth, or kaniki.

H.M.S. *Challenger* arrived at Melbourne on the 17th inst.: all well. On her voyage from the Cape of Good Hope, she reached the Antarctic Circle between E. long. 70° and 80°.

IN connection with our leading article this week we see with pleasure that Mr. Mundella gave notice in the House of Commons on Monday, that "at an early day he would call attention to the Report of the Science Commissioners on National Museums, and move that, in the opinion of the House, steps should be taken to render National Museums and Galleries of Art more available for instruction for the purposes of Science and Art." We sincerely hope Mr. Mundella's motion will lead to some decided step in advance.

WE are sorry to have to announce the death of Johann Heinrich Maedler, the distinguished German astronomer, at Hanover, on March 14, at the advanced age of eighty. One of his best-known works is a Map of the Moon, of which he was the joint author with M. Beer. He was appointed Professor of Astronomy and Director of the Observatory at Dorpat in Russia about 1840, and was also the writer of various astronomical treatises:—"Popular Astronomy," Berlin, 1849; "The Existence of a Central Sun," Dorpat, 1846; "Lectures on Astronomy," Mittau, 1845–47, &c.

WE are informed that the Royal Belgian Academy has resolved to place the bust of Quetelet in the hall where its meetings are held. We believe no successor to the Directorship of the Brussels Observatory has yet been named.

AT the last meeting of the Royal Irish Academy, the Rev. Prof. Jellett resigned the office of president, and Wm. Stokes, M.D., D.C.L., F.R.S., was elected in his stead. Dr. Sullivan also resigned the secretaryship of the Academy on being made president of the Queen's College, in Cork, and Dr. E. Perceval Wright, F.L.S., was elected to the post. Dr. R. McDonnell, F.R.S., was also elected to the secretaryship of Foreign Correspondence in the place of Sir W. Wilde.

THE Professorship of Astronomy in the University of Dublin, the holder of which is also Astronomer Royal of Ireland, is now vacant by the resignation of Dr. Francis Brünnow. Since its foundation this professorship has been held by Dr. Henry Ussher (1783), Dr. John Brinkley (1790), Sir William Hamilton (1827), and Dr. Brünnow (1865). The election will be held on April 18. Rumour in Trinity College points to Prof. R. Ball, LL.D., F.R.S., as the most likely successor to Brünnow, a distinguished graduate of the University of Dublin in both pure mathematics and experimental physics. Dr. Ball acquired an extensive knowledge of astronomy during the several years that he acted as the late Lord Rosse's assistant at the Observatory at Parsonstown.

AT a numerously attended meeting of the Fellows of the Royal College of Surgeons, Ireland, held in the College Hall, Dublin, on the 13th inst., it was resolved, by a large majority, that it is not expedient for this college to take part in the proposed conjoint scheme for the examination of medical graduates in Ireland. The conjoint scheme had already been approved of by the Council of the College, by the Medical Professors and Board of Trinity College, Dublin, by the King and Queen's College of Physicians, Ireland, and by the Governors of the Apothecaries Hall.

THE circular of the Board of Trade, respecting Storm Warnings, which appeared in our last, appears to require a few additional remarks by way of explanation. The circular

speaks of an explanatory pamphlet which is now before us, and we see from it that the intention of the present system of signals is to give an indication of the *direction* of the wind to be apprehended in every case. The drum is never to be used without the cone. Its signification in Admiral FitzRoy's time was "dangerous winds from nearly opposite quarters successively;" and it accordingly gave no indication of direction *by itself*. Experience has shown that there is a much greater degree of certainty in foreseeing the *direction* than the *force* of a coming strong wind. Furthermore an attempt is made to give a degree of numerical definitiveness to the warnings, which at once admits that they are not infallible. The Committee say:—"Hitherto it has been found that at least three out of five signals of approaching storms (force upwards of 8 Beaufort scale, a 'fresh gale,') and four out of five signals of approaching strong winds (force upwards of 6 Beaufort scale, a 'strong breeze') have been fully justified." We may fairly consider this as a step in the direction of treating weather indications by the laws of exact science.

WE are glad to learn that Prof. Alluard, of Clermont-Ferraud, has at last succeeded in surmounting the various obstacles which he met with in the establishment of his proposed observatory on the Puy de Dome, at an elevation of about 1,660 metres above the surrounding country (NATURE, vol. vii. p. 481). The chief difficulty arose from the opposition of the peasant proprietors to the invasion of their rights by the construction of a road and erection of the building. M. Alluard announces that the observatory will be ready to be inaugurated in September next, and has invited his meteorological friends to visit Auvergne on that occasion.

A LARGE deposit of Moa bones has lately been discovered in a swamp at Hamilton, in Otago. Besides *Dinornis*, the swamp contains bones of *Aptornis*, *Harpagornis*, &c. The whole have been secured by the curator of the Otago Museum.

The Sedgwick Geological Prize (Cambridge) has been adjudged to J. J. Harris Teale, B.A., St. John's College. The subject for the next prize will be—"The post tertiary deposits of Cambridgeshire and their relation to deposits of the same period in the rest of East Anglia."

THE French Society of Geography has decided upon holding an International Geographical Congress at Paris in 1878. Rules and programmes will be issued shortly.

THERE has recently been concluded in connection with the Liverpool Free Public Library and Museum, a carefully arranged and excellent course of Free Lectures. This is the ninth winter course in connection with the same institution, from which we are glad to infer that these free lectures have been a success. We should like to see similar courses inaugurated in all our large towns; we believe the results would be in the highest degree beneficial. The following is a summary of the Liverpool course:—Eight Lectures on Art, by Mr. W. J. Bishop; Three Lectures on Natural History, by Mr. T. J. Moore; Six Lectures on the Chemistry of Salt, and of the Manufactures depending on it, illustrated with Specimens, Experiments, Diagrams, &c., by Mr. Edward Davies, F.C.S., &c.; Three Lectures on Geology, by Mr. G. H. Morton, F.G.S., F.R.G.S.I.; Two Lectures on Mineralogy and Mining, by Mr. F. P. Marrat, M.L.G.S.; Six Lectures on Navigation and Astronomy, by Mr. J. T. Towson, F.R.G.S.; Two Lectures on Art and Antiquities, and one on Town Window Gardens, by Mr. Charles T. Gatty; Three Lectures on the Constitutional History of England, illustrated with Historical Maps, by Mr. James Birchall; Four Readings, by Mrs. H. J. Gorst.

THE Austrian amateur navigator, Count Wilczek, writing in the *Neue Freie Presse*, says that there is no ground for apprehension as to the fate of the Austrian Polar Expedition which sailed in the *Tegetthoff*, in the year 1872, and that news will probably be received from the expedition in October or November next. Letters for members of the expedition will be despatched by the Austro-Hungarian Government by means of whaling and other vessels bound for the Arctic seas.

MESSRS. TRÜBNER and Co. have in the press and will shortly publish a treatise on "Valleys, and their Relation to Fissures, Fractures, and Faults," by G. H. Kinahan, M.R.I.A., F.R.G.S.I. This work will be dedicated by permission to His Grace the Duke of Argyll.

MR. F. C. S. ROPER, F.L.S., has published a "Supplement to the Fauna and Flora of Eastbourne, together with a list of Eastbourne Cretaceous Fossils."

MESSRS. S. W. SILVER & Co. have just published a "Handbook for Australia and New Zealand," containing a large amount of varied and useful information about the various colonies in that quarter of the world. It is accompanied by a "Seasons'-Chart of the World."

THE additions to the Zoological Society's Gardens during the last week include two Palm Squirrels (*Sciurus palmarum*) from Ceylon, presented by Capt. Forster; a Sonnerat's Jungle Fowl (*Gallus sonnerati*) from South India, presented by Mrs. White; two Tench (*Tinca vulgaris*) British, presented by Mr. W. Arnold; a Black-eared Marmoset (*Hapale penicillata*) from Brazil, presented by Mr. F. Graham; a Leadbeater's Cockatoo (*Cacatua leadbeateri*) from Australia, presented by Colonel Carington; two Boat-bills (*Cancroma cochlearia*) from South America, deposited.

CELESTIAL CHEMISTRY*

IT now and then happens in the history of the human race upon this planet, that one particular generation witnesses the most stupendous advancement of knowledge, this advancement generally coming from what one might consider an exceeding small germ of thought. You will at once call to mind several such instances. You will recollect how once a Dutchman experimenting with two spectacle-glasses produced the Telescope; and how the field of the known and the knowable has been enlarged by the invention of that wonderful instrument. Again, you recollect how once Sir Isaac Newton was in a garden and saw an apple fall, and how the germ of thought which was started in his mind by that simple incident fructified into the theory of universal gravitation. You will also acknowledge that each step of this kind has more firmly knit the universe together, has welded it into a more and more perfect whole, and has enhanced the marvellous beauty of its structure.

I think that future times will say that either this generation, or perhaps the next, is as favoured a one as that which saw the invention of the telescope or the immortal discovery of Newton: for as by the invention of the telescope the universe was almost infinitely extended; as from Newton's discovery we learned that like forces were acting in like manner everywhere; so in our time does the wonderful instrument called the Spectroscope show us that like matter is acting in like manner everywhere; so that if matter and force be not identical, then these two, namely, matter and force, may be termed the foundation stones of the universe in which we dwell.

My present object is to bring before you as well as I can some first notions which are to be got out of this general examination of all matter beyond our own planet, in its chemical relations; this examination having been rendered possible by the spectroscope.

In the first instance, before I attempt to deal with chemical ideas in relation to the heavenly bodies, I have two things to do. I must first refer to our earthly notions of chemistry, not of course in their generality, for that would be impossible in the time at my disposal, but to that side of them which touches most intimately what I shall have to say by and by; and I must also refer to the results which we have already obtained with regard to the constitution, so to speak, of terrestrial matter, as it is brought before us by the spectroscope.

* Revised from short-hand notes of a Lecture delivered at the Quebec Institute, on Tuesday, December 16, 1873.

First, then, with regard to chemistry. What is chemistry? It is a science which deals with the matter which surrounds us, and of which the whole planet and we ourselves are built up. We see everywhere around us an enormous number of apparently perfectly distinct things, some of them having vital properties, some of them lifeless, motionless; but out of this apparently infinite diversity chemistry presents us with an almost perfect simplicity. It tells us that everything which exists here is really made up of only sixty-three different things; that the whole of the animal kingdom, the vegetable kingdom, the mineral kingdom—everything—is made up of only sixty-three different substances. That is a wonderful simplification, and science always simplifies.

Now we may look upon those sixty-three elements in two distinct points of view. We may consider them in their physical relations, or we may regard them in a more purely chemical aspect. If we look upon them in relation to their physical conditions, we find that amongst them are fifty-six solids, two liquids, and five gases. If we look upon them chemically, dropping all distinctions between solids, liquids, and gases, we say that some of them are metals, some metalloids; and of some, it may be truly said that it is very difficult to place them exactly—to determine whether they are on the side of the metals or on the side of the metalloids—in the same way as the biologist finds it absolutely impossible to put his finger upon any particular part of the organic world and say, Here the vegetable, or here the animal, kingdom begins. All these chemical distinctions, then, are quite independent of physical conditions. For instance, I shall have to show you that amongst the most metallic of the metals is a gas. Again, among the metals we have a liquid—mercury; so that we have a complete chain of gas, liquid and solid among the metals, although popularly the term metal is often imagined to apply only to such solids as gold, silver, and iron. On the metalloid side, again, we have gases among them the familiar oxygen and nitrogen; we have the liquid bromine, and so on, added to other unmistakable metalloids, such as phosphorus, sulphur, carbon, and iodine, generally thought of in their solid form.

Now what are the chemist's tools by which he has brought about this marvellous simplicity, what the processes by which he carries on his operations? I answer, in the main *vibrations*. He finds the world composed of molecules in millionfold complexities, combinations, and sizes, and he acts upon these molecules by vibrations. For gross molecules he finds in heat most that he wants, but when the molecules are more delicate, then electricity is called in, and electricity does for these what heat did for the others.

Let me here endeavour to make my meaning clear. I want you to assume a long series of vibrations, long at one end of the series and short at the other. We know that heat consists of vibrations, we know that light consists of vibrations. I will also ask you to think of electricity as connected with vibrations, and I ask you further to assume these vibrations to be short. We get heat from the sun, and among these vibrations are some to which our eye is tuned. We get an immense vibration of heat from the oxyhydrogen flame, a flame the heat of which is due to the formation of the gaseous molecules of water, but we get, practically speaking, no light. Many of the electrical phenomena with which we are acquainted take place unseen, and without heat, showing they are not long-wave phenomena; others are exquisitely visible to us, because the vibrations are within our ken; but, to get associated heat, we want pressure, and with pressure we can render the oxyhydrogen flame luminous. In fact—and here let me be perfectly frank with you—I call your attention to the "*as if*"—it is *as if* we have long heat-waves at one end of a long scale, and short electricity-waves at the other, each with different functions, heat giving us with solids and liquids *visible* phemonena, because of added shorter waves, electricity giving us visible phenomena with gases and vapours, because of added longer waves; heat passing invisibly through gases, electricity passing invisibly through solids; heat bringing about chemical changes in solids and liquids, electricity bringing about similar changes in the case of gases.

Now, this being so, let us assume, for the purposes of the present statement, that the mode of motion heat, with its long waves, chiefly affects the larger molecules, that is, compound bodies, and the mode of motion electricity, whatever electricity may be, chiefly affects the smaller molecules, that is, the atoms of simple substances. We shall find, in accordance with this assumption, that if a chemist wishes to reduce the millions of compound molecules in that very compound molecule a piece of ice, he applies heat, and he gets a physical simplification, but not a chemical one, when water is produced; a still further, and exactly similar, stage is reached when this water takes the form of steam, but it is not till an enormous temperature, with its added short vibrations, or electricity, is employed, that the compound molecule breaks up into the simple things oxygen and hydrogen, unless another vibration is superadded of a molecule of another simple thing (or element) which shall aid in shaking them apart.

As instances of the action of heat, I will show you one or two experiments to indicate that in a great deal of chemical action the heat vibration requisite to bring about that simplification by means of which the simple bodies have been determined to exist as such is supplied by the chemical action itself; it is the heat of arrested motion. In other cases we have to supply the heat artificially; but also bear this in mind, that whenever we apply artificial heat the heat is none of our making. It also is the result of a chemical combination. For instance, if I take some potassium and throw it into water, that potassium will instantly burst into flame. You will see that we have a perfectly cool metal put into perfectly cool water, and, as you see, it at once takes fire in consequence of the heat of combination which has been brought about by the attraction between the potassium and the water. And if I had time I could show you that as the result of that heat-vibration thus introduced the water has been simplified, one of its constituent simple things, hydrogen, has been liberated, and I might have collected it in a bell jar.

Another illustration is to be got from a mixture of water and sulphuric acid. I have, in a test-tube, some ether, and I have the water. When I pour the water into a glass you will see that the ether in the test-tube placed in the glass will remain as if nothing had happened. But now I will pour some sulphuric acid into the water, and what happens? We get an attraction between these two things: we get a heat vibration as the result of chemical combination; and, as the result of the heat vibration produced in that manner, the water gets hot and the ether boils, the boiling point of ether being below that of water.

Here is another experiment, and I have chosen these out of many others which might have been brought before you, to show the changes brought about by heat vibrations. Here we have some bichromate of potassium, and on the application of heat it will be instantly reduced. When I say instantly reduced, probably a few seconds will be required in order to allow the heat vibration to act, and you will then have a change of colour in the solution brought about by the application of heat, artificial, so to speak, in this case, although, as I have already cautioned you, the heat of the Bunsen burner which we employ is really an effect of chemical combination.

But not only have we heat with its long waves to bring about chemical action and its result, simplification, but, as I have said, we have another agent, electricity. I have here two tubes filled with water, and a battery, and in each tube connected with this battery is a strip of platinum. The instant that the circuit is made complete you see that the water is decomposed, bubbles rise from the platinum foil, which bubbles in the one case are bubbles of hydrogen, and in the other case bubbles of the other constituent of the water—oxygen. Here you see, by means not of the long waves of heat, but by means of electricity, we bring about a complete dissociation or a complete separation of the elements of the water which originally was in these two tubes. And if we were to allow the experiment to go on a little longer, you would see that not only is there the evolution of gas in each of the tubes, but that the evolution will be greater in one tube than in the other, for this reason, that in the water there are two equivalents of hydrogen to one of oxygen.

These then are instances of simplification brought about by heat and electricity. I quit this part of the subject by the remark that the ultimate particles of an element are called atoms; that agglomerations of atoms are termed molecules; elementary molecules when the atoms are alike; compound molecules when the atoms are dissimilar. The heat-waves generally help us to get at the molecule, and electricity helps us to get at the atom; and mark, I only say *generally*. It might be universally true if all elementary atoms were alike; but on that point we must be content to say that we do not know. But I might place much evidence before you which indicates that they are vastly different. We can only study them by their vibrations;

for, as Sir Wm. Thomson has calculated, the atoms in a drop of water are so small that if the drop of water were magnified to the size of the earth, the atoms would then be seen not larger than cricket-balls or not smaller than shot.

It must be clearly understood that I here refer to the true atom and not to the atom of the chemists, the weight of which they give as the "atomic weight." It may probably turn out that this is often a molecule, sometimes a complicated one, which great heat or electricity can divide, the latter sometimes more than once. It is clear that if this be so, then the vapour densities as referred to the atomic weight will be "anomalous," because the true atom and not the chemist's atom is in question at these high temperatures.

It is now time for us to pass to the action of the spectroscope. The spectroscope, as you know, is the instrument which enables us to deal with either the refraction or the diffraction of light; that is to say, by means of refraction or diffraction we sort out the rays of any beam which we may choose to use into a spectrum, and we then study by means of that spectrum the nature and conditions of the substance which gave us the light.

And there is more than this. Not only can we deal with the giving out of light as light is being given out by this lamp, or that flame, or that gas before me, but we can equally use the absorption of light by various substances, thus studying the nature and conditions of these substances. You know very well that if this lamp, instead of having a shade of ground glass had a red one, the light that would reach your eye would be red. That simply results from the fact that the red glass stops in the main all light but the red, and allows the red to reach your eye. That then is a case of absorption, as the giving out of light by the wick of the lamp is a case of radiation.

What, then, does the spectroscope tell us with regard to the physical differences in matter? It tells us that if we have matter in a solid state, that is matter the molecules of which are large and are near together, agitated by the waves of heat, or by electricity, we get a spectrum from it of a particular kind, called a "continuous spectrum," because the spectrum is absolutely continuous, the red, yellow, orange, green, blue, violet, are all there, as you see them in the rainbow; whereas, if we deal with a gas or vapour not too dense, that is with a substance the atoms or molecules of which are smaller and further apart than in the former case, similarly agitated by electricity or, in some cases, by heat, you find that instead of having what is called a continuous spectrum, you have a spectrum in which the light is not continuous, but broken. The result of this broken condition is that we have light as it were only here and there in the spectrum. We have in fact bright lines representing a few images of the slit, instead of a rainbow band, complete from the red to the violet, representing continuous images of the slit. This you see at once enables the spectroscope to tell us the difference between the rare and the dense states of matter quite independently of what that matter may be, and whether we use radiation or absorption as the test; since a substance with a certain molecular arrangement absorbs precisely the same undulations as it gives out with the same molecular arrangement. No matter what it is, the spectroscope at once tells us whether this matter is in a gaseous or vaporous state, in which case we have lines or bands; or in a state in which the molecules are nearer together, when we get a more or less complete continuous spectrum. This at once partly explains why the almost invisible long waves of the oxyhydrogen flame soon fill a mass of the most refractory metal with waves of all lengths, until it shines out almost like the sun. It would appear that molecules or atoms, when once set vibrating by either long or short waves, perform *all* the vibrations proper to them under the conditions present.

How then about the chemical differences? Here the information afforded by the spectroscope is of a much closer character. In the first place it tells us that if you take any substance whatever in a state of gas or vapour, not only do you get bright lines, which tell you that you are dealing with a gas, but you get different bright lines for every substance, so that you not only know that you are dealing with a gas or vapour, but you know at the same time what particular gas or what particular vapour. This is qualitative spectrum analysis, as the effects depend upon the quality of the atoms or molecules present. Further, we see a change in the spectrum from simplicity to complexity, by which I mean that the lines increase in number and broaden, and that the bands become more complete and their channelled structure, where it exists, comes out better, as we pass from a low to a high pressure. This is quantitative spectrum analysis, the change depends upon the quantity of the atoms or molecules present.

Again, the spectroscope at once enables us in the main (and I say in the main, because I have already referred to the borderland between the metals and the metalloids) to differentiate quite as sharply between metals and metalloids as it does between solids and gases.

A metallic spectrum is always a line spectrum when we employ electricity to produce the vapour. Only certain metals give us line spectra at low temperatures: these are mostly monad metals which vaporise easily.

A metalloidal spectrum is only a line-spectrum when we employ electricity. Long heat-waves in their action upon the molecules only produce bands and channelled spaces. Thus the vapour of sulphur has three spectra, two to be obtained by heat, the line spectrum only being obtained by electricity..

Nor is this all. As we can distinguish the spectrum of a metal from the spectrum of a metalloid by the appearance of the spectrum, so also does the spectroscope enable us to see a difference between the spectrum of a compound molecule and an elemental molecule. Let me explain what I mean:—If we are dealing with a metallic element, we get a spectrum of a particular kind so sharply defined that when any one has once seen it, he always knows that an atom of a metal is being dealt with. In the same way when we are dealing with metalloids, the spectrum is generally so entirely distinct from the spectrum of a metal, that when you have once seen the spectrum of a metalloid produced by the long heat-waves, you will always be able to tell it again, there is no possibility of mistaking it for the spectrum of a metal. So far we have been dealing with the elemental molecules, or perchance atoms of metals and metalloids, but we can take a compound molecule. Let us take the combination between metalloids and metals, such as some of the salts of strontium—the chloride of strontium, iodide of strontium, and so on: here we have compound molecules, that is, molecules no longer built up of one substance, but of two; and the long heat-waves, although they can set them vibrating and therefore make them radiate light, do not shake them asunder as high tension electricity does.

We find that the spectroscope is perfectly competent to separate such spectra from all others, so that when we have once seen the spectrum of, say, iodide of strontium, we shall for ever afterwards know that such spectra are given by such a compound molecule as iodide of strontium. The same remark applies to the compound molecules in which oxygen enters as one of the substances. Such spectra closely resemble the spectra of the metalloids, but the bands are farther apart and lie nearer the violet as a rule, so that it is not difficult to distinguish them.

Now when we have to do with a compound molecule, that is to say, with an association of two molecules or atoms of two different chemical substances, we shall at once see that this question of vibrations instantly comes into play; for if the function of vibration, whether we deal with large molecules and long heat-waves, or small molecules and electricity, is to render more simple what in the first instance was compound, then we ought to get spectroscopic differences.

Let us again take the iodide of strontium; the spectroscope is perfectly capable of letting us see the exact effects, not of every degree of temperature which we employ, but of any great differences of temperature. We can follow each increase of temperature by observing the lines or bands which disappear, or which begin to be visible, as the case may be, as the temperature is increased. And similarly, if we have a mixture at a temperature of dissociation, and gradually bring the temperature down until association takes place, then also the spectroscope is just as competent to help us as it was before when we were dealing with an increasing temperature. We find that as the temperature decreases in the latter case, the peculiar compound spectrum to which I have already referred gets more and more visible at the same time as the elemental spectrum gets less and less visible: the order being one of strict law absolutely capable of prediction the moment you know what are the elemental lines, and the lines of any particular compound which longest resists the action of pressure.

Now this is extremely important in its bearing upon the celestial side, so to speak, of this inquiry, and therefore if you will allow me I will still further enlarge what I have said about this distinction between the metals and the metalloids.

If I take sodium vapour at a very low temperature and at the

highest temperature that I can get on the earth either by the long heat-waves or by means of electricity, I find that there is absolutely no difference whatever in the molecular arrangement of that sodium vapour at the extreme points. Spectroscopically it is absolutely the same.

Then if I take, not sodium but another element, such as iron, I find it excessively difficult, by means of the heat-waves, to shake asunder the molecules of iron and the diatomic or polyatomic molecules of iron vapour at all. But we know that by electricity non-atomic iron vapour can be got; and then we may say, at all events so far as the lines in the spectrum are concerned (I do not mean their position, but their general nature), that we get a spectrum from the vapour of iron, similar in character to that of the vapour of sodium; but the spectrum has become more complicated as we pass from the monad metal to one with a higher atomicity.

Suppose that, instead of taking a monad metal like a sodium, with its few-lined spectrum, or a metal like iron, with its high atomicity and its many-lined spectrum, we take a *metalloid;* then we find that those conditions no longer hold good. It is not too much to say that in the case of the metalloids every change of even low temperature brings about a change in the spectrum. It is perfectly true, as I have said before, that by means of electricity we can get a line-spectrum from most of the metalloids. But from the ordinary temperature to the electric spark in the case of a metalloid, instead of getting the perfect similarity that we did in the case of sodium vapour, we get an equally perfect and equally beautiful dissimilarity; so that whilst we say that in the case of sodium we only know of but one spectrum, in the case of sulphur, to take one case, we certainly know of four.

You must let me again remind you that when we employ electricity the spectra of the metalloids present exactly the same appearance as the spectra of the metallic elements, such as iron and sodium, and that it is only when we employ heat-waves that those other changes to which I have referred take place.

One word more, too, on the fundamental difference between the spectrum of a metalloid and the spectrum of a metal on the one hand, and the spectrum of a compound on the other. The metalloid has a spectrum of channelled spaces or bands, sometimes to be found in the central part, that is to say, in the green part, or thereabouts, of the spectrum, whereas in the case of the vapour of metals such as iron, and so on, we get bright lines only, not bands; and these lines increase in number generally toward the violet, while in the case of the compound molecules, such as iodide of strontium, to which I referred, we get a something which is half channelled spaces and bands, and half lines, but in all the cases I have examined, excluding oxides, they are limited to the red end of the spectrum.

Let me attempt briefly to summarise what I have stated. With electricity in the case of all elements we obtain line spectra; as we are here dealing with the most complete simplification of matter that we can attain, let us call this the *atomic spectrum.*

With heat we can obtain a continuous spectrum, from solids, liquids, and some vapours; with electricity we can even obtain a similar spectrum from dense gases. Let us call this the *molecular spectrum.*

In the case of many of the metalloids we get, between these extremes, a channelled space spectrum. Let us term this the *sub-atomic spectrum.*

In the case of some compound molecules, we get by heat in some cases, and by electricity in others, a spectrum which is dissimilar from all these. Let us call this the *compound atomic spectrum.*

J. NORMAN LOCKYER

(*To be continued.*)

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 19.—Preliminary Notice of Experiments concerning the Chemical Constitution of Saline Solutions, by Walter Noel Hartley, F.C.S., Demonstrator of Chemistry, King's College, London.

The author has been engaged in investigating the above subject during the last eighteen months, and his experiments being still in progress, he thinks it desirable to place the following observations on record:—

In the examination of the absorption-spectra, as seen in wedge-shaped cells, of the principal salts of cerium, cobalt, copper, chromium, didymium, nickel, palladium, and uranium, to the number of sixty different solutions, it was noticed that the tinctorial properties of the substances could be ascertained by noticing the absorption-curves and bands, so that, provided water be without chemical action, it could be foreseen what change would occur on dilution of a saturated solution.

The Effect of Heat on Absorption-spectra

When saturated solutions of coloured salts are heated to 100° C. there are (1) few cases in which no change is noticed; (2) generally the amount of light transmitted is diminished to a small extent by some of the more refrangible (the less refrangible), or both kinds of rays being obstructed; (3) there is frequently a complete difference in the nature of the transmitted light. Anhydrous salts not decomposed, hydrated compounds not dehydrated at 100° C., and salts which do not change colour on dehydration, give little or no alteration in their spectra when heated.

Solutions of hydrated salts, and most notably those of haloid compounds, do change; and the alteration is, if not identical, similar to that produced by dehydration and the action of dehydrating liquids, such as alcohol, acids, and glycerine, on the salts in crystals or solution.

A particular instance of the action of heat on an aqueous solution is that of cobalt chloride, which gives a different series of dark bands in the red part of the spectrum at different temperatures, ranging between 23° C. and 73° C. Band after band of shadow intercepts the red rays as the temperature rises, till finally nothing but the blue are transmitted. Drawings of six different spectra of this remarkable nature have been made. The changes are most marked between 33° and 53°, when the temperature may be told almost to a degree by noting the appearance of the spectrum. Though to the unaided eye cobalt bromide appears to undergo the same change, yet, as seen with the spectroscope, it is not of so curious a character, the bands being not so numerous.

With cobalt iodide a band of red light is transmitted at low temperatures; this moves towards the opposite end of the spectrum with rise of temperature until it is transferred to such a position that it consists of green rays only. In this instance the change to the eye is more striking when seen without the spectroscope, because the mixtures of red, yellow, and green rays, which are formed during the transition, give rise to very beautiful shades of brown and olive green. Thus a saturated solution at 16° C. was of a brown colour, at − 10° C. it became of a fiery red and crystals separated, at + 10° reddish brown, at 20° the same, at 35° Vandyke brown, 45° a cold brown tint with a tinge of yellowish green, at 55° a decidedly yellowish green in thin layers and yellow brown in thick, 65° greenish brown, thin layers green, 75° olive-green. An examination of this cobalt salt has shown that there are two distinct crystalline hydrates; the one formed at high temperatures has the formula $CoCl_2.2H_2O$, and is of a dark green colour; the other, which contains a much larger proportion of crystalline water, is produced at a low temperature, and its colour is generally brown, in cold weather inclining to red.

The action of heat on solutions of didymium is characterised by a broadening of the black lines seen in the spectrum, more especially of the important band in the yellow; and in the case of potassio-didymium nitrate, this is accompanied by the formation of a new line. In the case of didymium acetate, which decomposes with separation of a basic salt, the lines thickened on heating.

Thermo-chemical experiments

Regnault (Institut, 1864; "Jahresbericht," 1864, p. 99) has shown that on diluting a saturated solution of a salt, as a rule there is an absorption of heat, but in one or two cases he noticed that heat was evolved. The change in colour that takes place on the dilution of saturated solutions of cobalt iodide, cupric chloride, bromide and acetate is very remarkable. There is every likelihood that this phenomenon is due in each case to the formation of a liquid hydrate. It is impossible of belief that accompanying such a circumstance there should be no measurable development of heat; and the author's experiments have proved that in the above cases, at any rate, the heat disengaged is very considerable, amounting, for instance, on the part of cupric chloride, at least to 2,565 "units when 1 gram molecule of the crystalline salt is displaced in its minimum of water at 16° C. and brought into contact with sufficient to

make the addition of 40 Aq." These numbers only roughly approximate the truth. On diluting a solution of cobalt iodide till the red colour appears, the thermal effect must be much greater, as not only does it register several degrees on an ordinary thermometer, but it may be perceived by the hand.

The conclusions indicated by these results are obvious, but it is beyond the scope of this paper to refer to them. The writer hopes before long to complete his experiments with the view of having them communicated to the Royal Society.

Spectroscopic Observations of the Sun, by J. Norman Lockyer, F.R.S., and G. M. Seabroke, F.R.A.S.

Note on the Intracellular Development of Blood-corpuscles in Mammalia, by Edward Albert Schafer.

Linnean Society, March 19.—Dr. G. J. Allmann, F.R.S., in the chair.—The following papers were read:—Observations on Bees and Wasps, by Sir John Lubbock, Bart., F.R.S. (for an abstract of which see another column), followed by an interesting discussion in which the president, Mr. Robert Warren, Major-General Strachey, Mr. A. W. Bennett, Prof. Newton, Prof. Thiselton Dyer, Mr. D. Hanbury, Mr. Elliot of New York, and others, took part.—On *Oniscigaster wakefieldi*, a singular insect from New Zealand, belonging to the family Ephemeridæ, with notes on its aquatic conditions, by R. M'Lachlan.

Zoological Society, March 12.—Prof. Newton, F.R.S., in the chair.—The Secretary called the attention of the meeting to an important addition that had been made to the Society's collection on the 7th inst., by the acquisition of a young male Javan rhinoceros (*Rhinoceros sondaicus*) from Batavia, believed to be the first example of this rhinoceros that had ever been brought alive to Europe.—A letter was read from the Rev. S. J. Whitmee, resident at Samoa, stating that he had forwarded, through Dr. G. Bennett, of Sydney, a *Didunculus* and two curlews for the Society's collection, and giving interesting particulars concerning the habits of this bird, and another peculiar Samoan species, *Pareudiastes pacificus*.—An extract was read from a letter addressed to the Secretary by Dr. George Bennett respecting a *Didunculus*, and other birds, he had received from the Rev. Mr. Whitmee, of Samoa, intended for the Society's collection.—Dr. Günther, F.R.S., gave some details concerning the recent introduction into this country, by Lord Arthur Russell, of the Ide (*Leuciscus melanotus*, var. *orfus*).—Prof. Huxley read a memoir upon the structure of the skull and of the heart of *Menobranchus lateralis*, describing the structure of the bony skull in the osteo-cranium, and giving a full account of the primordial skull or chondrocranium, which has not hitherto been noticed. The chondrocranium was compared with that of *Proteus*, and that of larval frogs and tritons, and its essentially embryonic character was indicated. The chondrocranium was further shown to be formed by the coalescence of three distinct classes of elements which were termed *parachordal*, *pleural*, and *paraneural*. The heart was described, and the septum of the auricles was shown to be an open network allowing of free communication between the right and left auricular chambers. The structure of the *Truncus arteriosus* was compared with that observed in other amphibians.—Mr. R. B. Sharpe communicated the descriptions of two new species of birds recently procured by Mr. H. T. Ansell, of Gaboon; these were proposed to be called *Centropus anselli*, and *Dryoscopus coronatus*.

Chemical Society, March 19.—Prof. Odling, F.R.S., president, in the chair.—On Dissociation, by Prof. Dewar. The lecturer premised that as he had but little that was new to tell, he must content himself with condensing and epitomising the results of others. After briefly referring to the theories of Priestly and Hutton, he described the famous experiments of Sir James Hall, who obtained a substance identical with marble by fusing carbonate of lime under pressure. He next noticed Grove's discovery that water was decomposed at a temperature lower than that produced by the union of oxygen and hydrogen, and then explained the masterly researches of Deville on the effect of heat in causing the dissociation of carbonic anhydride, carbonic oxide, water, &c. After this the lecturer showed that in dissociation the tension of the vapour evolved is constant for a given temperature and independent of the mass, illustrating it by Debray's experiments on the decomposition of carbonate of lime at a regulated heat, and the evolution of water from certain hydrated salts. The lecture, which was illustrated with diagrams of various curves of tension, concluded with some remarks on the dissociation of the compound of hydrogen and palladium, and with a description of an apparatus devised by the speaker for ascertaining the temperature produced by the explosion of a mixture of oxygen and hydrogen under various pressures.

Meteorological Society, March 18.—Dr. R. J. Mann, president, in the chair.—Mr. R. H. Scott, F.R.S., read a paper On an attempt to establish a Relation between the Velocity of the Wind and its Force (Beaufort scale), with some remarks on anemometrical observations in general. The author stated that he considered that the existing scales of wind force were unsatisfactory. The highest pressure corresponding to force 6 of the land scale was 36 lbs. per square foot, whereas pressures of above 40 lbs. had frequently been registered. He further brought forward proofs of the irregularity in the distribution of such high pressures. He then spoke of the Beaufort scale, and pointed out some of its defects, but stated that speaking generally it might be considered to be a rough classification of the wind force, exact enough for practical purposes, and proceeding by nearly equal degrees. He had recently made experiments at Holyhead and at Yarmouth to test the velocity recorded by the anemometer at each station at the hours when the several figures of the Beaufort scale were reported. The result was a scale which agreed very closely with that given by Schott, as a deduction from theory in his discussion of the observations made by Sir F. Leopold M'Clintock in the *Fox*, and published by the Smithsonian Institution. Inasmuch as the accordance of practice with theory was very great, he proposed this scale for general adoption—

Force.	Miles per hour.	Force.	Miles per hour.
0	2·5	7	40·5
1	8	8	48·5
2	13	9	56·5
3	18	10	65
4	23	11	75
5	28	12	90
6	33·5		

The paper then went on to point out from experience gained at Holyhead, Yarmouth, and Falmouth, the very serious discrepancies which had been proved to exist in the records of velocity for the various points of the compass, especially at Yarmouth, and which showed that the influence of local situation, not only as to the contour of the country, but even the very shape and height of the observatory and the adjacent buildings, exercised a most serious influence on the correctness of the data afforded by the instruments. It therefore seemed very dangerous to reason as to the mean motion of the air over the British Isles from the anemometrical records of one or two stations, as has been done by Dove.—The next paper read was by Mr. G. J. Symons, On the Sensitiveness of Thermometers, in which he gave the results of a series of comparisons of the speed with which thermometers with bulbs of various sizes took up the true temperature to which they were exposed. Three series of thermometers were used, a set with spherical bulbs filled with mercury, and varying in diameter from a quarter to three-quarters of an inch. The result was that the small bulb took up the true temperature in about three minutes, while the large bulb took three times as long; a second set were similar in form, but filled with spirit; they were more sluggish, but the small spirit ones were more prompt than large mercurial ones. Lastly, the new patterns of spirit minimum thermometers introduced by Mr. Casella and Mr. Hicks were tested and found as sensitive as ordinary mercurial thermometers. The instruments were all examined by the Fellows at the close of the meeting.—The last paper was by Mr. R. Strachan, On the Weather of Thirteen Autumns.

Royal Astronomical Society, March 13.—Prof. Adams, F.R.S., president, in the chair.—On an occultation of Neptune observed at Walthamstow on April 24, by Mr. Talmage. The planet was seen to skirt along the moon's limb, and was only occulted for a few seconds. The occultation was also watched for at Greenwich by Mr. Criswick, and although the difference of latitude only amounts to a few miles, the planet was never lost sight of.—On a remarkable structure visible upon the photographs of the solar eclipse of December 12, 1871, by Mr. Ranyard. In viewing the photographs by transmitted light a minute partially transparent spot can be traced at a height of about 9′ from the eastern limb on all the negatives of Lord Lindsay's series, and on four out of the six negatives of Col. Tennant's series. It appears to occupy identically the same place with regard to the dark details of the corona in all the photographs, and cannot therefore be due to any reflection within the camera, for the position of the corona

is shifted upon the different plates. On first making the discovery, he had been inclined to think that it must be due to a star seen through the corona, but on further reflection he had been obliged to abandon that idea, for a star would have been represented by a dark or opaque point, whereas this must be due to an object darker than the corona, apparently hiding or cutting out some of its light. On a closer examination of the negatives, with suitable lights, three partially transparent circular arcs concentric with the bright point were detected above it. Such forms are totally different from the corona structure visible on other parts of the plate, and there seemed no alternative but to suppose that they were due to some partially opaque body situated between us and the sun, cutting out or partially intercepting the light of the corona. The structure is similar to that which has often been observed in the nuclei and concentric comæ of comets, and Mr. Ranyard thought that it did not seem unreasonable to suppose that this was really a photograph of a faint though large comet near to perihelion. Mr. Christie said that he had examined the negatives and he did not think there could be any doubt about the existence of the structure. It was distinctly to be traced on Lord Lindsay's series, and also on those taken 120 miles away at Ootacamund by Col. Tennant.

Entomological Society, March 16.—Sir Sidney Smith Saunders, president, in the chair.—Mr. Champion exhibited specimens of *Euryporus picipes* taken near Chatham.—Mr. Edward Saunders exhibited a box of *Buprestidæ* collected by Prof. Semper in the Philippine Islands; and read some notes and descriptions of the new species.—A paper was communicated by Prof. Westwood on several additional species of *Lucanidæ* in the collection of Major F. J. Sidney Parry.

Geologists' Association, March 6.—Prof. Morris, F.G.S., vice-president, in the chair.—On the geology of the Nottingham district, by the Rev. A. Irving, F.G.S. The district under aonsideration comprises coal-measures, Permian, Bunter, Keuper, and Lias rocks—a border-land between the Palæozoic and Mesozoic epochs. No apparent unconformability exists between the Permian and Triassic series here; while that between the Permian and coal-measures is enormous. (1) *Coal Measures.* There are seven seams of coal at present workable in this field, with many more of inferior quality. The enormous unconformability between the coal-measures and the Permian is shown by the fact that at the Shire Oak Colliery near Worksop, 1,300 ft. of coal-measures are passed through before the "top-hard" is reached, whilst at Stretley, twenty miles to the south, the magnesian limestone rests directly (according to Mr. G. Fowler, C.E.) upon the "top-hard" seam. (2) *The Permian.*—The great unconformability between the Permian rocks and the coal-measures is rendered more significant by the absence of the Lower Red Sandstone (Rothliegende), whilst there are clear proofs of continuous deposition of the Permian and Lower Bunter. In this area stratigraphical evidence points to the Permian and Bunter as but portions of one great unbroken sequence of rocks deposited upon highly disturbed and denuded coal-measures. (3) The *Bunter.*—The Lower Mottled Sandstone is nowhere more than 100ft. thick. The Himlack stone exhibits the junction of the Lower and Middle Bunter. It is marked by unconformability. A bed of calcareous grit and breccia forms the basement of the pebble beds, or Middle Bunter. This is evidently a shore formation. The author concluded, from its composition and from the general prevalence of current bedding, that it occupied an area of deposition subject to shifting currents, but protected from the open ocean. (4) *Keuper.*—Two sections were given where the "water-stones," consisting of alternating beds of sandstone and marls, are seen resting upon the eroded surface of the bunter. In each case the junction is marked by a bed of highly calcareous breccia; and there is unconformability between the two formations. Footprints of *Cheirotherium* have been observed at Castle Donnington, and recently by the author at Colwick, near Nottingham. Ripple marks, &c., are also commonly met with. (5) The *Rhætic beds.*—The black paper shales were discovered by Mr. Etheridge a short time ago at Elton; there also the author has found a portion of the bone-bed. (6) The *Lias* may be observed capping the hills on the south side of the Trent Valley. Belvoir Castle crowns an escarpement of the Middle Lias (marlstone), abounding in *Rhync. tetrahedra* and *Ter. punctata.* (7) *Drift and Alluvium.*—The greater part of the former appears to have been long since carried down into the valley of the Trent, where extensive gravel-pits are worked, as *e.g.* at Saveley and Beeston.

PARIS

Academy of Sciences, March 16.—M. Bertrand in the chair. The following communications were read:—Note on the employment of flexible laminæ for the tracing of arcs with curvature of large diameter, by M. Resal.—Researches on symmetrical isomerism and on the four tartaric acids, by MM. Berthelot and Jungfleisch. The authors have determined the heat of solution of dextro-tartaric acid, lævo-tartaric acid, racemic acid, and inactive tartaric acid. The authors think it probable from their researches that water decomposes the inactive acid into its two active constituents during the act of solution.—On the crystalline hydrates of sulphuric acid, by M. Berthelot; also a thermo-chemical communication.—Experimental researches leading to a determination of the sun's temperature: a letter from P. Secchi to the perpetual secretary. The author has compared the solar radiation with that of the electric arc from a battery of 50 Bunsen's elements, using for this purpose his "thermo-heliometer." After making necessary corrections for atmospheric absorption the result obtained is 133780°, but the author considers this number only an approximation, and considers it possible that it may have to be raised to 169680°.—Report of the geodesic work relating to the new determination of the French meridian, by M. Elie de Beaumont.—Memoir on the swim-bladder from the point of view of station and locomotion, by M. A. Moreau.—On an application of the theory of substitutions to linear differential equations, by M. C. Jordan.—On the heat of combustion of different varieties of red phosphorus; a note by MM. Troost and Hautefeuille.—On the conditions which determine the movements of chlorophyll granules in the cells of *Elodea canadensis*; note by M. E. Prillieux. By a microscopical examination the author has sought to distinguish clearly in the example chosen the movements which are affected by light from those produced by lesion of the tissues during the act of preparation for microscopic examination.—The blocks and rolled flints in the Red Sandstone of the drift of Saint-Brieuc; note by M. T. Héna. These flints appear to have been brought from Erquy, 24 kilometres to the north-east of Saint-Brieuc by means of floating ice.—On the laws of the plane distribution of pressures in the interior of the isotropic bodies in the state of limited equilibrium; note by M. J. Bossinesq.—On the friction of glaciers and the erosion of valleys, by M. C. Grad. The author expresses his belief that neither the Alpine valleys, the Italian and Swiss lakes, nor the fjords of Norway and Greenland owe their origin to glacial erosion.—Chemical nature of the sulphide of iron (troïlite) contained in meteoric irons, by M. S. Meunier. A reiteration of the view, formerly expressed by the author, that this substance is a variety of pyrrhotine (Fe_7S_8) and not simply a ferrous sulphide (FeS).—On a phosphate of cerium containing fluorine, by M. F. Radominski. This mineral contains cerium, lanthanum and didymium, calcium, magnesium, iron, fluorine, phosphoric acid and traces of water. It was found near Fahlun in Sweden. During the meeting M. Gosselin was elected into the section of medicine and surgery to supply the vacancy caused by the death of M. Nelaton.

CONTENTS

THURSDAY, APRIL 2, 1874

MARY SOMERVILLE

Personal Recollections, from Early Life to Old Age, of Mary Somerville, with Selections from her Correspondence. By her daughter, Martha Somerville. (London: John Murray, Albemarle Street, 1873.)

IT would have been a lasting blot upon the biographers of our time if such an illustrious woman as Mary Somerville—a woman unique, or almost unique from one point of view, though so beautifully womanly from others—had been allowed to pass from among us without a satisfactory memorial of her characteristic thoughts, conversation, and domestic life.

The "Personal Recollections of Mary Somerville" will not satisfy those readers who may have hoped to find in the autobiography of the author of the "Mechanism of the Heavens" and the "Connection of the Physical Sciences" any special expositions of Science or practical hints for a successful method of scientific training. The studied care with which Mrs. Somerville avoided bringing scientific questions prominently forward in conversation has been rigidly preserved in the story of her life, where little or nothing is said of the processes by which she attained so exceptional and distinguished a place in the world of Science, and only passing references are made to the extraordinary success that attended her self-acquired knowledge.

As the record of a life in which the fulfilment of all the natural and conventional claims upon a woman's time was combined with practical and theoretical pre-eminence in the most abstruse departments of physical inquiry, no book can, however, be more interesting and suggestive than this volume, in which the personal recollections of Mary Somerville are noted down for us by her own hand and that of her daughter. The story of her life has, moreover, the special interest that it may, with perhaps equal justice, be made to yield arguments for and against the claims advanced for women's equality to men in intellectual capacity. The champions of such pretensions may well point with triumph to her achievements in the higher branches of analytical geometry. Where, indeed, could another instance be found of a person who, after having had to ask, at the age of 16, the meaning of "the *x's* and *y's* mixed with strange lines," which first excited her notice in the pages of a magazine of fashion, should unaided—for she was in all essentials a self-taught mathematician—have been able to begin her career as an author by producing a work like the "Mechanism of the Heavens," which still ranks as the best exposition that we possess of Laplace's "Mécanique celeste"?

The approval which this work won from the first mathematicians and physicists of the day seems to have surprised no one more thoroughly than the writer herself, who had carried on her studies with such unostentatious industry within her own home, that she was scarcely conscious how exceptional were her attainments. And it may be fairly said of her that by the publication of the "Mechanism of the Heavens," in 1831, she suddenly awoke, at the advanced age of 51, to find herself famous, the one woman of her time, and perhaps of all times, for whatever may be the advantages which are now happily being placed within the reach of women for benefiting by high scientific training, we can scarcely expect to meet with many Mary Somervilles. Her genius was unique of its kind, and wholly exceptional, and this fact seems to have been frankly and generously admitted by all who came in contact with her, who were capable of measuring the depths of her knowledge. But so successfully did she conceal her learning under a delicate feminine exterior, a shy manner, and the practical qualities of an efficient mistress of a household, coupled with the graceful, artistic accomplishments of an elegant woman of the world, that ordinary visitors, who had sought her as a prodigy, came away disappointed that she looked and behaved like any other materfamilias, and talked just like other people. No one, therefore, could possibly have afforded a stronger refutation of the axiom, almost universally upheld half a century ago, that scientific acquirements of a high order are wholly incompatible with the proper exercise of the natural and ascribed functions of a woman's destiny. And accordingly the name of Mary Somerville has always been a tower of strength to the promoters of woman's emancipation from the enactments established by man for her exclusion from the enjoyment of the various social, legal, intellectual, and other privileges, of which he has so long had the virtual monopoly.

Her fame did not rest only on her first book—in which she had verified Laplace's own testimony, that she was the only woman who had ever read his works, which, moreover, were not understood by twenty men in France as well as she understood them—for the list of her writings includes, in addition to those more generally known from their semi-popular form as the "Connection of the Physical Sciences," "Physical Geography," &c.; monographs on the Analytical Attraction of Spheroids, the Form and Rotation of the Earth, the Tides of the Ocean and Atmosphere, and, besides many others of equally abstruse nature, a treatise of 246 pages on Curves and Surfaces of the Second and Higher Orders, which she herself tells us she wrote *con amore*, to fill up her morning-hours while spending her winter in Southern Italy. A truly marvellous *catalogue raisonné* of the results of a woman's knowledge and industry!

It is impossible to speak too highly of the sympathy and hearty recognition of the value of her labours that Mrs. Somerville received from all the most eminent of her contemporaries. In France, Laplace, La Croix, Biot Poisson, Arago, Ampère, and many others welcomed her as one of themselves; in England she enjoyed the intimate friendship of the Herschels, Lord Brougham, Professors Whewell, Peacock, Babbage, Sedgwick, and Brewster, and others pre-eminent in science; and surely no greater tribute could have been paid to the exceptional intellectual superiority of Mary Somerville than that rendered by the University of Cambridge when, at the earnest recommendation of Profs. Whewell and Peacock, her "Mechanism of the Heavens" was introduced into the University studies as "essential to those students who aspire to the highest places in the examinations."

It would not be easy to over-estimate the extent and degree in which Mrs. Somerville's acquirements differed from those of women generally at that period; but then

it must be admitted that it is precisely through this exceptional character of her attainments that her case may be adduced in proof of the rule that women are not by nature adapted for studies which involve the higher processes of induction and analysis. If such powers as hers had been more generally granted to women, why is she the only woman on record amongst us who has exhibited them?

There was nothing exceptional in her bringing up, or her opportunities. In fact, no woman of her time and station could have had a more typical experience of life than she had. She was born nearly a century ago, in 1780, and spent her childhood and youth in Scotland, within an ordinary circle of the upper middle-class society of her age and country, and therefore very closely circumscribed by lines of defence against innovations and social changes of any kind. Her father, Captain Fairfax (a brave officer who commanded the *Repulse* during the war), received the news of her having taught herself the first six books of Euclid with the remark—"We must put a stop to this, or we shall have Mary in a strait-jacket one of these days. There was 'X.,' who went raving mad about the longitude!" This gallant captain was, moreover, a genuine good Tory, who took decided views in regard to all questions involving a departure from established precedents, and when his young daughter ventured to express her admiration for the short-cut hair, which was then the badge of a Liberal in politics, he exclaimed, "By G—, when a man cuts off his queue the head should go with it." Her mother, who found all her intellectual cravings amply satisfied with the reading of her Bible, a volume of sermons, and a stray copy of a newspaper, fully concurred in her husband's views of the education suited to young women, and was at great pains to thwart her daughter's unladylike taste for pursuits regarded at the time as the exclusive privileges of men, and to keep her mind and hands closely fettered by the bonds of a household possessed of very limited pecuniary means. The parents of the future authoress of the "Connection of the Physical Sciences" did not, therefore, afford her special facilities for mastering any of those higher branches of knowledge for which she seems to have had an instinctive yearning almost before she knew their names. Indeed, at the age of 10, Mary Fairfax was still a little ignorant savage, running wild over the hills and braes of Burntisland, and scarcely knowing her letters; yet before she was 13 she had surreptitiously possessed herself of some of her brother's books and taught herself Latin enough to construe "Cæsar's Commentaries." At that time she scarcely knew the simplest processes of arithmetic, but at the age of 17 the possession of a copy of "Bonnycastle's Algebra," procured for her by her uncle and future father-in-law, Dr. Sutherland—the only one of her relations who did not absolutely oppose her efforts to acquire knowledge—enabled her to solve the mystery of the X's and Y's; and from that hour till the day of her death, mathematics, in one shape or other, may be said to have formed part of her daily existence. For more than half a century they were the staple occupation of her morning hours when the duties of her house and family had been disposed of; at a very advanced age she began and mastered the study of Quaternions, and other forms of modern mathematics, and at 89 she "still retained facility in the calculus."

The restless activity of her intellect had indeed never slumbered. When she received her first lessons in painting and music, she had begun at once to try and trace out the scientific principles on which these arts are based, and never rested till she had gained some knowledge of the laws of perspective and of the theory of colour, and had learnt to tune her own instruments. In later years she may be said to have been always in the van of discovery—not indeed as an originator but as the readiest and aptest of students—and from the time when Young showed her how he conducted the experiments by which he claimed to have discovered the undulatory theory of light, and Wollaston made her one of the very first witnesses of the seven dark lines crossing the solar spectrum, whose detection laid the basis of some of the most wonderful cosmical discoveries of this or any age, Mary Somerville, to the last day of her long life of nearly 92 years, followed with quick and appreciative understanding every step in the advance of modern research. Age could not quench the fire of her intellect, and even in her 92nd year, when the Blue Peter, as she quaintly remarks, had long been flying at her foremast, and she had soon to expect the signal for sailing, she could interest herself in the phenomena of volcanic eruption, speculate on their effects, and follow with lively sympathy the progress of scientific inquiry, and the issues of passing events.

In reading the personal recollections of this wonderful woman nothing strikes one more than the ordinary and even commonplace conditions under which her great intellect advanced to maturity. In her case the only exceptional features were her natural gifts and her perseverance in cultivating them; and this is precisely the point that should not be lost sight of. Mary Somerville will always present a noble instance of what a woman has been capable of achieving, but it would be straining the argument too far to say that we are justified from her special case to draw general conclusions in regard to women's aptitude for the study of the higher forms of physical science.

EXTINCT VERTEBRATE FAUNA OF THE UNITED STATES

Contributions to the Extinct Vertebrate Fauna of the Western Territories of the United States. By Prof. Joseph Leidy. (Government Printing Office, Washington.)

THIS important volume is the first of five which are to form the "Report of the United States Geological Survey," and it will be supplemented by a memoir, embracing the same subjects, by Prof. Cope.

The large field for palæontological work recently opened up in the Western Territory of the United States has been as fruitful in the introduction of new and unexpected forms of extinct vertebrate life, as that so ably worked out by Cuvier, the Paris basin. By the establishment of a military station at Fort Bridger, opportunities have been afforded to geologists, which the offensive attitude of the Indian tribes had previously deferred, rendering inaccessible a district, the richness of whose past fauna must have been as remarkable as is its present desolation.

Fort Bridger is a military post about 100 miles E.N.E. of Great Salt Lake City, in the south-west corner of the Wyoming Territory. The valley in which it is situated stands nearly 7,000 ft. above the level of the sea at the base of the Uintah Mountains, which form its southern boundary; the Wind River Range defining it on the north-east, and the Wahsatch Mountains on the west separating it from the Great Salt Lake. The enclosed plain is evidently the remains of an extensive fresh-water lake, which in the Eocene period must have abounded with animal life, and whose borders must have been the haunts of animals, both huge and small, which lived and died by its marshy banks. Green River now runs through the plain, and it, with its smaller tributaries, by cutting up the easily eroded deposit, produces a scenery of a most peculiar character, consisting of flat-topped hills and cliffs, with perpendicular sides, and often most grotesque proportions. Those of the water-courses which do not dry up during the summer months are fringed with vegetation, such as cotton-wood, willow and aspen trees, but most of the country is treeless and barren, reminding the spectator more ot the ruins of a colossal city, than of any other existing scenery.

The flat-topped hills, table-lands, and scarp-rocks are termed "buttes," and the fossils are generally found at their bases, having fallen there from the gradual atmospheric disintegration of their sides, along with the *débris* of the deposits. The fossils consist mostly of the bones and teeth of vertebrata, together with lacustrine shells. The bones are generally black or brownish, sometimes yellowish; they are generally distorted and much broken, except the small ones, such as those of the carpus and tarsus. They do not withstand the action of the air at all well.

The remains of mammals, which are very abundant, are mostly of genera which are not found elsewhere. Several, however, approach those of the Paris tertiary basin. The odd-toed Ungulata, or Perissodactyla, are particularly numerous, whilst even-toed Ungulate or Artiodactyla are as remarkably few. True Proboscidians are not found, but if Prof. Marsh is correct in placing Dinoceras in an order by itself, animals equally huge, of an independent type, were far from uncommon. Most of the other mammalian orders are most probably represented, though much has yet to be done in the identification of specimens.

Prof. Leidy has not yet seen any remains of bird, but we, some time ago, called attention to Prof. Marsh's discovery of *Odontornis*, a bird with well-developed teeth in both jaws; quite different from *Odontopteryx* of Owen, which has not true teeth, but teeth-like processes of the jaws.

The remains of turtles are most numerous; many of them were aquatic, and some belong to genera which cannot be distinguished from those now existing. What is also particularly interesting to note is that the remains of Crocodilia, which are not very abundant, are all derived from species of true *Crocodilus*, the old-world form, with the lower so-called "canines" fitting into a notch in the upper jaw, and not from *Alligator*, the genus which is now found in the Mississippi and its neighbourhood, with the lower "canine" fitting into a maxillary socket.

From the large amount of material which has passed through his hands, most of which is deposited in the Museum of the Academy of Natural Science of Philadelphia, there are some types of animals which Prof. Leidy has been able to work out in sufficient detail to make his results of general interest. Perhaps the most complete of these is *Palæosyops*, a perissodactylate Ungulate, of about the size of the Tapir, portions of the bones and nearly complete sets of the teeth of which have been several times discovered. The dental formula was complete, the typical forty-four teeth being present, all close together in the usual numbers, namely i. $\frac{3-3}{3-3}$, c. $\frac{1-1}{1-1}$, p.m. $\frac{4-4}{4-4}$, m. $\frac{3-3}{3-3} = 44$. The canines were peculiarly large, having much the same proportions as in an average carnivorous animal, like the bear. The molars have a resemblance to *Palæotherium*, the inner lobes of the crowns of the upper molars being, however, more completely isolated. There was a third trochanter to the femur, and three toes, as in the Tapir, were present on the hind feet. *Palæosyops paludosus* is the most common species. It is not known whether the neck was long and curved, as that of *Palæotherium* is now found to have been, or whether it was short and straight, as in the Tapirs. *Limnohyus* is a closely allied genus, named by Prof. Marsh.

Another perissodactylate, *Hyrachyus*, closely resembles *Lophiodon* of France, but has an extra premolar in the lower jaw, and a lobe less in the last lower true molar.

Perhaps *Trogosus* is one of the most interesting of the extinct mammals from the "Mauvaises Terres." It is also perissodactylate, and slightly smaller than the common pig. Its dentition would almost lead to the idea that the long-missing form which may be supposed to connect the Ungulata with the Rodentia, has at last been discovered; for with the usual complement of molar teeth there are no canines, and a huge pair of rodent-like incisors, which, in the lower jaw at least, had an intermediate pair of very small teeth. The large incisors had *persistent pulps*, and were formed in part of a circle; they wore down obliquely, in the same way as in the Cavies; were grooved longitudinally, somewhat as in *Aulacodus*, and were covered with enamel on the anterior surfaces only.

It is not to be wondered at, when small fragments of the skull of an animal so unknown and aberrant as *Uintatherium* (or *Dinoceras* of Marsh) were obtained, that each piece should have been referred to a separate genus and species, and Prof. Leidy, in the latter part of his memoir, puts together, as parts of *Uintatherium*, the tusks, horn-cores, &c., as parts of one and the same animal, which he had considered to be portions of different animals in the earlier part of his work, and which he had no reason for associating until Prof. Marsh had described the complete skull of *Dinoceras mirabilis*, which we figured some time ago. As we also mentioned at the time, Prof. Cope has also named this genus *Eobasileus* and *Loxolophodon*.

Besides the above mentioned, most characteristic forms, some from other territory strata west of the Mississippi River, are described—ungulate, rodent, and carnivorous—many of which are intimately related to those of the Paris basin, and throw further light on them. Prof. Leidy also

figures and describes several of the Chelonia and other reptiles which come from the same locality.

The above notice of the results arrived at by American men of Science show that they deserve the careful study of English palæontolologists and geologists, as they have already thrown great light on the fauna of the Tertiary period, and give promise of adding much more to our knowledge of that epoch, so important to the student of the anatomy and classification of the higher vertebrata.

OUR BOOK SHELF

The Laboratory Guide, a Manual of Practical Chemistry for Colleges and Schools, specially arranged for Agricultural Students. By Arthur Herbert Church, M.A. (London: Van Voorst, 1874).

TEACHERS of chemistry will be glad to welcome the third edition of Prof. Church's "Guide," to which much new matter has been added. Being specially adapted for students of agricultural chemistry, the book is necessarily somewhat limited in its scope, but the amount of information conveyed within the small compass of 215 pages is very great, and is moreover lucid and accurate. The book is divided into three portions, the first treating of a chemical manipulation, the second of qualitative analysis, and the third of quantitative analysis. The author's preliminary remarks upon manipulation are excellent, and should be graven upon the mind of every chemical student. In the "Introduction" we are told that the student "must never forget that the experiment is the means, not the end. . . . . Merely to make a coloured precipitate or a flash of bright flame is not the end of experimenting."

These remarks are much to the purpose, and we commend them to the notice of chemists of older growth, as well as to beginners. The sudden introduction of equations on p. 8 without any previous explanation of the meaning of symbolic formulæ appears somewhat unsystematic, but the student is recommended by Prof. Church to attend some course of lectures on inorganic chemistry, and to study the corresponding chapters in Roscoe's Chemistry, at the same time that he is working through the "Guide." As the "Guide" is at present arranged, the student will find this absolutely necessary. The classification of the metals adopted by the author calls for remark—iron and manganese are classed as dyads and aluminium as a triad. Further on it is explained that this last metal is only a pseudo-triad, being in reality a tetrad. Why not class it with the tetrads at once? Hexad metals and pentad metals are ignored altogether, although manganese forms a hexafluoride, arsenic, and antimony, penta-haloid compounds, &c. We must protest also against the use of the words "vinculant," "vinculance," "univinculant," &c. No advantage is likely to accrue to the science from this new phraseology, and the terms "atomicity," "monatomic," "diatomic," &c., which are in general use, express the idea perfectly. The tables for qualitative analysis differ but little from those generally adopted. The quantitative processes for the analysis of natural products, soils, foods, &c., will be found very useful. In addition to the direct benefit arising from the issue of books like the present, there is an indirect benefit for which we ought to be also indebted to Prof. Church—we refer to the expulsion from the market of hastily compiled and inaccurate works by so-called "Science Teachers," such as it has been our duty to condemn on former occasions.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Prof. Tait and Mr. Spencer

As is shown by the passage from his *Thermodynamics* which he re-quotes, Prof. Tait holds that "Natural philosophy is an experimental, and not an intuitive science. No *à priori* reasoning can conduct us demonstratively to a single physical truth."

I hold, on the contrary, that as there are *à priori* mathematical truths, the consciousness of which results, not from our individual experiences, but from the organized and inherited effects of ancestral experiences, received throughout an immeasurable past; so are there *à priori* physical truths, our consciousness of which has a like origin.

I have endeavoured to show that Prof. Tait himself, by saying of physical axioms that the appropriately-cultivated intelligence sees "*at once*" their "*necessary* truth," tacitly classes them with mathematical axioms, of which this self-evidence is also the recognised character. Further, I have contended that the laws of motion are *à priori* truths of this kind; are enunciated by Newton as such; are adopted from him by Prof. Tait; and are not furnished by Prof. Tait with any such experimental proofs as he asserts are needful for the establishment of physical truths. And I have gone on to show that no experimental proofs of them are possible—that every supposed proof, whether derived from terrestrial phenomena or from celestial phenomena, involves a *petitio principii.*

In the course of the discussion I have examined the reason Prof. Tait gives for asserting that the laws of motion are not to be accepted as valid *à priori.* The reason is that "as the properties of matter might have been such as to render a totally different set of laws axiomatic, *these laws must be considered as resting on convictions drawn from observation and experiment, and not on intuitive perception.*"

The worth of this reason I have tested by asking the origin of Prof. Tait's professed knowledge that "the properties of matter might have been" other than they are. Here is the passage:—

"It will suffice if I examine the nature of this proposition that 'the properties of matter *might have been*' other than they are. Does it express an experimentally-ascertained truth? If so, I invite Prof. Tait to describe the experiments. Is it an intuition? If so, then along with doubt of an intuitive belief concerning things *as they are*, there goes confidence in an intuitive belief concerning things *as they are not.* Is it an hypothesis? If so, the implication is that a cognition of which the negation is inconceivable (for an axiom is such) may be discredited by inference from that which is not a cognition at all, but simply a supposition. Does the reviewer [a critic whose attack I was answering] admit that no conclusion can have a validity greater than is possessed by its premises? or will he say that the trustworthiness of cognitions increases in proportion as they are the more inferential? Be his answer what it may, I shall take it as unquestionable that nothing concluded can have a warrant higher than that from which it is concluded, though it may have a lower. Now the elements of the proposition before us are these:—*As* 'the properties of matter might have been such as to render a totally different set of laws axiomatic' [*therefore*] 'these laws [now in force] must be considered as resting . . . not on intuitive perception:' that is, the intuitions in which these laws are recognised, must not be held authoritative. Here the cognition posited as premiss, is that the properties of matter might have been other than they are; and the conclusion is that our intuitions relative to existing properties are uncertain. Hence, if this conclusion is valid, it is valid because the cognition or intuition respecting what might have been, is more trustworthy than the cognition or intuition respecting what is! Scepticism respecting the deliverances of consciousness about things as they are is based upon faith in a deliverance of consciousness about things as they are not!"

From this passage Prof. Tait has quoted a small part which, standing by itself, appears somewhat strange; but which ceases to appear strange when read along with the rest. In seeking the authority which Prof. Tait has for asserting that "the properties of matter might have been" other than they are, I have tried all possible suppositions; and as he professes to have faith only in experimentally-ascertained truths, I have asked whether this is one; by way of showing, unmistakeably, that in the absence of experimental warrant he must admit it to be, if not a mere hypothesis, then an intuition. Whence results the incongruity I have pointed out.

Prof. Tait says this argument of mine reminds him of a student whose conceptions of algebraic processes were shown by asking—"But what if x should turn out after all *not* to be the unknown quantity?" His imagination suggests to Prof. Tait an analogy too remote for me to perceive; and one which I think few will

follow him in perceiving. It seems to me that in this case "the unknown quantity" is the application of his story.

I have to add that Prof. Tait's letter gives the erroneous impression that I have made a gratuitous assault upon his views. Contrariwise, I have said respecting them no more than is needful in self-defence. A critic who thought me greatly in need of instruction respecting the nature of proof and the warrants we have for our ultimate scientific beliefs, quoted, for my benefit, the foregoing passage from Prof. Tait; and he did this in a manner implying that when he had told me what Prof. Tait said, there remained for me no alternative but to abandon my position. As I did not coincide in his general estimate of Prof. Tait's *dicta*, and as this particular question is one of some philosophical interest, I thought it worth while to justify my own belief, and, in so doing, was obliged to assail that of Prof. Tait.

In Prof. Tait's desire to avoid controversy I quite sympathise. Though sometimes scarcely avoidable, it entails, as I know too well, a grievous loss of time. But as Prof. Tait decided not to answer, I think it would have been better to keep silence absolutely, rather than to try and dispose of the matter by tearing a sentence from its context, and telling, *à propos* of it, a story not to the point.

Athenæum Club, March 30 HERBERT SPENCER

Herbert Spencer versus Sir I. Newton

PROF. TAIT is not the only one who has to complain of hard treatment in the pamphlet by Mr. Herbert Spencer, referred to in the Professor's letter of last week. As the unlucky author of the obnoxious criticism that gave rise to the pamphlet in question, I of course come in for a lion's share of the abuse; but neither Prof. Tait nor myself are, after all, treated so cruelly as is Newton, who, though his life was spent in maintaining the experimental character of all physical science, is cited as an authority for the *à priori* character of the most important of all physical truths—the well-known Three Laws of Motion.

Mr. Spencer had asserted that these Laws of Motion are *à priori* truths, and had supported this statement by alleging that Newton gave no proof of them, and therefore intended them to be so regarded. After sheltering myself under the authority of Professors Tait and Thomson, I answered that "the whole of the *Principia* was the proof," whereon Mr. Spencer replies as follows:—

"I have first to point out that here, as before, the reviewer escapes by raising a new issue. I did not ask what he thinks about the *Principia* and the proof of the laws of motion by it; nor did I ask whether others, at this day, hold the assertion of these laws to be justified mainly by the evidence the solar system affords. I asked what Newton thought. The reviewer had represented the belief that the second law of motion is knowable *à priori* as too absurd even for me openly to enunciate. I pointed out that since Newton enunciates it openly under the title of an axiom, and offers no proof whatever of it, he did explicitly what I am blamed for doing implicitly. And thereupon I invited the reviewer to say what he thought of Newton. Instead of answering, he gives me his opinion to the effect that the laws of motion are proved true by the truth of the *Principia* deduced from them. Of this hereafter. My present purpose is to show that Newton did not say this, and gave every indication of thinking the contrary. He does not call the laws of motion 'hypotheses;' he calls them 'axioms.' He does not say that he assumes them to be true *provisionally*, and that the warrant for accepting them as actually true will be found in the astronomically-proved truth of the deductions. He lays them down just as mathematical axioms are laid down—posits them as truths to be accepted *à priori*, from which follow consequences which must therefore be accepted. And though the reviewer thinks this an untenable position, I am quite content to range myself with Newton in thinking it a tenable one—if, indeed, I may say so without undervaluing the reviewer's judgment."

To the sneer in the last sentence, and the remark that follows to the effect that the reviewer had evaded an issue "which it was inconvenient for him to meet," I shall reply by recommending Mr. Spencer to dogmatise either less elaborately or less rashly about the views of a philosopher like Sir I. Newton, whose works are so accessible and whose style is so clear, and at once pass on to call his attention to two passages in Newton's letters to Roger Cotes, who was at the time superintending the printing of the *Principia*.

In speaking of the special sense in which he used the word "hypothesis"—a sense which quite justified him in saying of himself "hypotheses non fingo"—Newton says:—

"In experimental philosophy it is not to be taken in so large a sense as to include the first *Principles or Axiomes which I call the laws of Motion. These Principles are deduced from phenomena and made general by Induction, which is the highest evidence that a Proposition can have in this Philosophy.*" (Letter lxxxi., edited by Edleston.)

And in the next letter he says:—

"On Saturday last I wrote to you representing that Experimental philosophy proceeds only upon Phenomena and deduces general Propositions from them only by Induction. And such is the proof of mutual attraction. And the arguments for y[e] impenetrability, mobility, and force of all bodies, and *for the laws of motion are no better.*"

I must confess to feeling a difficulty in reconciling the above extracts with the view that Newton posits the laws of motion "as truths to be accepted *à priori*."

THE AUTHOR OF THE ARTICLE IN THE BRITISH QUARTERLY REVIEW.

An Experiment on the Destructive Effect of Heat upon the Life of Bacteria and their Germs

I RECENTLY carried out an experiment which I shall not soon have the opportunity of repeating, and which I am consequently anxious to put on record. It is probably now familiar to those interested in the matter, that the experiments of Dr. Sanderson have established the fact that in an infusion of turnips and cheese prepared as directed by Dr. Bastian, heating to a temperature of 102 C. is sufficient to prevent the subsequent development of life (Bacteria) in the infusion even when the exposure to that temperature is only maintained for a few minutes. Boiling for five or ten minutes, according to Dr. Sanderson, is not sufficient to prevent the subsequent development of Bacteria, but according to the experiments of Dr. Pode and myself, boiling for ten minutes or a quarter of an hour *is* sufficient, provided that care has been taken to exclude visible lumps of cheese, and when the infusion is enclosed in a tube which tube is submerged in boiling water. Further, Dr. Sanderson has stated the following most important result, namely, that exposure to the boiling temperature (100° C.) was in all cases sufficient to prevent the subsequent development of Bacteria if it was carried on for so long as *one hour*.

This being the case, it occurred to me that since in all probability Bacteria and their germs, or spores, are killed by *through-heating* to a temperature a little below 70° C. (as established by various experiments in regard to Bacteria, but not in regard to possible germs, and admitted by both sides in the controversy as to their biogenetic or abiogenetic origin), it is desirable to recognise in our experiments the two distinct factors of this through-heating to any given temperature—namely, (1) the temperature to which the infusion to be heated is to be exposed; and (2) the length of time during which it is exposed to that temperature. If one of these variables—the time—be taken as a horizontal, and this line be divided into equal spaces representing periods of five minutes—whilst the perpendicular represents the range of temperature divided into degrees from 65° C. to 120° C—and if the results of observations with a given infusion indicating the time of exposure to a particular degree of temperature required in order to prevent the subsequent development of Bacteria be marked off on such a scheme, we should expect to obtain a series of points defining an asymptotic curve, the time required at the highest temperature being infinitely small, and at the lowest temperature infinitely great. This curve would vary in its character according to the properties of the infusion made use of. It was my intention to determine the principal points in this curve for Dr. Bastian's turnip and cheese infusion, but at present I have only made a tentative experiment at a low temperature. Using tubes of quarter-inch bore and three inches in length half filled with Dr. Bastian's infusion, and then submerged in water maintained at the desired temperature, I found that exposure for *six hours* to *a temperature of* 75° C. *was sufficient* to prevent the subsequent development of Bacteria. The same infusion enclosed in a similar tube and not heated at all, teemed with living Bacteria after four days; the same infusion boiled for ten minutes in an open tube remained barren. I submit this plan for a series of experiments to the readers of NATURE, without attaching much importance to the single but definite result which is above recorded.

I have not seen any reference in the pages of NATURE to the experiments which have been carried on in German laboratories in consequence of Prof. Huizinga's advocacy of Abiogenesis. Dr. Paul Samuelson, experimenting with Huizinga's infusions under the direction of Prof. Pflüger of Bonn, has obtained results which negative the inferences of Prof. Huizinga. Dr. Samuelson's paper appeared in Pflüger's *Archiv*, during the past year, and another experimenter (to whom I am unable to refer explicitly) has obtained equally definite results opposed to the speculations of Bastian and Huizinga.

Paris, Feb. 8 E. RAY LANKESTER

Animal Locomotion

I AM surprised to find that the Duke of Argyll prefers a charge of plagiarism against me in 1874 (NATURE, vol. ix. p. 381), said to have been committed by me in a lecture delivered at the Royal Institution of Great Britain in 1867. As his Grace was present at the lecture in question, and lodged no complaint in writing or otherwise, it appears to me that the charge, if not unfounded and out of place, is at least out of time. As I am not conscious of having perpetrated the plagiarism attributed to me, I wish to apprise your readers that the lecture referred to is published *in extenso* in the Proceedings of the Royal Institution of Great Britain, under date March 22, 1867, and may be consulted by all interested in the present discussion. That I had no wish to appropriate from his Grace, but was, on the contrary, desirous of giving him due credit for what he had done, will, I hope, be evident from the following quotation :—"In order to utilise the air as a means of transit, the body in motion, whether it moves in virtue of the life it possesses or because of a force superadded, must be heavier than it. If it were otherwise, if it were rescued from the operation of gravity on the one hand, and bereft of independent movement on the other, it must float about uncontrolled and uncontrollable, as happens in the ordinary gas balloon. The difference here insisted upon was, I have learned since writing the above, likewise pointed out by his Grace the Duke of Argyll, in his very able and eloquent article in *Good Words*, entitled the 'Reign of Law.' . . . This article, I am glad to find, has been reprinted in a separate form with numerous illustrations, and should be read by all interested in the subject of aëronautics." ("On the various Modes of Flight in Relation to Aëronautics ;" Proceedings Royal Institution of Great Britain, March 22, 1867.)

The only passage in the lecture bearing upon the point at issue *is opposed* to his Grace's explanation of the direction of the down stroke of the wing and in accordance with that originally given by me and defended by Mr. Wallace in NATURE, vol. ix. p. 301. *It cannot consequently be regarded as a plagiarism.* The Duke, it will be remembered, contends that the wing of the bird strikes *vertically downwards* during the down stroke. I, on the other hand, believe that the wing, during the down stroke, invariably strikes *downwards and forwards*. In this Mr. Wallace agrees with me. The passage in question runs as follows :—

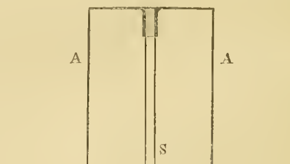
"All wings obtain this leverage by presenting oblique surfaces to the air, the degree of obliquity gradually increasing in a direction from behind *forwards and downwards* during extension, when the sudden or effective stroke is being given, and gradually decreasing in an opposite direction during fluxion or when the wing is being more slowly recovered preparatory to making a second stroke. The effective stroke in insects, and this holds true also of birds, is therefore delivered *downwards and forwards*, and not as the majority of writers believe, vertically, or even slightly backwards. This arises from the curious circumstance that birds, when flying, actually fall through the medium which elevates them, their course being indicated by the resultant of two forces, viz., that of gravity pulling vertically downwards, and that of the wing *acting at a given angle in an upward direction*. The wing of the bird acts after the manner of a boy's kite, the only difference being that the kite is *pulled forwards* upon the wind by the string and the hand, whereas in the bird the wing is *pushed forwards* on the wind by the weight of the body and the life residing in the pinion itself." (*Op. cit.*, March 22, 1867.) The Duke, it is true, compares the expanded motionless wings of a bird when sailing to a kite, while I, as stated, attribute a kite-action to the wings both when they rise and fall. The kite-action in the one instance is, however, not to be confounded with the kite-action in the other. That the wings invariably strike *downwards and forwards* during the down stroke, and *upwards and forwards* during the up stroke, and act as kites in either case, is a matter of observation, but still more of experiment. I have again and again witnessed the movement in the crow, cormorant, wild duck, and other birds, and repeated experiments with natural and artificial wings serve more and more to convince me that what I state is correct. But for the downward and forward and upward and forward curves made by the wings during the down and up strokes, progressive flight would be impossible. The curves in question, when the bird is advancing, unite to form *waved tracks* on either side of the body, thus representing the paths pursued by the vibrating wings in every form and variety of flight.

With regard to the poetical quotation introduced by me in my lecture and alluded to by his Grace, I venture to think that few will regard this as a case of plagiarism.

Edinburgh, March 23 J. BELL PETTIGREW

Electric Experiment

THE following striking experiment to show the rapidity of the influence of sulphuric acid in removing the invisible film of moisture that in ordinary circumstances adheres to the surface of glass and deprives it of its quality as an electric insulator, was recently shown to the Natural Philosophy class in the University of Glasgow by Sir William Thomson, and as it may be interesting to some of your readers, I send you an account of it. The apparatus used were a gold-leaf electroscope, and one of the ordinary table insulators long used in this University, of which the following is a description. A A is a hollow cylinder of brass, the lower part of which can be readily detached, replaced, and fixed in position by a bayonet-joint. The cylinder is supported at the top by the glass rod S, which passes through a circular opening in the bottom of the cylinder and is fixed to the sole plate C. In the lower part is placed a circular canal of lead containing a number of pieces of pumice stone *p p*, which for insulating purposes are moistened with a few drops of strong sulphuric acid. On the previous evening the pumice *pp* was moistened with a few drops of water, the cylinder closed and



left till morning. The experiment was then performed thus The gold leaves of the electroscope were connected with A A by a fine wire and a charge communicated ; the gold leaves at first repelled each other, but almost immediately collapsed. This was repeated once or twice, to show distinctly that there was no insulation.

The pumice containing water was then removed, and was replaced by other pieces moistened with sulphuric acid (in both cases the moistening was so little that the pumice had the appearance of being quite dry) and the vessel was closed. As the experiment was made towards the end of the lecture and time was pressing, a warm hand was placed on the side of the insulator to accelerate the drying process by creating connective currents in the air. Whether this hastened the effect or not sensibly it is impossible to say, but the insulation at once began to improve, and in less than five minutes it was shown to be perfect by the gold leaves remaining diverged to their full extent.

The University, Glasgow, March 21 D. M'FARLANE

Fertilisation of the Fumariaceæ

THE accompanying note has been given me by my friend Mr. J. Traherne Moggridge, and I should feel obliged if you would insert it in NATURE with the view of eliciting the communication both of other similar phenomena, and of some explanation of them.

ST. GEORGE MIVART

Mentone, March 18

Note on apparently useless Colouring in the Flowers of a Fumitory (*Fumaria capreolata var. pallidiflora, F. pallidiflora* Jord.)

I observe that in this plant at Mentone the flowers attain their brightest colouring after the ovaries are set, and when fertilisation is no longer necessary, or indeed possible. During the period previous to impregnation, the flowers are pale and nearly white, and the pedicels erect or horizontal; afterwards they become pink, or even crimson, and the pedicels are recurved, and the colour of the petals, which retain their form and position ntil the ovary has nearly attained its full size, intensifies with the lapse of time.

If the reverse had been the case there is little doubt that we should have regarded the bright colouring as specially adapted to attract insects, and as existing for that purpose, insects being, according to Prof. F. Hildebrand,* important agents in the fertilisation of fumitories; but here, as the brighter flowers are those which no longer need or are capable of profiting by the interference of insects, this explanation ceases to be possible.

This little fact, therefore, would seem to be one which might be classed with those which teach us that, side by side with the developments and modifications which are plainly beneficial to the organism of which they form a part, there are others, which, as far as we can see, are neither useful nor harmful to their possessor, though they may, and frequently do, supply features which especially attract our attention and admiration.

J. TRAHERNE MOGGRIDGE

* "Ueber die Bestäubungsvorrichtungen bei den Fumariaceen," in Pringsheim's "Jahrbücher," vol. vii. part 4, p. 423 (1870). Reviewed in "Bull. Soc. Bot. de France," xix. (1872), p. 145.

OCEAN CURRENTS

TWO papers which Mr. Croll has recently published "On the Physical Cause of Ocean Currents" (*Philosophical Magazine* for Feb. and Mar. 1874), bring the main question at issue between him and myself into very distinct view; and as the results of the *Challenger* Temperature-survey of the Atlantic, lately made public by the Admiralty, afford (as it seems to me) important data towards the settlement of this question I shall be glad to be allowed to point out what seem to me their chief bearings upon it.

The position taken by Mr. Croll is, that all the great movements of ocean-water, deep as well as superficial, depend on the action of winds upon its surface. And whilst freely admitting that Polar water finds its way along the floor of the great ocean-basins into the equatorial area, he affirms that this is merely the reflux of the current which has been driven into the Polar basins by the agency of winds.

On the other hand, it is fully recognised by myself, that the *current* movements of *surface*-water are, for the most part, produced by the agency of winds; but these movements, I contend, all belong to a *horizontal circulation*, *which tends to complete itself*,—a surface indraught being produced wherever a surface outflow is kept up, as we see in the horizontal circulations of the North and South Atlantic, the North and South Pacific, and the Indian Ocean, depicted in Mr. Croll's own map. But I maintain that the *deep* movements of ocean-water are the result of a *vertical circulation*, which is maintained by the continuance of a disturbed equilibrium between the Polar and equatorial columns, occasioned by the surface-action of Polar cold and equatorial heat.

As Mr. Croll is unable to understand why I should speak of Polar cold, rather than equatorial heat, as the *primum mobile* of this vertical circulation, and accuses me of an ignorance of the fundamental principles of physics in so regarding it, I may be allowed first briefly to explain myself; since others may experience the same difficulty, from some want of precision on my part in stating my case. The eminent physicists, however, with whom I have had the advantage of discussing this point, do *not* share Mr. Croll's objection, but hold my statement to be perfectly correct.

Heat applied to the *surface* of any body of *fresh* water, whether by solar radiation, or by the experimental application of a heated plate, will raise the temperature of the *surface-film*, without producing any downward convection. Limited downward convection, however, is occasioned in *salt* water by the sinking of the surface-films which are concentrated by evaporation; but this convection I found in my Mediterranean observations, which have been fully confirmed by those of the *Challenger* in the equatorial area, to be practically limited to the first fifty fathoms. Water in a long trough may thus be superficially heated (as I have experimentally ascertained), by the application of surface-heat to one-sixth of its length, until the temperature of its whole surface-film is raised to 100° or more; but the further application of surface-heat expends itself in vaporisation, and does not communicate itself in any sensible degree to the mass of water beneath, which, therefore, *can not be put in motion* by such application. On the other hand, the moment that *surface-cold* is applied, a downward convection is produced, as Mr. Croll may easily ascertain for himself if he will only try the experiment; and the continued application of such surface-cold to any one portion of the surface will maintain a constant movement through the entire mass of the liquid, until thermal equilibrium is restored by the cooling-down of the whole. But if the restoration of this thermal equilibrium be prevented by the application of heat to another part of the surface, the disturbance of equilibrium will be kept up, and a *vertica circulation* maintained, as long as these two opposing agencies are in operation. If Mr. Croll cannot see that this *must be* the case, I am not responsible for his failure to apprehend that which theory and experiment alike sanction.

I re-affirm, then, that *cold* applied to the *surface* has exactly the same motor power as *heat* applied at the *bottom*; and that its motor agency is more potent than that of heat applied at the surface, simply because the former is diffused by convection through the entire mass of the water, which it keeps on *cooling* and *moving*, whilst the latter is limited to the surface-film, and expends itself in producing evaporation.

Mr. Croll objects to this, that, if it were true, nearly the whole mass of oceanic water must have an almost Polar temperature. I accept this issue; and refer to the *Challenger* temperature-soundings, as justifying it. If he will look at the section taken across the equator, he will find that—*as I had predicted*—Polar water there lies within a very short distance from the surface. At less than 100 fathoms' depth, the temperature falls from 78° at the surface to 55°, and the isotherm of 40° is reached at about 320 fathoms. Below this lies a *stratum of more than* 2,000 *fathoms thickness*, whose temperature, ranging downwards from 40° to 32°·4, shows it to consist mainly of Polar water. And as, from the data supplied by the Mediterranean and Gulf of Suez temperature-soundings, a body of equatorial water secluded from all connection with the oceanic circulation might be expected to have the uniform (or isocheimal) temperature of 75° from 50 fathoms downwards, it is clear that the influence of Polar cold here extends itself upwards within 100 fathoms of the surface.

Again, Mr. Croll says that I have made no allowance for the *excess* of salinity in equatorial water, which, according to him, must counterbalance the increase of specific gravity produced in Polar water by the reduction of its temperature. Here, again, he is unfortunate

as regards his facts. He appears to have overlooked the observations proving the *lower* salinity of inter-tropical water, which I had cited as furnishing an additional indication that Polar water is constantly rising from the bottom towards the surface in the equatorial area. These observations have been most remarkably confirmed by those taken by the physicists of the *Challenger*. For, whilst in the extra-tropical area the sp. gr. of surface-water was in excess of that of bottom-water, in the equatorial area it was reduced to an almost precise correspondence with it, due allowance for temperature being of course made.

According to Mr. Croll's doctrine, the whole of that vast mass of water in the North Atlantic, averaging, say, 1,500 fathoms in thickness, and 3,600 miles in breadth, the temperature of which (from 40° downwards) as ascertained by the *Challenger* soundings, clearly shows it to be mainly derived from a Polar source, is nothing else than *the reflux of the Gulf Stream*. Now, even if we suppose that the whole of this stream, as it passes Sandy Hook, were to go on into the closed Arctic Basin, it would only force out an equivalent body of water. And as, on comparing the sectional areas of the two, I find that of the Gulf Stream to be about 1·900th that of the North Atlantic underflow; and as it is admitted that a large part of the Gulf Stream returns into the Mid-Atlantic circulation, only a branch of it going on to the north-east; the extreme improbability (may I not say impossibility?) that so vast a mass of water can be put in motion by what is by comparison such a mere rivulet—the north-east motion of which, as a distinct current, has not been traced eastward of 30° W. long.—seems still more obvious.

Lastly, the *Challenger* observations in the South Atlantic have proved exactly what I had anticipated, viz., that the bottom-temperature is lower, and that the Polar underflow lies much nearer the surface in this ocean than in the North Atlantic. Now this case appears to me to afford the *experimentum crucis* between Mr. Croll's doctrine and my own. For my prediction of this result was based on the fact, that, as there is here a perfectly open communication between the Polar and equatorial areas, the vertical circulation would take place more freely. On the other hand, according to Mr. Croll's doctrine, it would have been expected that there should be a far smaller reflux, or no reflux at all. For, though a portion of the equatorial current passes southwards when it meets the coast of South America, there is no ground whatever for believing that it ever goes near the Antarctic circle; and if it did find its way thither, there is no "closed basin" from which it can drive back a return current.

As it is usually considered in scientific inquiry that the verification of a prediction affords cogent evidence of the validity of the hypothesis on which it is based, I venture to submit that so far my case has been made good.

WILLIAM B. CARPENTER

THE DEATH OF DR. LIVINGSTONE

THE daily papers have obtained from the London office of the *New York Herald* the following telegram, containing details of the death of Dr. Livingstone, dated Suez, Sunday, March 29:—

"The *Malwa* arrived off Suez at eleven on Saturday night, having Mr. Arthur Laing and Jacob Wainwright on board, with the body of Livingstone. He had been ill with chronic dysentery for several months past. Although well supplied with stores and medicine, he seems to have had a presentiment that the attack would prove fatal. He rode a donkey, but was subsequently carried, and thus arrived at Muilala, beyond Lake Bemba, in Bisa country, when he said, 'Build me a hut to die in.' The hut was built by his followers, who first made him a bed. He suffered greatly, groaning night and day. On the third day he said, 'I am very cold; put more grass over the hut.' His followers did not speak or go near him. Kitumbo, Chief of Bisa, sent flour and beans, and behaved well to the party. On the fourth day Livingstone became insensible, and died about midnight. Majuahra, his servant, was present. His last entry in diary was on April 27. He spoke much and sadly of home and family. When first seized he told his followers he intended to change everything for ivory, to give to them, and to push on to Ujiji and Zanzibar, and try to reach England. On the day of his death the followers consulted what to do. The Nassick boys determined to preserve the remains. They were afraid to inform the Chief of Livingstone's death. The secretary removed the body to another hut, around which he built a high fence to ensure privacy. They opened the body and removed the internals, which were placed in a tin box and burned inside the fence under a large tree. Jacob Wainwright cut an inscription on the tree as follows:—'Dr. Livingstone died on May 4, 1873,' and superscribed the name of the head man Susa. The body was preserved in salt, and dried in the sun for twelve days. Kitumbo was then informed of the death, and beat drums and fired guns as a token of respect, and allowed the followers to remove the body, which was placed in a coffin formed of bark, then journeyed to Unyanyembe about six months, sending an advanced party with information addressed to Livingstone's son, which met Cameron. The latter sent back a bale of cloth and powder. The body arrived at Unyanyembe ten days after advanced party, and rested there a fortnight. Cameron, Murphy, and Dillon together there. Latter very ill, blind, and mind affected. Committed suicide at Kasakera; buried there. Here Livingstone's remains were put in another bark case, smaller, done up as a bale to deceive natives who objected to the passage of the corpse, which was thus carried to Zanzibar. Livingstone's clothing, papers, and instruments accompany the body. When ill Livingstone prayed much. At Muilala he said, 'I am going home.' Chumah remains at Zanzibar. Webb, American consul at Zanzibar, is on his way home, and has letters handed to him by Murphy from Livingstone for Stanley, which he will deliver personally only. Geographical news follows. After Stanley's departure the Doctor left Unyanyembe, rounded the south end of Lake Tanganyika, and travelled south of Lake Bemba, or Bangneoleo, crossed it south to north, then along east side, returning north through marshes to Muilala. All papers sealed. Address Secretary of State, in charge of Arthur Laing, a British merchant from Zanzibar. Murphy and Cameron remain behind."

These details are few but intensely touching. We believe that the Peninsular and Oriental Company's Bombay steamer *Malwa*, with Dr. Livingstone's body on board, is due on April 13 at Southampton. The body will be landed at that port and conveyed to London, by railway, for interment in Westminster Abbey; it is to be regretted that the faithful Chumah does not accompany his master's remains. It is impossible that Government will fail in doing what the whole civilised world takes for granted it will do—pay all possible honour to the remains of H. M. Consul, and of probably the greatest traveller that this or any other country ever produced.

REPORT OF PROF. PARKER'S HUNTERIAN LECTURES "ON THE STRUCTURE AND DEVELOPMENT OF THE VERTEBRATE SKULL"

THE new Hunterian Professor, Mr. W. Kitchen Parker, has just completed his course of eighteen lectures at the College of Surgeons, embodying in them the results of his researches on that most difficult problem, the deve-

lopment of the vertebrate skull. The plan pursued by Mr. Parker has been to describe first in their adult state, and afterwards in the various stages of their development, the skulls of certain prominent vertebrates which should serve as types for the other members of the group, and to deduce from the facts thus established the principles on which the cranium is constructed in the whole sub-kingdom. The types selected were the shark, skate, salmon, axolotl, frog, snake, fowl, and pig.

I.—*Morphological Elements of the Skull.* Nothing can be more hopeless than the attempt to unravel and explain the vertebrate skull by the study of adult forms only. The modification of face and brain-case, in the long line of creatures which begins with the lamprey and ends with man, are so endless that, until the study of embryology put the matter on a new and firm foundation, the best observers failed signally to produce a true "theory of the skull," the most elaborate attempt of the kind—the "vertebral theory" started by Goethe and Oken in Germany, and perfected by Prof. Owen in England—having resulted only in a convenient working hypothesis.

When, however, instead of starting with the highly differentiated skulls of adult animals, the embryos of these animals from their earliest conditions are made the subject of investigation, a new light is shed on the whole question. It is found that the skulls of all the vertebrata which have yet been thoroughly worked out, originate in, practically, a precisely similar manner; and even in some of the more advanced stages it would be hard to point out very essential differences between the skulls of a fish, a bird, or a mammal. Before entering upon the description of the skull of the shark, the first type to be gone into,* it will be advisable to consider the distinct elements of which the *primordial cranium* of any vertebrate animal is made up.

a. On either side of the anterior termination of the notochord, or primitive axis of the body (Fig. 1, Ch.), is developed a cartilaginous plate (I.M), which as a rule unites both above and below the notochord with its fellow of the opposite side. These plates taken together were termed by Rathke the *investing mass*: in the language of Prof. Huxley, they constitute the *parachordal elements* of the primordial skull or *chondro-cranium*.

b. In front of and below the investing mass, cartilaginous thickenings with intervening spaces are developed in the side walls of the body, enclosing, rib-like, the

FIG. I.

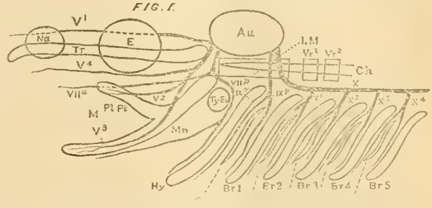


FIG. 1.—DIAGRAM OF VERTEBRATE SKULL. Ch, Notochord; Vr^1, Vr^2, first and second vertebræ; I.M, investing mass; Au, auditory capsule; E, eye; Na, nasal capsule; Tr, trabecular; Mn, mandibular; Hy, hyoid; Br.1-5, branchial arches; Pl.Pt, pterygo-palatine process; M, mouth; Ty.Eu, tympano-Eustachian passage; Cl.1-5, branchial clefts; V^1, orbito-nasal; V^2, maxillary; V^3, mandibular; V^4, palatine division of the trigeminal nerve; VII^a, vidian; VII^p, hyomandibular divisions of portiodura; IX, glossopharyngeal; X, vagus.

pharyngeal cavity. These are the *visceral arches* (pleural elements, Huxley), the spaces between them the visceral clefts. The usual number of these bars is eight, although in certain exceptional cases they may be increased to nine (Hexanchus) or ten (Heptanchus). Taken from before backwards, the pleural arches are named as follows:—1. trabecular (Tr), 2. mandibular (Mn), 3. hyoid (Hy), 4-8. branchial (Br. 1—5), the clefts separating them being in like manner, the mouth (M), the tympano-Eustachian passage (Ty Eu) and the branchial clefts (Cl 1—5). At a very early period, the mandibular arch gives off a forward process, the palato-pterygoid arcade (Pl Pt) which in certain cases takes on the form of a distinct pleural element. In the branchiate vertebrata (Fishes and

FIG. 2

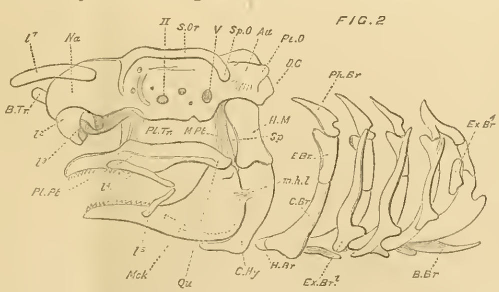


FIG. 2.—SKULL OF SHARK. O.C., occipital condyle; Pt.O, pterotic, and Sp.O sphenotic process; S.Or, supra-orbital ridge; B.Tr, basi-trabecular l^1, l^2, l^3, l^4, l^5, labial cartilages; Pl.Tr., palato-trabecular ligament; M.Pt., meta-pterygoid; Mck, Meckel's cartilage; H.M, hyo-mandibular; C.Hy, cerato-hyal; Ph.Br, E.Br, C.Br, H.Br, and B.Br, pharyngo-, epi-, cerato-, hypo-, and basi-branchial; Ex.Br, extra-branchials; Sp, spiracle; II, Optic foramen.

Amphibia) all these arches with the single exception of the trabecular may bear functional gills, the presence of these organs being the chief physiological test of their serial homology.

Far more important, however, in the determination of these elements of the skull, are the morphological landmarks afforded by the cranial nerves, especially by the 5th, 7th, 9th, and 10th pairs. It is the constant habit of these nerves to fork above a visceral cleft, one of the branches thus formed supplying the posterior face of the arch in front of the cleft, the other the anterior face of the arch behind and (see Fig. 1). The orbito-nasal or ophthalmic (V^1) and the palatine (V^4) divisions of the trigeminal are the special trabecular nerves, the former passing over the optic nerve, the latter below it. The posterior primary subdivision of this nerve passes behind the mouth-cleft, and divides into two branches, both of which are distributed to the anterior (or in the altered position of the three foremost arches, outer) side of the mandibular arch; the mandibular, or inferior maxillary nerve (V^3) passing along the original direction of the arch, the superior maxillary (V^2) following the pterygo-palatine process. The seventh nerve, or portiodura, divides above the tympano-Eustachian passage, its anterior

* The development of the skull in the Marsipobranchii (Lamprey and Hag), the lowest group of craniate Vertebrata, has not yet been studied with sufficient accuracy to allow of the determination of its parts with any degree of certainty.

branch (VII[a]) going to the inner (posterior) side of the mandibular arch, and its posterior (VII[p]) division to the outer side of the hyoid. The glossopharyngeal (IX.), in like manner, is distributed to the inner side of the hyoid and the front face of the first branchial, the hinder face of which, as well as all the remaining branchial arches, is supplied by the great tenth nerve, or vagus (X).

By Rathke, to whom are due the first accurate observations on the development of the skull, the trabecular arches were looked upon as mere forward processes of the investing mass, and were called *trabeculæ cranii*, or "rafters of the skull." This misconception of their true nature arose from the fact that they very soon coalesce with the investing mass, and are only to be found distinct in extremely early stages.

c. Round the organs of smell and hearing cartilaginous investments are formed, known respectively as the nasal (Na) and auditory (Au) capsules. The latter become, at a very early period, united with the investing mass, while the nasal capsules come into close relations with the anterior or distal ends of the trabeculæ.* These are the *paraneural elements* of the primordial skull.

d. Certain cartilages may be developed in relation with and external to the visceral arches, called from this circumstance "extra-viscerals." Of this nature are the labial cartilages, which take so large a share in the formation of the skull of many cartilaginous fishes.

e. Lastly, the general membranous roof and walls of the brain-case may chondrify to a greater or less extent, but this chondrification is in nearly every case continuous with the trabeculæ and nasal capsules in front and below, and with the investing mass and auditory capsules behind.

Not only is the originally membranous cranium thus strengthened by deposits of cartilage, but osseous deposits may take place either in the primordial skull itself, or in the subcutaneous tissue surrounding it. The latter are called "investing-bones," or *parostoses;* the former may be of two kinds; when occurring as mere calcifications of the substance of the cartilage, they are known as *endostoses*, when having the structure of true bone, as *ectostoses*.

II.—*Skull of the Shark* (*Lesser Spotted Dog-fish*, Scyllium canicula).—The skull of the shark is one of the best examples of the chondro-cranium in its least altered state, being entirely uncomplicated by the development of investing bones, and covered simply by a close-set series of superficial calcifications.

The brain-case is much flattened both above and below. Seen from above, it is greatly excavated in its central portion by the orbits, but expanded in front by the rounded nasal capsules (Fig. 2, Na), and behind by the more or less quadrate auditory capsules (Au). The cartilaginous roof of the skull, or *tegmen cranii*, is interrupted by an oval membranous space, or "fontanelle," situated between the hinder boundaries of the nasal sacs, a position peculiar to the sharks. The upper surface of the otic capsules exhibits three well-marked elevations for the semi-circular canals, and just within that for the anterior canal, a small rounded aperture, the remains of the primitive involution of the integument from which the organ of hearing arose. An elevation on the hinder end of the posterior canal marks the position of the epiotic ossification so well developed in the osseous fish; the pterotic is also indicated by a large outstanding process (Pt O) which forms the postero-external angle of the skull, and the sphenotic (post-frontal of Cuvier) by the posterior portion of the supra-orbital ridge (S Or) when it coalesces with the auditory capsule (Sp O). The anterior extremity of this ridge forms in like manner the pre-frontal process. One very noteworthy point, observable both in an upper, under, or side view, is the presence between the nasal capsules of a short rod of cartilage (B Tr) representing the median basal portion, or keystone of the trabecular arch, and hence called the basi-trabecular.

Viewed from behind, the skull presents a large foramen magnum, bounded below and at the sides by the well-developed occipital condyles, between which is a slight elevation, showing the point where the notochord originally entered the investing mass. External to the occipital foramen, and marking the original boundary between the parachordal and otic elements of the skull is the foramen for the exit of the 9th and 10th nerves. The trigeminal foramen, which always points to the anterior limit of the otic region, forms a large aperture in the side wall of the brain-case (V), as also does the optic foramen (II).

The jaws are very loosely united to the other parts of the skull, and consist of an upper and a lower dentigerous arch, the former of which is connected with the skull by two bands of ligamentous fibres. The lower arch (Mck), which articulates with the posterior end of the upper, is the homologue of Meckel's cartilage, the rod which forms the foundation of the lower jaw in all vertebrata, but which as a rule, owing to the great development of investing bases, is reduced to a more slender style, or is even suppressed altogether. The posterior portion of the upper dentigerous arch (Qu) answers to the quadrate, a bone which in all Teleostei, as well as in Amphibia and Sauropsida, gives attachment to the mandible. The remainder of this "upper-jaw" represents the series of bones (pterygoid, meso-pterygoid, and palatine) which in the osseous fish connect the quadrate with the fore-part of the skull, the meta-pterygoid or proximal end of the mandibular arch being represented by the band of fibrous tissue (M Pt) which connects the quadrate with the auditory capsule.

Close behind the attachment of the meta-pterygoid ligament, a large phalangiform cartilage (H M) is articulated to the auditory capsule; this represents the hyomandibular of the osseous fish, the largest bone in the suspensory apparatus of the lower jaw, and the uppermost portion of the hyoid arch. Between this cartilage and the meta-pterygoid is a space (Sp), which in the recent state forms a communication between the cavity of the mouth and the exterior. This is called the spiracle, and answers to the tympano-Eustachian passage of the higher vertebrata. The distal portion of the hyoid arch consists of a large and strong cartilage, the cerato-hyal (C Hy), below which is a basal piece, common to both sides (shown in the figure by dotted lines), the basi-hyal. This is an extremely simple mode of segmentation of the hyoid arch, and approaches nearly to the primitive condition.

The cerato-hyal is connected with the mandible by a ligament—the mandibulo-hyoid ligament (mhl).

There are five branchial arches, all of which are split up into four segments, called, after the names originally given by Prof. Owen to the corresponding parts in the Teleostei, pharyngo- epi-, cerato-, and hypo-branchial. The inferior median piece, or basi-branchial (B Br), occurs only in the hinder part of the series.

The extra-viscerals are represented by the labial cartilages (l^1—l^5) and by the extra-branchials (Ex Br 1—5), between which and the branchial arches extend cartilaginous rods, acting as supports to the septa between the gill-pouches. The last arch, however, bears no gill and has no extra-branchial corresponding to it. The hyoid also is devoid of an extra-visceral, although it bears a series of greatly divided cartilages, which support the anterior wall of the first gill-sac; this arch, consequently, carries a half-gill. The branchia of the mandibular arch is represented by a vascular plexus (pseudo-branchia) on the anterior side of the spiracular opening.

* The Sclerotic, the fibrous (mammalia), or cartilaginous (Sauropsida and Ichthyopsida) capsule developed around the organ of sight (E) never really forms part of the skull, although in the sharks and rays, and some osseous fish, it is articulated with the side walls of the brain case by a cartilaginous pedicle. The form of the skull is, however, greatly governed by the presence of these optic capsules.

NOTES

AN International Horticultural Show is to be held at Florence in May, from the 11th to the 25th. The *Société Royale Toscane d'Horticulture* offers 100 medals of gold, 221 of silver, and 131 of bronze, and five grand *prix d'honneur* are offered respectively by the King of Italy, the Minister of Agriculture and Commerce, the province of Florence, the town of Florence, and the lady patronesses. Prince Demidoff and Prof. Parlatore have also placed gold medals for special classes, at the disposal of the committee. Coincidently with the Show the International Botanical Congress will be held at Florence under the presidency of Prof. Parlatore. The programme of subjects for discussion includes questions on the nature and functions of hairs on plants, on cell circulation, on the latex, on the automic movement of the leaves of plants, on the causes which determine the direction of the root in the germination of a seed, on the causes which influence the direction of the growth of branches, especially of weeping trees, on the analysis of the organs of reproduction between cryptogams and phanerogams, as well as many other subjects more widely known, and subjects of debate such as the origin of *Bacteria*, the determination of fossil plants by their leaves, the distinction between *species*, *race*, and *variety*, and the origin of insular and alpine floras. The President and Secretaries of the *Société Royale Toscane d'Horticulture* announce their readiness to communicate with any botanists who wish for further information with a view to attending the Congress. The official language of the Congress will be Italian, but papers may be communicated and discussions conducted in any language. Representatives to the Congress have been appointed from the various countries of Europe, and from Egypt, Australia, Mexico, Brazil, &c. Among the names of those who are expected are announced the following English botanists:—Messrs. Hooker, Trimen, Ball, Hiern, Hogg, Maw, Murray, Allmann, and Binney. As a measure of precaution against the introduction of the *Phylloxera*, the importation of vines and of other fruit-trees into Italy has been rigorously prohibited since October 31 last.

THE Syndics of the Cambridge Botanic garden in their annual report state that the Curator has nearly completed the re-arrangement of the herbaceous plants, and it is hoped the laborious task will be finished in the ensuing year. The plant houses are in a good state of repair, but over-crowded. The Professor and Curator are unable to see in what manner the number of plants kept in them can be materially reduced without injuring the efficiency of the garden. Several of the finest and most valuable specimen plants now threaten to grow through the roof of the houses. The Syndics acknowledge some donations of foreign seeds and plants, but they are under the necessity of discouraging gifts of seeds of plants belonging to warmer regions, because of the want of room for their proper cultivation.

WE are very glad to hear that negotiations are pending for the transfer of the valuable Museum of Natural History, which was formerly in the possession of the East India Company, from the India House, where it has been for some time stored, to South Kensington, where it will at last be available for reference and study. This desirable transfer we strongly recommended in an article which appeared about a year ago (NATURE, vol. vii. p. 457).

A PURSE of 540 guineas has recently been presented by members of the British Association and other friends to Mr. W. Pengelly, F.R.S., F.G.S., as a testimony to the high value of his labours in conducting the exploration of Kent's Cavern, Torquay, and of his other services to science. After the presentation it appeared that many of Mr. Pengelly's friends and advisers had been left in ignorance of what was proposed. To enable all such persons to join in this mark of appreciation the hon. sec. to the testimonial fund, Mr. J. E. Lee, F.G.S., Villa Syracusa, Torquay, is prepared still to receive subscriptions up to the 17th of April.

A GERMAN Natural History and Anthropological Society for Eastern Asia has now existed for a twelvemonth, having been established on March 22, 1873. The headquarters is at Tokio, and the Society consists of fifty-two members, twenty-three being resident at Yokohama, twenty at Tokio, seven in Hiogo, and two at Singapore. Herr von Brandt, the Minister for the German Empire in Japan, is its president. The Society has already published a volume of "Proceedings," containing several interesting and important papers on the subjects for the cultivation of which the Society was founded, especially on the ancient customs and history of Japan.

A MONUMENT to Antonio Bertolini, author of "Flora Italica," has been inaugurated at Bologna.

DR. ASCHERSON, of Berlin, has gone to Egypt as a member of a commission of exploration. Prof. Planchon, of Montpellier, has been sent by the French Government to the United States to inquire into the new vine disease caused by the *Pemphigus vitifolia*. Other botanists at present occupied with foreign exploration are, Sig. Pichler in the east, and Messrs. Lorentz and Hieronymus.

THE chairs of Botany at the Universities of Genoa and of Modena were announced vacant at the end of January.

THE new edition of Pritzel's "Thesaurus" will be edited by Prof. Jessen.

PROF. STEFANO DE' ROSSI has just started in Rome a *Bulletino del Vulcani*. The learned geologist has undertaken to chronicle and to comment upon all the volcanic phenomena which are observed in Italy and the surrounding islands. Two parts of the periodical have been published, giving details of every commotion felt during 1873. The ground was in such activity that Prof. Stefano de' Rossi has been able to report more than three hundred separate phenomena. The mean number of seismic commotions in the whole Peninsula is almost *one daily*.

AN aëronautical experiment of great importance took place on March 22. The balloon "Etoile Polaire" was sent up with two aëronauts, M. Sivel and Croce-Spinelli, to test if the respiration of an air rich in oxygen would enable observers to reach a high level without being suffocated by the rarity of the surrounding medium. The experiment was suggested by M. W. de Fonvielle in his "Science en Ballon," and an apparatus was constructed by M. Paul Bert, Professor at the Sorbonne, and a Member of the National Assembly. The "Etoile Polaire" started at 11.40 A.M. from the La Villette gasworks, and at 12.4 P.M. had reached 5,000 metres. The temperature, which was + 13° C. on the ground, had sunk to − 10° C. M. Croce-Spinelli was almost suffocated, but by using the oxygenised-air respirator he recovered. His pulse, which was beating 86 on the ground, was beating 140, and with the respirator 120 only. These experiments were conducted from 12.4 to 1.30 P.M., when the balloon had reached 7,400 metres, where the thermometer sank to − 24°. No observation was taken during the descent, which took place at 2.12 P.M. at Bar-sur-Seine, 120 miles from Paris. On landing, the temperature was + 17°. M. Croce-Spinelli had with him a little hand spectroscope supplied by M. Janssen. He states that all the aqueous lines belonging to the vapour had disappeared, and that the solar rays *D* and *F* were growing very dark. When not using the respirator the sky seemed quite dark, but the blue colour was restored when respiring oxygenised air. The measurement of the balloon was 2,800 cubic metres. It was elevated with 1,650 metres of lighting

gas, carrying with it 380 ballast, of which no more than 40 were left for descending from 7,400 metres. The altitude is higher than any French aëronaut has reached up to the present time, but Mr. Glaisher, without the help of any oxygenised air, navigated the atmosphere on several occasions to that distance from the sea-level—as on August 28, 1862, April 18, 1863, June 26, 1863, &c. He had no feeling of suffocation except when he reached 10,000 metres on September 5, 1862. It is to be supposed that with proper care and with persons properly trained and selected, the method, although efficacious, is not required except at higher level or for the purpose of increasing the comforts of aërial travellers. It is very probable that it is useless to keep several mixtures and that pure oxygen is better as being more efficacious and less bulky.

THIS year's International Exhibition at South Kensington opens next Monday.

AT the annual general meeting of the Royal College of Physicians of London, held on March 30, Sir George Burrows, F.R.S., was re-elected President of the College.

ASTRONOMERS will be interested to learn that among the numerous able men whom the President of the republic of Ecuador has gathered to that city in order to develop the University of Quito, there has appeared one, Father Menten, whose interest in astronomy has been such as promises to settle the long-mooted question as to an observatory in that city. Menten has now returned to Quito laden with a portion of the instrumental outfit that he was ordered to secure at Munich. Among the apparatus is a six-inch meridian circle. Father Menten was for some time a pupil of the eminent Argelander.

THE Royal Academy of Belgium has announced the following subject for its prize essay for 1875:—The relation of heat to the development of phanerogamic vegetation, especially with respect to periodic phenomena, and the value of the dynamic influence of solar heat on the evolution of plants.

IT has been proposed to hold a fungus show in Scotland; a preliminary meeting is to be held in Marischal College, Aberdeen, on April 14.

MR. J. C. MELLIS, late Commissioner of Crown Property at St. Helena, announces as in the press a work on the geology, fauna, flora, and meteorology of St. Helena. Separated so far as the island is from any mainland, and showing no trace of any former connection with a continent, there are many questions of interest as to the origin of its flora and fauna. This work is stated to be based on Mr. Mellis's own observations, and promises to be of great value.

MR. WATSON has brought to England a series of paintings by a Japanese artist illustrating some of the customs of the Ainos, who inhabit the island of Yezo, or Sesso as it is sometimes spelt, north of Niphon. Not much is known of the Ainos, but they are regarded as the aborigines of Yezo, who have been driven inland by the fringe of Japanese settlements all round the coast. The first of the series is said to represent the traditional origin of the race. A woman is in a cave weeping, and a dog is carrying to her a red flower, apparently a rose. It does not, however, appear to be known what this symbolises. A coloured drawing of a male Aino executed with great care and regard to detail, shows bows and arrows of native make and a sword of Japanese manufacture. A cord is worn round the head to help to form a support for a weight, as they never carry burdens on their backs. The portrait of a female shows the broad tattooing round the upper and lower lip and on the arms, as the sign of marriage. Both the male and female wear earrings, which is a contrast to the Japanese, who never wear personal ornaments. The woman is playing on a kind of guitar with five strings. In the views of the interior of the dwellings all cooking utensils have their Japanese names written against them by the artist, so that their use may be known though their shape is not familiar. Some of the series illustrate whale harpooning, which is done with a two-pronged harpoon, and many are devoted to the festival of the bear. After killing a bear they appear to sit round it in state solemnity, as if worshipping it and offering it food and drink. Dresses of many colours are worn, and the bear is decorated. Their commerce is represented as the collecting of seaweed, drying it, packing it in bundles and selling these by weight to Japanese. The drawings of the articles used for food, laminaria, crabs, holothuria, cuttle-fish, &c., are drawn with great detail and delicacy of colouring.

THE first volume of "Repertorium annuum Literaturæ Botanicæ Periodicæ," has appeared, published at Harlem under the editorship of Van Bemmalen. It professes to give an account, for the year, of all botanical papers read in full or in abstract before Societies, and also to notice memoirs and communications to Societies.

DR. L. JUST, Professor of Agricultural Chemistry in the Polytechnic School at Carlsruhe, has just published, with the co-operation of several distinguished men of science, an Annual of Botany, intended to form a complete record of all botanical works published during the year.

THE Bureau des Longitudes is no longer connected with the National Observatory of Paris. It is to have its own budget, library, and a public building will be arranged for its private use. The most influential member and president is M. Faye, who is making a public appeal to French astronomers asking them to devote themselves to the spectroscopic observations of the sun.

MR. W. S. CLARK, president of the Massachusetts Agricultural College, publishes a lecture On the Circulation of Sap in Plants, containing a great amount of information as to our knowledge of the subject, and a number of tables and diagrams to illustrate the maximum and minimum pressures of the sap in different trees. Mr. Clark maintains, in opposition to some recent statements, that there is a flow of crude sap upwards in the wood, and a flow of organisable material essential to the life of the plant proceeding from the leaf to the root through the bark and cambium layer, from which the growth of the season is formed.

THE annual *réunion* of the Sociétés Savantes des Départements of France, will take place at the Sorbonne from April 8 to 11.

ONCE every year French astronomers hold a general meeting at the office of the Minister for Public Instruction. It will take place this year in the beginning of April.

FRENCH officers belonging to the general staff are regularly attending the observatory to be trained in astronomy. A special building has been constructed for their use by M. Leverrier.

DR. HYRTL, the eminent Professor of Anatomy in the University of Vienna, delivered his final lecture on March 16, and took leave of his class. In the afternoon he met an assemblage of more than three thousand pupils and friends, who presented him with addresses and other expressions of esteem, which were feelingly acknowledged by him.

THE additions to the Zoological Society's Gardens during the past week include two Laughing Kingfishers (*Dacelo gigantea*) from Australia, presented by Mr. J. Hayward; a White-necked Crow (*Corvus scapulatus*) from the Gold Coast, West Africa, presented by Capt. E. Whitehead, 42nd Highlanders; an Eland (*Oreas canna*), born in the Gardens; two Yellow-headed Conures (*Conurus jendaya*) from south-east Brazil, purchased.

CELESTIAL CHEMISTRY*

II.

WE have now gone through as briefly as I can manage to do it, the principal points in chemistry and the principal points in spectrum analysis with which we have to deal when we are dealing with the chemical substances of our own planet. You see the point of inquiry is the chemical and spectroscopic study of the differences between atoms and molecules. We have now to apply these two lines of thought to a consideration of what I have called Celestial Chemistry.

In the first place, how is the study of Celestial Chemistry carried on? To answer this question I will give you an idea of the way in which the spectroscope is added to the telescope. We, of course, require a spectroscope in order to bring into play refraction or diffraction, and we equally, of course, require a telescope in order to collect the light which comes to us from the various light sources which are to be found in the sky. You now see a photograph of what is technically called the eye-piece end of the most perfect and most powerful telescope in the world, which I am proud to say is in England. It is the telescope belonging to Mr. Newall of Gateshead. We see the principal telescope and the various finders, which enable the observer to find the most delicate object which shines in the sky.

You will get an idea of the enormous quantity of light collected by this instrument, when I tell you that the diameter of the pupil of the eye is less than a quarter of an inch, and that the diameter of the object-glass of this telescope is 25 inches, and that the quantity of light utilised depends upon the squares of the diameters. Of course, when we have to deal with feeble celestial objects lying at an immense distance from us, and which give but little light, it would be absolutely impossible to use the prism with any effect unless in the first instance we thus collected a large amount of light to work with.

Now then, having our spectroscope attached to our telescope in the way indicated, to what must we turn our attention? You will see in a moment that it is useless to consider such a body as the moon. I say useless, of course bearing in mind that we are here dealing with chemical considerations, because the light which we get from the moon is simply sunshine second hand, and the moon has no atmosphere. The same remark applies to a certain extent when we deal with the planets, because they also, as you know, are lit up like the moon by the sun, but they have atmospheres, and much is to be learned from them in this way. What we have to do in the main to get a just general outline, in order to study this Celestial Chemistry is, to confine our attention to those bodies which shine by their own light. And if you think the matter over for a minute you will see that there are two distinct classes of such bodies. In the first place there are the *Nebulæ*, and *Comets*, and *Meteors*, which shine by their own light. And again, there are the *sun* and the *fixed stars*, which shine also by their own light; but with this important difference, that while we get the initial light radiated by a nebula, a comet, or meteor, the light which we get from a star is not the initial light, but a difference light; a great deal of the light radiated having been stopped by the atmosphere of the star. So that in the case of a sun, by which of course I mean a star—our sun being merely the star which is nearest to us—although it shines by its own light, we get a difference light while we get what we may call the total light from the first class.

And here let me add that i is the chemical composition of the atmosphere of the star which thus stops the light which we can study. If the stars had no atmospheres there could be no star chemistry, because their spectra would be continuous, and in that case neither qualitative nor quantitative spectrum analysis would be possible.

We deal then with radiation in objects of the first class and with absorption in objects of the second class.

Let us commence our study of those objects which shine by their own light by the study of the comets and the meteors. It is unfortunate that since the more general use of the spectroscope, no large comet has made its appearance, but still some small ones have been observed.

There is a spectrum which in the main is common to a great many of the compounds of carbon; and here I may parenthetically remark that carbon is, of the sixty-three elements to which I have referred, the only element which with the electric power that we can employ in the arc presents us with the distinct appearance of a compound spectrum. Side by side with this generic spectrum of the compounds of carbon I will show you the spectrum of the head of a comet which was observed some years ago; and I may add that several other comets have been observed since, with the indication that their spectra are to a very large extent, if not absolutely, the same; so that we may

FIG. 1.—Head and Envelopes of a Comet.

say there is a probability that, in the case of some of the comets at all events, we are dealing with a class of bodies in which a compound of carbon is concerned, or if not that, that the molecules of the comet resemble somewhat those of the chemical substances which give us such spectra.

Closely connected with comets by the recent hypothesis of

1 2 3 4

FIG. 2.—1, Spectrum of Brorsen's comet; 2, Spectrum of Winnecke's comet; 3, Spectrum of carbon in olefiant gas; 4, Spectrum of carbon in olive oil. (Huggins.)

Schiaparelli, are meteors, and falling-stars. So far as I know at present, in the case of falling stars the cometary spectrum has not been seen, but it has been noticed in several shooting-stars that the vapour of sodium is present, indicated by the double bright line in the yellow part of the spectrum. Now the meteorites are large meteors which have fallen to the

* Revised from short-hand notes of a Lecture delivered at the Quebec Institute, on Tuesday, December 16, 1873. Continued from p. 414.

earth, and this being so, we can chemically examine them as easily as substances which have consolidated here. These bodies may be roughly divided into iron meteorites and stone meteorites, and roughly again into meteorites which contain elementary metallic molecules, and others which contain compound molecules, that is, mixtures of metals with the metalloids.

The observations of the spectra of nebulæ we owe mainly to Mr. Huggins, a distinguished English observer, who has given very much attention to this branch of inquiry. One thing we know for certain about the nebulæ from these observations is this: we are dealing either with gases alone or with solids banging about in gases, and one of the bright lines which we observe tells us that we are dealing with hydrogen gas; so that the same method of inquiry which, applied to comets, tells us that probably in some cases we are dealing with a compound of carbon, tells us that we are chiefly dealing, in the case of nebulæ, not with a compound of carbon or with a compound of anything, but with a true element—hydrogen.

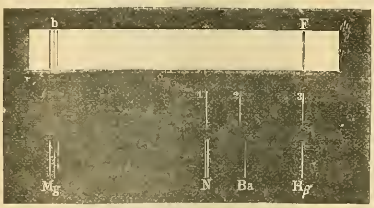


FIG. 3.—Spectrum of the nebulæ.—1, 2, 3, lines observed. Above, the solar spectrum is shown from *b* to F; below, the bright lines of magnesium, nitrogen, barium, and hydrogen, in the corresponding part of the spectrum.

That, you see, is a very great step; and a very few years ago it would have been considered presumptuous almost to think that man could ever tell what substances were building up the nebulæ which lie at such infinitely remote distances from us.

So much then for comets and meteors and nebulæ. These exhaust the bodies in space which shine by their own light, the light not being subsequently absorbed by an atmosphere through which it passes; we will now therefore pass to the class of Stars.

With regard to stars, I have a diagram to bring before you, which summarises in a convenient way a good deal of the work which has been very carefully done by Father Secchi of Rome. I shall have to refer to several other diagrams afterwards; but this, I think, is the best one to place before you in the first instance.

The spectra in the diagram are the spectra of various stars. You will at once see that there is a difference between those spectra, and you will see that there is a double difference between some of them. In the first place, you have an extreme simplicity in some cases and complication in the others. But you see, also, that the question of simplicity and complication is not the only question, that is a question merely of degree; but there is a difference in kind. For instance, you will at once acknowledge a difference in kind between the spectrum of α Herculis and Sirius.

FIG. 4.—Ring nebula in Lyra, with its spectrum.

The diagram of the former, although it has been made in no laboratory, and although it deals with no metalloids or no compounds which have been got upon the earth, is as good a diagram as I can put before you to explain what I mean by the channelled structure of the spectrum of the metalloids as opposed to the line spectrum of the metals.

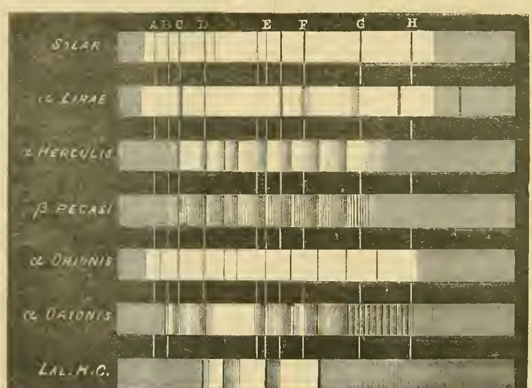


FIG. 5.—Various Stellar Spectra (Secchi).

Bearing in mind the great simplicity of the spectra of stars like α Lyræ and Sirius, and the greater complexity of the spectral lines in a star like the sun; bearing in mind, also, the difference in kind between the spectra that I have referred to, we can divide all the stars which shine in the heavens which we have already observed, into three classes. This has been done by Rutherfurd and Secchi.

Let me strengthen what I have to say by showing you rather more elaborate drawings of three stars belonging to these different classes. You will now see the importance of the considerations which I have brought before you regarding the spectra of the metals and the metalloids. There is the channelled space spectrum of the star α Herculis; there is the banded spectrum of the star α Orionis; and there is the equally banded spectrum of a star in the constellation of the Scorpion. In all these cases you will see we are dealing, not with the first class in which we have simple spectra, but with the second and third classes.

Now let me contrast on another diagram the spectra of two stars, one in the first class and the other in the second. Let us contrast the spectrum of Sirius with the spectrum of the star in Orion, to which I have already referred. In the spectrum of

Sirius observe—for this is a very important point—the extreme thickness of the lines, which are the lines due to hydrogen, and contrast the thickness of these lines and the simplicity of the spectrum with the thinness and great number of the lines in the star in Orion, and the complexity of its spectrum ; and remembering that both these maps are on the same scale, let me point out that all the lines which are so thick and so obvious in the spectrum of Sirius, are altogether wanting in the spectrum of the star in Orion.

I hope I have convinced you, by the sight of these diagrams, that supposing the observations on which they are based to be true, we have in the stars which shine three perfectly different kinds of absorption of light going on in the atmospheres of those stars. We have an absorption which we may call a simple absorption, seeing that the lines are few in number ; we have an absorption of the same kind, but different in degree, which we may call complicated, seeing that the lines are still lines, but that they are very much increased in number. And, again, in the third class we have an absorption of a different kind altogether ; instead of having an absorption of lines we have an absorption of bands. This I shall venture to call a metalloidal absorption.

Of course if we were merely limited to the spectrum of these distant stars, in spite of the enormous skill and care which Mr. Huggins and Father Secchi have brought to bear upon this inquiry, we probably should never go very much further; but you know that the sun is, after all, our sun, merely for the reason that it is the nearest star ; and therefore it is clear to you that if we observe the sun with anything like the attention that it deserves, bearing in mind its comparative nearness to us, we ought to be able to get out of the sun a great number of facts which will help us the better to understand the various appearances in the different stars.

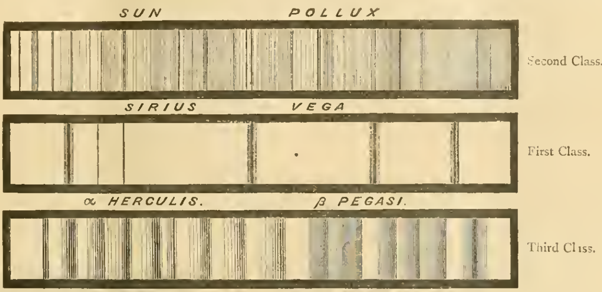


FIG. 6.—The Three Classes of Stars (Secchi).

I need not say to you that a great deal of trouble has been taken to understand the sun, to study its physical and even its chemical constitution ; and if you will allow me, I will put before you two or three considerations having reference to the sun, which have a bearing of considerable importance upon Celestial Chemistry.

In the first place, let me call your attention to the sun as we see it ordinarily. We see that on the sun there are spots, and that on the limb there is a dimming ; both the dimming of the limb and of the spots being due to the absorption of the sun's atmosphere which is at work, as I have already told you in the case of the stars, and which separates the stars as a class from the comets, meteors, and the nebulæ.

Next consider the sun as it is seen in an eclipse. Some of you may be surprised to learn that the sun, as we see it every day, is not by any means the whole sun, but only, so to speak, the kernel of an enormous mass of vapour extending for thousands and tens of thousands of miles around the visible sun.

Now in an eclipse, when all the sun ordinarily visible is hidden, we get indications of a very bright something extending to some little distance above the visible sun. On this point I may specially call attention to a photograph taken in the eclipse of 1870, at Syracuse, in which, outside the dark moon which is covering the sun, and therefore outside the sun, a mass of light which we know to be due to vapours surrounding the sun is indicated.

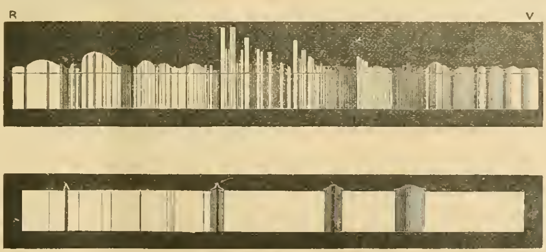


FIG. 7.—Spectra of α Orionis and Sirius (Secchi). In the spectrum of α Orionis the brightness of the spectrum is represented by the height.

In a photograph taken in India in the year 1871, under somewhat different conditions, we were fortunate enough to record a great deal more of the sun's surroundings. In this, surrounding the dark moon we have an immense mass of something not very bright extending to a very considerable distance indeed above the visible sun.

Now, by studying these phenomena in the case of the sun, of course we are studying similar things in the case of every star ; and what do we find ? We find, in the case of the sun, that surrounding the visible sun there extends to a very considerable distance an atmosphere of an element that we have not here, and which is probably lighter than hydrogen. Immersed in this, and therefore extending to a smaller distance from the sun, is another envelope, which has been called the chromosphere, consisting, in the main, of hydrogen. The brightest part of this lies pretty close to the sun. This region is excessively bright—so bright, that by a certain method it can be seen without any eclipse whatever. Immersed in this hydrogen and

therefore still nearer the sun there is an enormous quantity of vapours of the different elements existing in the sun, in what we may term a reversing layer, and it is to the absorption of the elements in this layer that the absorption of the sunlight, and therefore, so to speak, the creation of the spectrum of the sun, is in the main due.

I will now direct your attention to two photographs of the solar spectrum, and reminding you that the complexity of a spectrum depends upon the number of elements, and upon the pressure at which the vapours of those elements exist in the atmosphere of any star, you will gather from these photographs a pretty good idea of the extreme complexity of the sun's reversing layer to which I have referred.

In a photograph of any part of the sun's spectrum each of the lines of course has its story to tell, not only so far as the substance which is at work doing that particular part of the absorption is concerned, but also even so far as the quantity of that substance is concerned; because not only will a certain substance absorb particular waves of light, but it will absorb many waves, or few, or none at all, according to the quantity of that particular substance in the envelope surrounding the sun. Now there is a great deal of calcium in the sun, and therefore the absorption lines of the calcium are very thick, the absorption lines of the other metals which do not exist in such great quantities in the sun being very much thinner.

Having brought before you these various points connected mainly with the sun, so far as its physical constitution goes, let us consider what is the chemical constitution of the sun.

I have already told you that surrounding the sun is an envelope composed in the main of hydrogen, and of a new element, and that nearer to the sun is a region of vapours of great complexity, containing at least one new element. This region contains, besides hydrogen, and dealing with known elements, magnesium, sodium, titanium, calcium, nickel, chromium, iron, manganese, aluminum, copper, zinc, barium, cobalt, and so on, and latterly we have had reason to suppose that some six or seven new elements must be added to the list—potassium, lead, cerium, uranium, strontium, and cadmium. Further, if instead of the new "atomic weights" of the elements we take the old "combining weight" we find that the arrangement of these layers round the sun follows the vapour densities of the various substances either absolutely or very closely.

This then is the verdict of the prism with regard to the chemical constitution of the sun, the nearest star that we can get at; and I think you will acknowledge that if the prism had done nothing else it would have done good work. But I think it has done very much more, because it has enabled us not only to chronicle those things as existing in the sun, but in connection with the other facts which I have already brought before you it has enabled us to place the sun in its proper position amongst the stars. For instance, I have already called your attention to the first, second, and third classes of stars. Is the sun in the first, the second, or the third class? Does its spectrum contain few or many lines? or are there channelled spaces or bands? Its spectrum is not excessively simple; there are no channelled spaces or bands; and therefore the sun is to be placed in the second class of stars. Can we then go beyond this chronicle of facts, which I am afraid some of you may have considered rather dry?

You know that what a scientific man has to do in any research is not merely to add fact to fact, and to go blindly looking after facts irrespective of order. What he has to do after he has accumulated a certain number of facts is, to try whether it is possible to arrange them in order. If you wish to get a law out of any accumulation of facts in physics, in chemistry, or astronomy, you must first get your facts into order or you will never do it. Is there any possible order into which we can group these various facts to which I have referred? I venture to think there is.

Call to mind the three classes of stars. Is there any other physical quality tacked on to those differences? Yes. The stars with the simplest spectra are on the whole the brightest stars in the heavens; and the channelled spaced stars are on the whole the dimmest stars in the heavens. Of about 500 stars which have been already observed, over 300 are of the complicated second order or type. There are a great many bright stars of the first order, but an extremely small number, only, I think, about 27 of the third order with the channelled space spectrum. Now, if this be true, and if it be fair to assume that the star which is the brightest is on the whole the hottest, and I think it is fair to say so, if you take all other things as equal, then you come to a generalisation of this kind, that the brightest and hottest stars in the heavens have the simplest spectra, and the dimmest, reddest, coldest stars have a spectrum entirely different. If this be so, can we connect these facts? I think so. Grant these facts (and the future alone will show whether they are facts), and the thing is clear. We may group them all together by supposing that in the stars of the first and second classes there are dissociating forces at work which, from considerations which I have not time to bring before you now, we can imagine to be infinitely higher, or at least considerably higher, than any dissociating force that we can get here even with the electric spark. If you imagine in these stars an atom-severing force greater than we can obtain here, you can at once group in a working hypothesis all the facts which I have brought before you, and in a simple way; and let me add that simplicity in Science is a very great evidence of truth.

If you assume that at the highest possible temperature—here I use the word temperature for want of a better—of a star you have work done in continuation of the work done in terrestrial furnaces, that is to say, if instead of having 63 elements which we have here with our furnaces, there is a much smaller number, taking into consideration the increase of temperature, you will see at once that the brightest and hottest star in the heavens should have the simplest spectrum, because there you have the fewest elements, and that the coldest, reddest, dimmest star should have a spectrum indicating metalloids and compounds because you have there a low temperature, at which the metals do not exist except in combination. And if you think this matter over you will see that this suggestion of a higher temperature giving us a simpler condition of what we with our paltry temperatures call chemical elements, instead of making

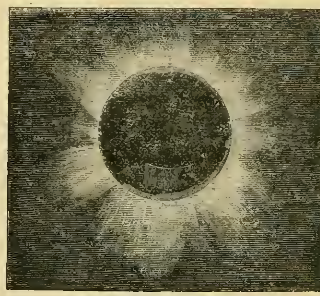


FIG. 8.—The Corona (Indian Eclipse, 1871).

these stellar spectra complicated, difficult to recollect and to understand, puts them all in one line easily to be grasped, and a line which I venture to think is somewhat coincident with the probabilities of the case.

Does the work stop there? Has it nothing to say to comets and meteorites? Here again it has a question to ask. The beautiful hypothesis of Schiaparelli, which is accepted by all astronomers, has made it perfectly clear that a comet is nothing more than one of an infinite number of meteors or meteorites, or whatever you like to call them, travelling in cometary orbits round the sun, and to which the showers of shooting stars are due. We know that there is a comet connected with that particular meteor swarm which gives us the November meteors, and we know that there is another comet connected with that particular meteor swarm which gives us the August meteors; and we assume that in all probability there are millions, or any enormous number that you like, of meteors, or meteorites, or shooting stars peopling a part or the whole length of that concrete orbit so to speak.

How is it then that there is only one comet amongst all that infinite number of potential meteors or meteorites? Here again I am sure that the future will enable the prism to throw an immense light, and we already have a glimmering. If, for instance, you assume that out of a star of the second class, in the reversing layer of which there are no metalloids, portions of the atmosphere are, by forces which we know to be at work, thrown bodily from the sphere of the star's attraction into space, those vapours on being cooled would give us very much the same kind of chemical composition that we get in the well-known masses called iron

meteorites, composed principally of iron and nickel. While on the other hand, in the case of stars of the third class, in which it seems excessively probable that we have both metalloids and compounds, and very little pure metal, that is to say, metal not in combination, in the reversing layer, we have also the large class of silicate meteorites, the origin of which is possibly due to such stars in exactly the same way as the origin of the iron meteorites would be due to stars of the second class.

If this be so, then it would seem that a comet is simply a meteorite which contains something which is volatile at a very low temperature. Amongst the vapours known to chemists, which are volatile at the lowest temperature, are the hydrocarbons. I have already pointed out to you that as far as observations have gone on comets we have been able to detect nothing but the possibility of a spectrum of carbon, or of a compound of carbon.

Here again dimly and darkly the prism is pointing us to a possible connection between all the stars in heaven and all the comets and all the meteors which flit through the celestial spaces and fall upon our own earth.

I have already referred to the verdict of the prism in connection with the nebulæ, and there can be very little doubt, I think, that before the world is very much older the prism will also be perfectly competent to connect nebulæ with stars as it may possibly have already connected comets and meteors with them; but this point certainly is at present one of great difficulty, and it is a difficulty which no student of science will care to get out of, since in matters of this kind a difficulty is a matter of the highest importance, showing you as it does that part of the field of nature which requires most study.

I quite feel that this enormous subject, which modern science is opening up, is one the importance of which is so great and the interest in which is so general that I am sorry that the task of talking about it has not fallen upon the shoulders of one who is more competent to do it than I am. I hope, however, that feeble as my advocacy may have been, you are prepared to agree that the time will come when Celestial Chemistry, as investigated by means of the prism, will be acknowledged to be one of the most important branches of modern science.

J. NORMAN LOCKYER

SCIENTIFIC SERIALS

Journal of the Franklin Institute, February.—In this number Mr. Prindle has a paper (with numerous illustrations) On Recent Improvements in Construction of the Gunpowder Pile-driver.—A long and instructive paper by Mr. Loiseau, On Artificial Fuel, gives a *résumé* of what has hitherto been done in this direction; the author describing his own method, in which a mixture of 5 per cent. clay and 95 per cent. coal-dust, moistened with milk of lime, is moulded into oval lumps, which are then bathed in a waterproofing liquid (rosin dissolved in crude benzine) and dried. With 14 men only, a production of 150 tons per day can, it is said, be easily attained.—Prof. Houston announces the discovery of a new allotropic modification of phosphorus, obtained by boiling good phosphorus repeatedly in potassium hydrate (under certain conditions). This new modification retains for an indefinite time, apparently, the liquid state, even when exposed to temperatures considerably below the melting-point of ordinary phosphorus, from which it also differs in its non-oxidation on exposure to air, and, consequently, its not shining in the dark.—Mr. Chesebrough describes the construction of the Detroit River Tunnel; and Prof. Thurston has a note relative to the estimation of the chemical value of coals containing large quantities of ash.—Among the "Items and Novelties," it is stated that Prof. Thurston has gone very carefully into the subject of a scheme published by Mr. Chesebrough, for keeping canals open in winter by warming the water. The professor's calculations are given, and he finally arrives at an estimate of 5,412,500 dols. as the first cost of apparatus for a canal 350 miles long, 70 feet deep, in the latitude of Central New York; and 1,670,200 dols. for the maintenance per annum. He thinks the scheme deserving of investigation.

Astronomische Nachrichten, Nos. 1,976 and 1,977.—These numbers contain a paper by M. Lohse on the estimation of the depth of sun-spots, and at the same time to ascertain the influence of solar refraction. The principle of his method is as follows:—When a spot having its umbra concentric with penumbra, when seen from the vertical, is seen near the sun's limb, the umbra becomes excentric, and the depth of the umbra p' will be given by the formula $p' = \frac{\epsilon}{\cos \alpha}$ when ϵ is the excentricity and α the heliocentric position-angle of the spot from the axis, and assuming the spot steady, p' should remain constant as α and with it ϵ change. This, however, is found not to be the case, for p' gradually increases as the spot gets from the limb, showing it was raised by refraction at the limb, and therefore this change in the value of p' gives a measure of the sun's refraction. The same author also contributes a paper on the effect of the atmosphere of Venus in the transit over the sun, and he recommends the examination of its atmosphere with the spectroscope for absorption-bands.—J. Hortazzi gives the observations of transits for longitude of Nikolagew.—J. Palisa gives a large numb r of ring-micrometer observations on the minor planets and a few comets.—Dr. Holetschek gives the position of some seventy comparison-stars for planets and comets.—E. Stephan gives a list of ten new nebulæ discovered and observed at Marseilles; all seem excessively small. The elements of the new comet are given by Wilhelm as follows:—

$$\begin{aligned} T &= \text{March } 9\cdot8125 \text{ Berlin time.} \\ \Omega &= 48^\circ\ 17'\ 37''\cdot6 \\ \Pi &= 309^\circ\ 27'\ 46'' \\ i &= 52^\circ\ 29'\ 52''\cdot3 \\ \log. q &= 8\cdot591600 \end{aligned}$$

Memorie della Soc. degli Spectroscopisti Italiani, Oct. and Nov. 1873.—These numbers contain an interesting paper by P. Rosa, assistant at the Observatory at Rome, on the variability of the sun's diameter. He discusses the observations at Greenwich and other places from the year 1750 to 1870, during which time some 13,000 measurements of the solar diameter were made. From these observations he has constructed curves showing the variation of diameter, together with the variation in the number of spots. The agreement of these two curves is not very strong, but on his constructing secondary curves from every fourth year of these primary curves, beginning with any year, the resemblance becomes striking. There are also monthly curves given, showing the mean variation in diameter of the sun for each month, taking a mean of ten years for each curve. These show two maxima in March and September, and two minima in January and June. On examining the curve of variation in diameter, a marked minimum occurs about the year 1792. The author sets forth a theory to account for this variation, that since a comet, when at its perihelion, throws off large quantities of matter, so the sun when at its periastre may throw off matter and become reduced in size, and if such is the case its periastre happened in 1792.—G. Lorenzoni contributes papers on observations on the chromosphere, and on observing contacts in eclipses of the sun with the spectroscope.—G. de Lisa gives observations on solar spots in September, October, and November 1873, made at Palermo, giving a mean of about ten spots a day.—Prof. Young gives a note on the use of M. Rutherford's gratings in the place of prisms for the spectroscope.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 19.—On the Attractions of Magnets and Electric Conductors, by George Gore, F.R.S.

Being desirous of ascertaining whether in the case of two parallel wires conveying electric currents the attractions and repulsions were between the currents themselves or the substances conveying them, and believing this question had not been previously settled, I made the following experiment:—

I passed a powerful voltaic current through the thick copper wire of a large electromagnet, and then divided it equally between two vertical pieces of thin platinum wire of equal diameter and length (about six or seven centimetres), so as to make them equally white hot, the two wires being attached to two horizontal cross wires of copper.

On approaching the two vertical wires symmetrically towards the vertical face of the one pole of the horizontally placed magnet, and at equal distances from it, so that the two downward currents in them might be equally acted upon by the downward and upward portions respectively of the currents which circulated round the magnet-pole, the one was strongly bent towards and the other from the pole, as was, of course, expected; but not the least sign of alteration of relative tempe-

rature of the two wires could be perceived, thereby proving that not even a small proportion of the current was repulsed from the repelled wire, or drawn into the attracted one, as would have occurred had the attraction and repulsion taken place, even to a moderate degree, between the currents themselves; and I therefore conclude that *the attractions and repulsions of electric conductors are not exerted between the currents themselves, but between the substances conveying them.*

Some important consequences appear to flow from this conclusion, especially when it is considered in connection with Ampère's theory of magnetism, and with the molecular changes produced in bodies generally by electric currents and magnetism.

As every molecular disturbance produces an electric alteration in bodies so, conversely, the discoveries of numerous investigators have shown that every electric current passing near or through a substance produces a molecular change, which is rendered manifest in all vessels, liquid conductors, and even in the voltaic arc by the development of sounds, especially if the substances are under the influence of two currents at right angles to each other. In iron it is conspicuously shown also by electro-torsion, a phenomenon I have found and recently made known in a paper read before the Royal Society.

Numerous facts also support the conclusion that the molecular changes referred to last as long as the current. De la Rive has shown that a rod of iron, either transmitting or encircled by an electric current, emits, as long as the current lasts, a different sound when struck; and we know it also exhibits magnetism. The peculiar optical properties of glass and other bodies with regard to polarised light discovered by Faraday also continue as long as the current. A rod of iron also remains twisted as long as it transmits and is encircled by electric currents; and in steel and iron the molecular change (like magnetism) partly remains after the currents cease, and enables the bar to remain twisted.

That the peculiar molecular structure produced in bodies generally by the action of electric currents also possesses a definite direction with regard to that of the current, is shown by the rigidly definite direction of action of magnetised glass and many other transparent bodies upon polarised light; also by the difference of conductivity for heat and for electricity in a plate of iron parallel or transverse to electric currents; by the stratified character of electric discharges in rarefied gases, and the action of electric currents upon it; and especially by the phenomenon of electro-torsion. In the latter example an upward current produces a reverse direction of twist to a downward one, and a right-handed current developes an opposite torsion to a left-handed one; and the two latter are each internally different from the former. As each of these four torsions is an outward manifestation of the collective result of internal molecular disturbance, and possesses different properties, these four cases prove the existence of four distinct molecular movements and four corresponding directions of structure; and the phenomena altogether are of the most rigidly definite character.

As an electric current imparts a definite direction of molecular structure to bodies, and as the attractions and repulsions of electric wires are between the wires themselves and not between the currents, repulsion instead of attraction must be due to *difference of direction of structure* produced by difference of direction of the currents.

Although the Amperean theory has rendered immense service to magnetic science, and agrees admirably with all the phenomena of electro-magnetic attraction, repulsion, and motion, it is in some respects defective; it assumes that magnetism is due to innumerable little electric currents continually circulating in one uniform direction round the molecules of the iron; but there is no known instance of electric currents being maintained without the consumption of power, and in magnets there is no source of power; electric currents also generate heat, but a magnet is not a heated body.

If, however, we substitute the view that the phenomena of attraction and repulsion of magnets are due, not to continuously circulating electric currents, but (as in electric wires) to definite directions of molecular structure, such as is shown by the phenomena of electro-torsion to really exist in them, the theory becomes more perfect. It would also agree with the fact that iron and steel have the power of retaining both magnetism and the electro-torsional state after the currents or other causes producing them have ceased.

According to this view, a magnet, like a spring, is not a source of power, but only an arrangement for storing it up, the power being retained by some internal disposition of its particles acting like a "ratchet," and termed "coercive power." The fact that a magnet becomes warm when its variations of magnetism are great and rapidly repeated, does not contradict this view, because we know it has then, like any other conductor of electricity, electric currents induced in it, and these develop heat by conduction-resistance.

According also to this view any method which will produce the requisite direction of structure in a body will impart to it the capacity of being acted upon by a magnet; and any substance, ferruginous or not, which possesses that structure has that capacity; and in accordance with this we find that a crystal of cyanite (a silicate of alumina) possesses the property, whilst freely suspended, of pointing north and south by the directive influence of terrestrial magnetism, and one of stannite (oxide of tin) points east and west under the same conditions.

Geological Society, March 11.—John Evans, F.R.S., president, in the chair.—The following communications were read:—On the relationship existing between the *Echinothuridæ* Wyville Thomson and the *Perischoechinidæ* McCoy, by R. Etheridge, jun. In this paper the author referred in the first place to the peculiar characters of the genera *Calveria* and *Phormosoma* Wyville Thomson, and especially to those in which they approach the cretaceous genus *Echinothuria* S. P. Woodward, and which led Prof. Wyville Thomson to include these three forms in his group Echinothuridæ. He remarked that an overlapping of the interambulacral plates, more or less like that occurring in these three genera, is met with also in *Archæocidaris* McCoy, and *Lepidechinus* Hall, belonging to the group of palæozoic Echini which McCoy proposed to call Perischoechinidæ, and which is characterised by the presence of more than three rows of plates in the inter-ambulacral areas. As there is no overlapping of these plates in the other genera referred to this group, it includes two types of structure. The author then discussed the characters presented by the test in the genera of the Perischoechinidæ (namely, *Archæocidaris*, *Palæchinus Perischodomus*, *Lepidechinus*, *Eocidaris*, *Melonites*, and *Oligoporus*), and pointed out that although we have no conclusive evidence of the presence of membranous interspaces along with the overlapping plates in *Archæocidaris*, the fragmentary condition in which the remains of that form are usually found would lead us to infer their existence. No known palæozoic genus exhibits the want of distinction between the ambulacra and interambulacra on the ventral half of the test seen in the recent genus *Phormosoma*. In *Melonites* and *Oligoporus* the author described an increase in the number of rows of plates in the ambulacra, and he indicated that all the Perischoechinidæ differ from the later Echini by the increased number of perforations in the ocular and genital plates.—On the discovery of Foraminifera, &c., in the boulder-clays of Cheshire, by William Shone, jun. In this paper the author described the occurrence of Foraminifera, Entomostraca, and some other small organic bodies in the boulder-clay at Newton by Chester and at Dawpool. They were found partly in the interior of specimens of *Turritella terebra*, and partly free in the boulder-clay.—On the occurrence of a Tremadoc area near the Wrekin in South Shropshire, with description of a new fauna, by Charles Callaway. The author stated that in an exposure of light green, micaceous shales dipping south-east at 50° at Shineton near Cressage, which are represented as of Caradoc age in the Geological Survey Map, he found a series of trilobites and other fossils which induced him to regard these Shineton shales as belonging to the Lower Tremadoc series. He described as new species:—*Asaphus eos*, *Conocoryphe salteri*, *C. angulifrons*, *Platypeltis croftii* *Conophrys salopiensis*, *Lichapyge cuspidata*, *Lingulella nicholsoni*, *Metoptoma sabrinæ*, and *Theca lineata*. The author regarded these shales as the equivalents of beds containing *Dictyonema*, found near Malvern and at Pedwardine.

Anthropological Institute, March 24.—Prof. George Busk, F.R.S., president, in the chair.—The President exhibited and described an Ashanti skull. The specimen, with other bones of the body, was taken by Surgeon-Major Gore from an outlying camp which had been deserted on the approach of the British troops. It presented the characteristics rather of a female than a male skull, but Mr. Gore affirmed that he had never heard of the Ashantis carrying about the bones of a woman. Women, in fact, held such an inferior position, that it could scarcely be believed that the Ashantis would take trouble in the preservation of their remains. If the skull exhibited belonged to a man, he could not have been a military leader, but he might have had

such a rank in his tribe as entitled him to the honours that were evidently bestowed on his remains. The paper gave full descriptions and detailed measurements.—A paper was read by Rev. Dunbar I. Heath, On the Origin and Development of the Mental Function in Man. He thought that in the ordinary view the mind is considered as a central essence. Around it is the brain, and still further on the outside the world surrounds the brain. It would conduce towards explaining the facts of mental function if we supposed a material film to coincide with the outside surface of the brain, which might be specialised under the name of Psychoplasm. To that film he would confine mental, as distinguished from cerebral, function; so that the mind would be imaged, not as being the centre, but between brain and world. The paper explained mental growth on that hypothesis.—Mr. W. L. Distant read a paper On the Mental Differences between the Sexes. The question discussed in the paper was—Is there clearly proved to be mental difference between the sexes, and is that difference one of kind or only of degree? Authorities were quoted to show the undoubted physical differences, such as weight of brain, form of skull, &c., also the now moderately well-established fact that in primitive races the hair of women approximates more closely to that of man than obtains in a higher state of civilisation. But it having been clearly proved that the advance of man is shown by a higher form of skull and increase of the cranial capacity, an attempt was made to show some of the conditions that had retarded woman in the mental struggle. The result seemed to prove that the mental divergences might be greatly accounted for—firstly, by sexual selection, difference of education, and force of custom; secondly, by physiological conditions; and that as the race progresses, the cranial capacity of the sexes, though not becoming identical, which is a physical impossibility, will yet become much less distinct and divergent, which is a moral certainty if based on moral conclusions.

Physical Society, March 21.—Dr. J. H. Gladstone, F.R.S., in the chair.—J. H. Fleming, read a paper On the new contact-theory of the Galvanic Cell. After discussing the most recent views regarding the contact and chemical theories, Mr. Fleming exhibited the action of his new battery in which metallic contact of dissimilar metals is completely avoided. The battery consisted of thirty test-tubes of dilute nitric acid alternating with the same number of tubes of sodium pentasulphide, all well insulated. Bent strips of alternate lead and copper connected the neighbouring tubes. By this device the terminal poles are of the same metal. On connecting with a coarse galvanometer, the needle was violently and permanently deflected. Tested by the quadrant electrometer the potential was shown to increase regularly with the number of cells. The sixty cells on first immersion showed an electromotive force exceeding that of Daniell's cells. The principle upon which the action depends is that in the acid lead is positive to copper; in the sulphide it is negative. Mr. Fleming further showed how by using the single fluid nitric acid and the single metal iron, a similar battery could be constructed, provided one-half of each iron strip was rendered passive. In this form also no metallic contacts occurred.—Prof. F. Guthrie illustrated by experiment the distribution of a current of electricity in passing from one pole to another across a conducting medium. This was shown in the case of solids by the stratification of iron filings in the sheets of tin-foil and lead. A current of electricity was passed between two points in a horizontal line lying on the surface of metal placed vertically in the magnetic meridian, and the distribution explored by means of a freely suspended magnet needle. As the needle was gradually lowered its direction of deflection was observed to change at a certain point from east to west. This point was ascertained by experiment to be at a distance below the horizontal line, in which the current entered and left the plate, equal to one-third of the interval between the poles. A similar effect was shown in a liquid conductor.—Prof. G. C. Foster, Dr. Wright, and Dr. Gladstone took part in the discussion of the communications.

Royal Horticultural Society, March 18.—Scientific Committee. Dr. Hooker, P.R.S., in the chair.—The Rev. M. J. Berkeley brought for exhibition Montagne's original drawings of *Artotrogus*. He pointed out that this was only the $\frac{1}{1100}$ inch in diameter, while *Volutella*, with which Mr. W. G. Smith had supposed it might be identical, was from $\frac{1}{300}$ to $\frac{1}{400}$ inch in diameter. Montagne had also found a second species of *Artotrogus*, and of this he showed a drawing. He also remarked that a knowledge of the resting spore of *Peronospora infestans* was a great desideratum. It was to be hoped that, as 100*l*. had been presented to Prof. de Bary to investigate the whole subject, that that would be a matter on which he would throw some light.—Mr. Smee communicated a paper on a disease at present very destructive to *Daphne indica*. Numerous diseased plants were exhibited, and the opinion of the Committee was requested upon them. Prof. Westwood said that as the young leaves of the Daphne were entirely free from acari or the young larvæ of *Coccidæ* or *Aphidæ*, although the adjoining full-grown leaves were much diseased, he was not inclined to regard the disease as originating from the attacks of any of these insects, although it might be due to punctures of some flying species of *Capsidæ*, such as *Phytoxoris campestris*, which attacks the buds and young foliage of the common Chrysanthemum, flying from plant to plant.—Prof. Westwood adverted to the Tea Bug of Assam, which he believed to be identical in Upper India, Java, and Ceylon, and not a new species. The insects of Java were often identical with those of Assam, but he supposed that in this case the insect might have been conveyed from one to the other. Dr. Hooker said that this was very probable. The Ceylon tea-plant was the so-called "hybrid variety" introduced from Assam, and was probably sent from Ceylon to Java.—Prof. Thiselton Dyer exhibited a specimen of an Acacia with a curious white balaniform exudation of insect origin, from the Botanic Garden at Cape Town. Prof. Westwood stated that the insect upon the Acacia was quite new to him, and was closely allied to the *Cionops cataphractus*, a rather rare British insect, allied to the *Coccidæ*; the specimens were females, which had emitted a mass of waxy matter, striated in ridges; the waxen mass was in many places covered with minute larvæ, differing in form from the ordinary larvæ of the *Coccidæ*.

General Meeting.—Mr. H. Little in the chair.—The Rev. M. J. Berkeley called attention to pods ripened in the gardens of Mr. W. Terry, of *Vanilla aromatica* (it has fruited this year abundantly in the Victoria house at Kew); a charming specimen of *Aloe plicatilis*—a miniature tree in form, with fine flowering spikes—came from Mr. J. T. Peacock's collection.

Newcastle

Chemical Society, Feb. 26.—Dr. Lunge, president, in the chair.—A paper was read by Mr. J. Pattinson On the rate at which bleaching powder loses its available chlorine. The examination of a number of samples of bleaching powder, from time to time, during about twelve months, was undertaken with the view of making a contribution towards the solution of this question, "How much available chlorine does bleaching powder lose in a given time?" and also to the further one, "Does weak bleaching powder, say containing 32 per cent. of chlorine, retain its strength better than a stronger bleaching powder?" Three sets of samples were obtained from different manufactories on the Tyne, each set consisting of three samples. It was intended that the three samples of each set should be taken from the same portion of lime—one when it contained about 33 per cent. of available chlorine, one when it contained about 35 per cent., and the third when it contained about 37 per cent.—and with this object the lime was placed in a box in the chlorine chamber, so that it could be easily removed in order to take out the samples at each stage. On examining the tables given in the report it is seen that, with reference to the question as to the relative stability of weak and strong bleaching powder, there is practically no difference in the rate at which they lose available chlorine.

Glasgow

Society of Field Naturalists, March 20.—Annual Meeting.—Mr. J. Allan, vice-president, in the chair.—Mr. P. Cameron, jun., exhibited two sawflies new to Britain: *Blennocampa aterrima* Klug, taken by Dr. Buchanan White at Braemar; *Hoplocampa pectoralis* Thomson, taken by the Rev. T. A. Marshall, F.L.S., at St. Albans. The only recorded locality is Gothland, where it was captured for the first time by Prof. Boheman.—Mr. Cameron also exhibited the two new sawflies described by him in the last number of the *Entomologists' Monthly Magazine*: *Taxonus glottianus*, of which a single specimen was taken at Kenmuir Bank near Glasgow in May; and *Nematus graminis*, a not uncommon species in the district, the larva of which feeds on grasses. The Annual Reports of the Secretary and Treasurer having been read and adopted the Officers and Council for the ensuing year were elected.

Philadelphia

Academy of Natural Sciences, December 2, 1873.—Dr. Ruschenberger, president, in the chair.—Fertilisation of Yucac.

Mr. Thomas Meehan detailed at length the discoveries of Dr. Engelmann and Prof. Riley in regard to the fertilisation of the Yucca by the aid of a small night moth, *Pronuba yuccasella* of Riley, and observed that in this region the fertilisation was effected by this insect every year. In the Rocky Mountains of Colorado in 1871, he saw the *Yucca angustifolia* everywhere seeding in great abundance; but in his journey in 1873 he saw not a solitary seed-vessel in any of the plants, and he suggested that perhaps some periodical insect might take the place of the *Pronuba* in that country.—Note on a Fungoid Root Parasite. Mr. Thomas Meehan exhibited a small Norway spruce, in which the branches and leaves were all of a golden tint. He explained that when plants had little food, or lost their fibres in wet soil by which they could not make use of food, the yellow tint was generally exhibited in the leaves of plants. The similarity of the appearances suggesting, he examined and found the roots thickly enveloped by the mycelia of a fungus, which destroyed the young fibres as fast as they were developed. He had supposed it was one of the small microscopic forms of fungi; but in October of the present year the mycelia developed into a brown agaric with a pileus about two inches broad, but the exact species of which he could not positively determine.

Dec. 9.—Mr. Vaux, vice-president, in the chair.—On the Expansion of the Coma in *Asclepiadaceæ*. Mr. Thomas Meehan exhibited some seed-vessels of *Gonolobus obliquus*, and remarked that, though the hairy appendage to the seed known as the coma in asclepiadaceous plants was of course well understood, he knew of no one who had placed on record any observation in regard to the suddenness of the expansion after the seed left the capsule. It was indeed so very rapid, that the common expression of "like a stroke of lightning," was scarcely an exaggeration. It was only with difficulty that the eye could follow the motion. In the seed-vessel each set of long silky hair was drawn up into a close linear fascicle; but on the instant of the seed being relieved from its case, the coma expanded into a perfect hemisphere. Some of the hair formed a right angle, and others more or less acute ones, each seeming to have its fixed place to fall back to. It was generally supposed that these hairy appendages, and others of a similar character in seeds, were for the express purpose of aiding in seed distribution by wind; but he had failed in so many instances to see the advantages, that it often seemed as if it were the seed profiting by developed organs, rather than that these were especially formed for an express purpose. In the case of the *Gonolobus*, it did seem as if there were better grounds than perhaps in any other case for believing that the hairy appendage is designed expressly to facilitate distribution by wind or air currents. The seeds are heavy, and are borne on the plant but a few feet from the ground; they would fall there in a few seconds on the opening of the capsule, if the mass of hair remained long in its closely compact condition.—On Lingula in a Fish of the Susquehanna. Prof. Leidy.

PARIS

Academy of Sciences, March 23.—M. Bertrand in the chair.—The following communications were read:—Thermal study of the phenomena of solution; reaction of water upon nitric acid, by M. Berthelot. As the result of his investigations the author finds that the heat evolved by the addition of an equivalent of water to acids and bases generally decreases in accordance with a law analogous to a geometrical progression when the equivalents of water (n) increase in arithmetical progression. A formula is obained approaching $Q = \frac{A}{\rho^n}$ where the quantity of heat is Q and ρ, a number near unity. The author discussed the relationship between this formula and the analogous one obtained by M. Becquerel for the electromotive force of acid and alkaline solutions, viz., $= x\,\frac{a}{r^n}$.—On an operation of transfusion of blood performed by M. Béhier at the Hôtel Dieu: note by M. Bouley.—On the origin of the Muscado mace and of mace in general, by M. H. Baillon.—On the pathogenetic rôle of ferments in surgical maladies; new method of treatment for amputations: note by M. A. Guérin.—On the plane distribution of pressures in the interior of isotropic bodies in the state of limited equilibrium; mode of integration of the differential equations: note by M. J. Boussinesq.—On the law of astronomical attraction on the masses of the different bodies of the solar system, and particularly on the mass and duration of the sun, by M. E. Vicaire. The author seems to think it far from being demonstrated that the number called the *mass* of the sun is a real measure of the quantity of matter contained in it.—Programme of a system of geography founded on the exclusive use of decimal measures, of an international meridian 0°, and of stereoscopic and gnomonic projections, by M. B. de Chancourtois.—On the refraction of compressed water, note by M. Mascart.—Reply to the critical observations of M. H. Sainte-Claire Deville, on a method for the determination of vapour densities, by M. Croullebois. The author attempted to defend the apparatus, of which a description had previously been communicated to the Academy.—On the compounds of hydrogen with the alkaline metals, by MM. L. Troost and P. Hautefeuille. The authors have obtained compounds of potassium and sodium with hydrogen, having the formulæ K_2H and Na_2H, and have studied the tensions at every 10° of the hydrogen evolved on heating these compounds from 330° to 430°. K_2H dissolves a further quantity of hydrogen; Na_2H dissolves only a very small quantity of this gas. The authors find that lithium heated to 500° in hydrogen gas at 760 mm. pressure absorbs seventeen times its volume of the gas, while thallium under the same conditions absorbs only three times its volume.—On some bronzes from China and Japan, by M. H. Morin.—On the exotic terrestrial lombricians of the genera Urocheta and Pericheta, by M. E. Perrier.—On some general facts which arise from comparative androgenesis, by M. A. Chatin.—Atmospheric dusts, by M. G. Tissandier. The author has determined the suspended matter in the air of Paris and made analyses of atmospheric dust.—Researches on the formation of superphosphate of lime, by M. J. Kolb.—On the systems of curve-planes, algebraical or transcendental, defined by two characteristics, by M. Fouret.—Explicit condition that a conic may have a fifth-order contact with a given curve, by M. Painvin.—Two new theorems on the wave surface, by M. A. Mannheim.—On a Greek sundial found by M. O. Rayet at Heracleum of Latmos.—On the magnetisation of steel, by M. E. Bouty.—Calorific effects of magnetism in an electro-magnet with several poles, by M. A. Cazin.—Researches on trichloracetates and their derivatives, by M. A. Clermont. The author has obtained trichloracetyl-urea, by acting upon trichloracetate of urea with phosphoric anhydride, and also by the action of trichloracetyl chloride upon urea. The same substance was obtained by this last reaction by Tommasi and Meldola in this country in January.—On some endosmotic properties of the membrane of the shell of birds' eggs, by M. U. Gayon.—On the red colouring-matter of the blood, by M. Béchamp.—On the employment of potassium bisulphate for the distinction of native sulphides, by M. E. Jannettaz.—Observations on the spermatophores of decapod crustacea, by M. Brocchi.—Differentiation of induced and spontaneous movements.—Study of the action of some reputed anæsthetic agents on the functional irritability of the stamens in *Mahonia*, by M. E. Haeckel.—Experimental study upon "ammoniémie," by MM. V. Feltz and E. Ritter.

CONTENTS

THURSDAY, APRIL 9, 1874

BRITISH QUADRUPEDS

A History of British Quadrupeds. By Thomas Bell, F.R.S. Second Edition. (Van Voorst).

THIS excellent work having originally appeared in 1839, a second edition in 1874 deserves more than a passing notice. In a country like our own, which has been well populated for so many centuries, and in which the people are increasing at a rate only possible in connection with vast strides in our knowledge of sanitary laws, it is not difficult to form several deductions with regard to the nature of the changes which must be taking place in its fauna, together with their ultimate tendencies. As time progresses, works on the zoology of our island, now not many in number, nor large in size, must dwindle to the proportions of those that might be written on a country like China, in which by degrees nearly every wild species has been exterminated. As there, form after form must die out, giving place to the increase in numbers of the one dominant species, man; till in time a history of British quadrupeds will be better studied from the works of Hume and Lingard than from those of White and Bell. These and other considerations make it a question of more than ordinary importance what stress is to be laid, in scientific investigation, either for the purpose of classification or of minute study on the present geographical distribution of animals. On all sides we see remarks which show most clearly that their authors do not fully realise the true bearing of distribution. They think that it is in opposition to the Darwinian hypothesis; that the camel being found in Africa and Asia, whilst its only close ally, the llama, is a native of the Andes, is a significant fact in favour of the doctrine of "special creation," and the tapirs of Sumatra and South America, only, point in the same direction. But when we begin to realise how the whole fauna of countries can be and have been wholly changed within the extremely brief geologic time of man's existence, and that most palæontological evidence is in the same direction, it is clear that the stress which must be laid on the present distribution of any particular form is not so great as might have been imagined from the results obtained by earlier workers on the subject.

The strong predilection of our countrymen for sport also makes it highly improbable that any important fresh species of terrestrial mammals should be added to our fauna, and so we find that Mr. Bell's second edition includes only a single land animal which is not to be found in the first, namely, *Sorex pigmæus*, the Lesser Shrew, the smallest British mammal, with a total length, tail included, of less than 2½ in. The case is different, however, with respect to the aquatic species which visit our shores. The rapid strides made in our knowledge of the Cetacea by the excellent researches of Prof. Reinhardt. Flower, Turner, and others have considerably increased the number of existing genera and species; and this, taken in connection with the improvement in our powers of identification from the skeleton alone, has added so many as ten well-authenticated species new to our fauna The claims of the Greenland and Atlantic Right whales are however very feeble, and only a single specimen of Cuvier's whale, that described by Prof. Turner from Shetland, is known. Amongst the Phocidæ, also, a specimen obtained by Mr. J. H. Gurney, and identified by Prof. Flower, adds the Ringed Seal; whilst the Hooded Seal has been twice obtained from our eastern coast. Several changes have also had to be made among the Cheiroptera. None have had to be added, but some have been removed, on account of previous imperfect identification. The magnified views of the nose and head of each of our native species at the end of the different chapters, when taken in connection with the carefully compiled tables of measurements, will make it easy for anyone who obtains specimens of these rarely seen animals to identify them without much labour.

Mr. Bell in this edition of his work has, for several reasons, had to avail himself of the assistance of other workers in the same subject, for its completion. The Cheiroptera and Insectivora have been carefully revised and brought up to our present state of knowledge by Mr. R. F. Tomes; but the latter part of the book, including all the new matter on the seals and whales, has been undertaken and most efficiently executed by Mr. E. R. Alston. This latter gentleman, from his acute discriminative powers and persevering industry, has made the portions of the work which it has been his good fortune to superintend the standard literature of the subject on which he treats.

Throughout the book there is an ease and elegance of style which is rarely found, now-a-days, in connection with the frequently but too dryly stated facts of science. This adds an attractiveness to the subject which implants and developes an extra charm in the mind of the reader, leading him on, by its inherent value, to the perusal of page after page, till he has finished the book, and unconsciously acquired an amount of zoological information, that, but for the manner in which it is presented to him, he would never have taken the trouble to acquire. As an example we may quote the description given of the wide-spread superstitions and prejudices which exist with reference to bats in general.

We read, "That the ancient Greek and Roman poets, furnished with exaggerated accounts of the animals infesting the remote regions with which their commerce or their conquests had made them acquainted, should have caught eagerly at those marvellous stories and descriptions, and rendered them subservient to their fabulous but highly imaginative mythology, is not wonderful; and it is more than probable that some of the Indian species of bats, with their predatory habits, their multitudinous numbers, their obscure and mysterious retreats, and the strange combination of the character of beast and bird which they were believed to possess, gave to Virgil the idea, which he has so poetically worked out, of the Harpies which fell upon the hastily-spread tables of his hero and his companions, and polluted whilst they devoured the feast from which they had driven the affrighted guests"—rather active measures for a Pteropine bat, no doubt, but none the less within the limits of human exaggerative powers.

We notice that Mr. Alston, in naming the families of the animals of which he writes, uses the termination -idæ on all occasions, as in Phocidæ, Balaenopteridæ, &c.; but in the earlier part of the work, when the generic name

from which that of the family is derived, ends in -a, the termination -adæ is employed, so that we find the words, Ursidæ, Musteladæ, Talpadæ, &c. With all due deference to Mr. Bell, and in spite of the first line of Lucretius' poem, which commences with "Æneadum genetrix," we cannot help feeling that for the sake of uniformity and the feelings of the many propounders of scientific names who are not so well versed in the dead languages as they might be, it is better to continue the now nearly universally employed -idæ on all occasions.

The illustrations of the species described maintain the general character of the work, some being evidently new, as in the case of the deer. Many chapters have a picturesque and respectively appropriate sketch as a conclusion; and we notice that in the additional chapters, instead of fresh sketches, there are in their place (we say it with regret) views, both in profile and from above, of parts of the skeletons of the subjects of the text.

SCLATER AND SALVIN'S "NOMENCLATOR AVIUM NEOTROPICALIUM"

Nomenclator Avium Neotropicalium, sive avium quæ in Regione Neotropica hucusque repertæ sunt nomina systematicè disposita adjecta sua cuique speciei patria. Accedunt generum et specierum novarum diagnoses. Auctoribus Philippo Lutley Sclater et Osberto Salvin, (Londini: sumptibus auctorum, 1873). 1 vol. fol., 164 pp.

THE naturalists whose names are attached to the present work have been for some years working together on American ornithology. Besides numerous papers and articles of greater or less importance published in the "Ibis," the "Proceedings of the Zoological Society," and elsewhere, they completed in 1869 a quarto volume of "Exotic Ornithology," containing one hundred coloured lithographic plates representing new or rare birds of South and Central America, with accompanying letterpress. These works are understood to be all written with a view to the ultimate incorporation of the results arrived at in an "Index Avium Americanarum," or complete treatise on the ornithology of Central and South America. In further progress towards this end the authors now give us a "Nomenclator" or list of the generic and specific names of the species of birds as yet ascertained by them to occur in these countries, which form the "neotropical region" of Mr. Sclater—one of the six principal regions into which he has proposed to divide the earth's surface zoologically. After the name of each species is added the "patria" or "habitat," indicating the exact locality in which the species has been observed.

The neotropical region is now well known to be the richest in the world, ornithologically speaking; the "Nomenclator" contains the names of no less than 3,565 species of birds which, as the authors have convinced themselves by personal examination, are found in it. About 2,000 of these belong to the great order Passeres, and rather more than 1,500 to the nineteen other orders of birds met with in the neotropical region. One order alone is unrepresented in South and Central America, namely, the Apteryges, which is confined to New Zealand; but on the other hand the neotropical region possesses two peculiar forms of bird-life of ordinal rank (the *Opisthocomus* and the *Tinami*) which are unknown elsewhere. Besides these, many extensive families are entirely restricted to the limits of this region; for instance, the Tanagers with 302 species, the Humming-birds with 387 species, the Dendrocolaptidæ with 217 species, and the Formicariidæ with 211 species. A few Tanagers and Humming-birds have invaded the neighbouring nearctic region (*i.e.* America north of Mexico), but the great bulk of these large groups of birds and of several other less numerous though equally distinct families, is essentially neotropical.

Nor must it be supposed that we are yet by any means fully acquainted with the riches of the neotropical region. The active ornithologists of the day are making continual additions to the long list—chiefly through the exertions of collectors in various parts of the Andean Chain, where almost every valley appears to contain distinct species of birds. At a recent meeting of the Zoological Society, twenty-four new species of birds (several belonging to new genera) were described from a single district in Peru, and Mr. Gould is constantly recording additions to the long series of humming-birds which he has so admirably monographed. Besides this, the anatomy and osteology of the greater number of exotic birds is almost utterly unknown, so that there is ample work in the neotropical region alone for many future generations of ornithologists.

The two collections upon which the "Nomenclator" has been principally based are those of Mr. Sclater and of Messrs. Salvin and Godman. The former of these contains an unrivalled series of the American species of the great order Passeres, and a set of representatives of the other higher orders, down to the end of the parrots—altogether about 7,000 specimens. The latter collection is still larger and more general, embracing the whole series of American birds. It is especially rich in Central American forms, the owners having themselves visited several districts of the Central American Republics, and employed private collectors in other districts for the enrichment of their cabinets.

The "Nomenclator" gives us a summary of all the species represented in these two great collections, and of other species examined by the authors, but of which they have not yet succeeded in obtaining specimens.

In an appendix are added characters of nine new genera, and of thirty-one new species, founded on specimens contained in one or other of the above-mentioned collections.

OUR BOOK SHELF

The Mishmee Hills; an Account of a Journey made in an Attempt to penetrate Thibet from Assam to open new Routes for Commerce. By T. T. Cooper, F.R.G.S., Acting Political Agent at Bhamo. (London: Henry S. King and Co., 1873.)

MR. COOPER is already well known as an enterprising traveller and delightful story-teller through his "Travels of a Pioneer of Commerce in Pig-tail and Petticoats;" the present narrative is one of the most attractive published for a long time; it is one of the few books now published one feels inclined to read through at a sitting. Mr. Cooper tells his story without apparent effort, and in

simple, unaffected style. For many centuries China has had the monopoly of supplying the Thibetans with tea, of which they are most extensive consumers. The Lamas of Thibet have the exclusive privilege of retailing this tea, and both they and the Chinese naturally do all in their power to prevent the possibility of any rivalry in the lucrative trade. It was on this account that Mr. Cooper was prevented from completing his intended journey from Shanghai overland to India. In the present work the author describes an attempt which he made to penetrate into Thibet from the Indian side, for the purpo e of discovering whether it would not be possible to open up a way for the introduction into that country of the abundant produce of the Assam tea-plantations. He proceeded from Calcutta to Sudiya, on the north-east frontier of Assam, from which, after making all due preparations, he set out on his adventurous journey in the latter part of 1869. Notwithstanding that Mr. Cooper was accompanied by a Khamtee chief, Chowsam—a fine manly fellow—who knew the country well, and was feared and respected by the people through whose country Mr. Cooper had to pass, the latter, amid great hardships, succeeded in penetrating north-eastward along the Brahmapootra, only about 100 miles, when, through the determined opposition of the Thibetan officials, he was compelled to turn back. No doubt Mr. Cooper failed in accomplishing the object on which he had set his heart, but his journey has been the means of giving to the world a book full of interesting information about the peoples and the countries where he sojourned, both in Assam and the districts just beyond its north-eastern frontier. The book contains a great deal of information on the present and past condition of Assam and the Assamese, and much information on the state of the tea-cultivation in that country. Mr. Cooper is particularly observant of men and manners, and most readers will find in his book a great deal that is quite new concerning the small tribes that live along the route by which he attempted, in the interest of commerce, to enter Thibet; his description of the Khamtees is especially interesting. Mr. Cooper does not pretend to give any scientific record of the natural history of the country through which he passed, though he makes occasional observations that may interest naturalists. The following description of the land-leeches which pestered him during his journey, seems to us particularly interesting:—

"Of all the hardships and unpleasant sensations experienced in the Assam jungle none have left a more disagreeable recollection than the attacks of land-leeches. Often, on sitting down, I could count a dozen of these little animals hurrying from all directions to their prey. In length they are about an inch, while their thickness does not exceed that of an ordinary sewing needle. Their mode of progression is curious in the extreme. Fixing one extremity by means of its bell-shaped sucker firmly on a leaf or on the ground, the leech curves itself into an arch, the other end is then advanced till the creature resembles a loop, again to expand into an arch, but the movement is quicker than words can describe it; the rapidity with which they thus progress along is quite startling. As they occasionally rear themselves perpendicularly and sway about from side to side, taking a survey round them in quest of prey, the observer cannot fail to conceive a dread of the bloodthirsty little creatures. They exercised quite a fascination over me. I could never resist watching them whenever I took a seat. Their power of scent was evidently keen. At first they would hold themselves erect, then suddenly, as though they had just discovered my whereabouts, they would throw themselves forward and with quick eager strides make towards my unfortunate body, and it was a long time before I could restrain a shudder at their approach, but use does wonders, and at last I used to flip them off my clothes and hands, Khamtee fashion, with great indifference. There are several species of leeches in Assam, but I have only come in contact with three kinds: the common brown one, just described; the red, or hill leech, which is larger than the former and of a light red colour, inflicting a venomous, though not dangerous, bite; and the hair-leech, so called by the Khamtees from its great length and extreme tenuity. This last description of leech lies in wait in the grass, and as animals feed it enters the nostrils and fixes itself firmly in the interior, where it takes up permanent quarters, causing the poor beasts great irritation. It seems to inflict itself entirely on animals, which is fortunate, or man would suffer greatly from this scourge of the jungle."

Mr. Cooper has done well in telling the world the story of his travels.

Transactions of the Albany Institute, vol. vii. (Albany, U.S., 1872.)

THIS institution is one of the oldest of its kind in America, having been originally founded upwards of eighty years ago, just after the conclusion of the American War of Independence. At present it is one of the most comprehensive and active of the American societies, its sphere of work embracing all departments of literature and science. In an eloquent annual address, which is the first paper in this volume, Orlando Meads, one of the oldest members of the Institute, sketches its history, and gives reminiscences of some of the most eminent men who have been connected with the Society, including several who have left their mark on the country. A characteristic feature of this volume is the reports of what has been done during the year, both in America and Europe, in the various divisions of science and literature, the institution being divided into three departments—Physical Sciences and the Arts, Natural History, and History and General Literature, and these again into a number of classes. Thus we have in the present volume, reports on botany, zoology, chemistry, and general literature. Of the papers in this volume we may notice one On Nitro-glycerine, as used in the construction of the Hoosac Tunnel, by Prof. G. M. Mowbray. The author traces the history of the dangerous article, gives an account of his own investigations regarding it, and describes the method in which it was used in boring the Hoosac tunnel.—On certain new Phenomena in Chemistry, by Verplanck Colvin, describes some very remarkable experiments in amalgamation made by the author. From Newton to Kirchoff, by Dr. L. C. Cooley, traces in an interesting way the progress of research on Light during the period indicated; and in Researches in the Theory and Calculus of Operations, by J. A. Paterson, we have a most elaborate and intricate investigation on the theory of the actions of various forces of Nature. Mr. C. H. Peck contributes a Synopsis of New York Uncinulæ.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Microscopic Examination of Air

IN support of the conclusions arrived at by Mr. Douglas Cunningham, of Calcutta, in his "Microscopic Examinations of Air" (NATURE, vol. ix. p. 330), and in illustration of the method which he employed, perhaps I may be allowed to describe some observations of the same kind which I made three years ago but have not had leisure to continue or prepare for publication.

A sentence in Dr. Parkes' "Manual of Hygiene," alluding to the importance of minute examination of the air, turned my thoughts in that direction. The instrument which I constructed for the purpose was contrived after the manner of a weathercock, presenting the wide mouth of a funnel to the wind, while the

tube of the funnel was bent upwards and had an orifice about 1-20th of an inch in diameter. Close above this orifice was placed a glass slide, held by springs and bearing a drop of glycerine on its lower surface. The tube and glass slide were protected by a roof and two cheek-boards, which formed the vane of the weather-cock. The glass slide was so placed that the current of air issuing from the narrow orifice of the bent tube, under pressure of the wind on the wide mouth of the funnel, impinged on the centre of the drop of glycerine, and a large proportion of any solid matters carried by the air was caught on the glycerine. After a day or two, according to the weather, the slide was removed, a thin disk of glass was placed on the glycerine-drop, and the contents were then examined under the microscope, a duplicate slide being left in the aeroscope for the next observation.

This instrument depended for its function on the wind. If there was no wind, there was no current through the tube, and nothing was caught on the glycerine; but in general there was wind enough, and the captures were ample, often embarrassing by their multitude. The observations were mostly made in the neighbourhood of London, at the Greenwich Observatory. The nature of the captures varied according to the direction and velocity of the wind, the state of the weather, and the season of the year. A north-west wind, blowing over London, brought soot and globules of coal-tar, textile fibres, nondescript *débris*, a few vegetable spores, now and then an epithelial scale or two, always a number of half-cooked starch-grains (identified by their reaction with iodine and by traces of concentric lamination giving a black cross with the polariscope), and sometimes microscopic bread-crumbs (half-cooked starch-grains in meshes of gluten). The starch-grains were the most constant capture of all, in all seasons and for all directions of wind. They seem to be very durable. (If I remember rightly, M. Pouchet found starch-grains in all specimens of dust, even the most ancient, obtained from the neighbourhood of human dwellings.) A southerly wind, blowing from the country, brought a great variety of vegetable spores and pollen-grains and *débris*, with a smaller proportion of matters characteristic of town air. The size and quantity of the captures depended mainly on the velocity of the wind. Once or twice a strong wind swept a living acarus, or an entomostracan, or the shell of a diatom into the glycerine. In dry windy weather a quantity of siliceous sand was caught, which gave trouble by tilting the disk when in preparation for the microscope, and the larger grains had to be removed with the point of a needle.

The most interesting variation in the character of the organic captures was that which depended on the season of the year. In January and February scarcely anything was found (besides *débris* and inorganic matter) but a few fragments of mycelium of some fungus; but with the first fine weather in March the glycerine began to yield good returns. Spherical grains of poplar pollen were caught in large numbers, thirty or forty in a single drop, though the nearest poplar tree was a quarter of a mile distant. These were soon followed by the triangular pollen of birch and hazel—trees depending, like poplar, on the agency of the wind for fertilisation. From this time onward, through spring and summer, a great number and variety of pollen grains were caught. Cryptogamic cells increased in number through the summer, and reached their maximum in the autumn, when brown septate spores and others of various kinds, which my imperfect knowledge did not enable me to identify, appeared in abundance. If left for some days, they began to germinate. Towards winter their number diminished, the latest being minute dark brown oval spores of some species of agaricus (?). The winter months were comparatively barren.

I did not find any Bacteria, but there were numbers of excessively minute particles, of which I could not tell the nature. Once, after leaving the aeroscope for several days, I found the glycerine swarming with a minute *torula* which had evidently multiplied in that pabulum. In fact the glycerine was fermenting.

Among these facts, the only one which seems to have any bearing on the question of the propagation of infectious diseases is the great prevalence of cryptogamic spores in the air in autumn, when those diseases are especially rife.

To avoid fallacy in the results obtained, I used to place two drops of glycerine on the same slide, but only directed the air-current against one of them; both were examined under the microscope, and the difference credited to the air. By using glycerine that had been boiled with carmine, many of the organic captures were made more distinct: the nuclei of epithelial scales and of many other cells were brightly stained by the carmine. Glycerine had the disadvantage of absorbing moisture in damp weather and swelling to an inconvenient bulk. At such times I used oil instead, with good effect. My plan of examination was to sweep the whole disk in successive parallel zones, by the aid of mechanical stage-movement, and make record of every organic body that could be recognised. Such as I had not seen before were sketched with pen and ink and coloured chalk in a book devoted to that purpose.

It will be seen that my observations entirely support Mr Cunningham's, as to the abundant presence of living spores in the air. I was satisfied that this branch of research, in the hands of one thoroughly familiar with these microscopic forms, would lead to results of great interest, and I heartily congratulate Mr. Cunningham on the valuable work which he has produced.

HUBERT AIRY

Animal Locomotion

MR. WALLACE'S last letter seems to call for a word of explanation from me. I did not refer to the up stroke of the bird's wing because this was not the point in dispute. But in reply to Mr. Wallace's latest stricture—that I appear "to ignore the great downward reaction, added to gravitation, during every up stroke"—I would say (1) that the downward reaction is not great, (*a*) because, as Mr. Wallace has himself observed, of the valvular action of the feathers; (*b*) because of the convex form of the upper surface of the wing; and (*c*) in some cases, because the wing is less expanded in the up stroke. (2) As to the effect of gravitation, this was already allowed for in determining the resultant motion consequent on the down stroke, and must not be reckoned twice. Just as with an arrow shot from a bow, so with the bird; the motion consequent on the down stroke lasts long enough for the wings to be raised before it is spent. Mr. Wallace is certainly right in saying that the down stroke should counteract the downward reaction of the up stroke, but this downward reaction being slight cannot require "a highly-inclined upward motion," and what is more, it cannot require that the under surface of the wing should be directed forwards as Dr. Pettigrew asserts.

Again, I do not say the movement of the wing as a whole is downward and backward, but that the action of its surface is in that direction. The Duke of Argyll is no doubt correct in maintaining that the wing as a whole moves in a perpendicular line, or perhaps with a slight forward overlap.

I cordially agree with Mr. Wallace that the matter is not to be settled by "discussing theoretically, but by observation and experiment;" still the elementary principles of mechanics may surely be heard in evidence without disadvantage even at the outset of the inquiry.

JAMES WARD

Trinity College, Cambridge, March 30

Rudimentary Organs

IN a former communication (NATURE, vol. ix. p. 361) I promised to advance what seems to me a probable cause—additional to those already known—of the reduction of useless structures. As before stated, it was suggested to me by the penetrating theory proposed by Mr. Darwin (NATURE, vol. viii. pp. 432 and 505), to which, indeed, it is but a supplement. Epitomising Mr. Darwin's conception as to the dwarfing influence of impoverished conditions, progressively reducing the average size of a useless structure, by means of free intercrossing; the present cause may be defined as the mere cessation of the selective influence from changed condition of life.

Suppose a structure to have been raised by natural selection from 0 to average size 100, and then to have become wholly useless. The selective influence would now not only be withdrawn, but reversed; for, through Economy of Growth—understanding by this term both the direct and the indirect influence of natural selection*—it would rigidly eliminate the variations 101, 102, 103, &c., and favour the variations 99, 98, 97, &c. For the sake of definition we shall neglect the influence of Economy acting below 100, and so isolate the effects due to the mere withdrawal of Selection. By the condition of our assumption, all variations above 100 are eliminated, while below 100 indiscrimi-

* See former communication, NATURE, vol. ix. p. 361.

nate variation is permitted. Thus, the selective premium upon variation 99 being no greater than that upon 98, 98 would have as good a chance of leaving offspring (which would inherit and transmit this variation) as would 99: similarly, 97 would have as good a chance as 98, and so on. Now there is thus a much greater chance of variations being perpetuated at or below 99, than at or above 100; for at 100 the hard line of Selection (or Economy) is fixed, while there is no corresponding line below 100. The consequence of free intercrossing would therefore be to reduce the average from 100 to 99. Simultaneously, however, with this reducing process, other variations would be surviving below 99, in greater numbers than above 99; consequently the average would next become reduced to 98. There would thus be "two operations going on side by side—the one ever destroying the symmetry of distribution" round the average, "and the other ever tending to restore it." It is evident, however, that the more the average is reduced by this process of indiscriminate variation, the less chance there remains for its further reduction. When, for instance, it falls to 90, there are (numerically, though not actually, because of Inheritance) 89 to 9 in favour of diminution; but, when it falls to 80, there are only 79 to 19 in such favour. Thus (theoretically) the average would continue to diminish at a slower and slower rate, until it comes to 50, where, the chances in favour of increase and of diminution being equal, it would remain stationary.

Having thus, for the sake of clearness, considered this principle apart, let us now observe the effect of superadding to it the influence of the Economy of Growth—a principle with which its action must always be associated. Briefly, as this influence would be that of continually favouring the variations on the side of diminution, the effect of its presence would be that of continuously preventing the average from becoming fixed at 50, 40, 30, &c. In other words, the "hard line of Selection," which was originally placed at 100, would now become progressively lowered through 90, 80, 70, &c.; always allowing indiscriminate variation below the barrier, but never above it.

It will be understood that by "cessation of selection from changed conditions of life" I mean a change *of any kind* which renders the affected organ superfluous. Take, for example, the exact converse of Mr. George Darwin's illustration, by supposing a herd of cattle to migrate from a small tract of poor pasture to a large tract of rich. Segregation would ensue, the law of battle would become less severe, while variation would be promoted in a cumulative manner by the increase of food. The young males with shorter horns would thus have as good a chance of leaving progeny as "their longer-horned brothers," and the average length would gradually diminish as in the other case. Of course, as the predisposing cause of impoverished nutrition would now be absent, the reducing process would take place at a slower rate. Moreover, it is to be remarked that this principle differs in an important particular from that enunciated by Mr. Darwin, in that it could never reduce an organ much below the point at which the Economy of Growth (together with Disuse) ceases to act. For, returning to our numerical illustration, suppose this point to be 6, the average would eventually become fixed at 3.

That the principle thus explained has a real existence we may safely conclude, theoretical considerations apart, from the analogy afforded by our domestic races; for nothing is more certain to breeders than the fact that neglect causes degeneration, even though the strain be kept isolated. It will be observed that, if this principle has a real existence, it is of considerable importance, theoretically, since it must act, to a greater or less extent, in all cases where Disuse and the Economy of Growth are in operation; and although in the initial stages of reduction, when the purchase, so to speak, of the last-named principle is great, its influence would be comparatively trivial, this influence would be more and more felt the smaller the organ became—*i.e.*, the nearer the point at which the Economy of Growth ceases to act. The Cessation of Selection should therefore be regarded as a reducing cause, which co-operates with other reducing causes in all cases, and which is of special importance as an accelerating agent when the influence of the latter becomes feeble.

GEORGE J. ROMANES

Lakes with two Outfalls

ON June 22, 1863, the late Captain Speke published his map, giving (on native authority) *four* outlets from Lake Victoria Nyanza, converging to *one* valley or water-flow—the Nile.

On June 27 and on July 20 I wrote to the *Athenæum*:—"I think that this native information will prove to be erroneous;" that I thought "that no lake can have more than one outlet;" and I added, "May I lay the question as to the matter of fact before the readers of the *Athenæum*?" In reply, the Black Loch in Dumfriesshire was stated to have *two* outlets to *two* distinct valleys or water-flows—one to the Nith, the other to the Ayr. The Loch, however, has but one outlet, and that *artificial*. The water-parting has been cut through by man—a mill-lead made to Lord Bute's Borland mill, and the one outlet is an iron sluice in a stone dam. All this is beautifully shown in Sir Henry James's admirable 25-inch Ordnance Maps.

Dr. Bryce ("Geology of Arran," 3rd edition, p. 3) says that Loch-an-Davie has two outlets to two different valleys. It has, however, but one outlet, to the south—to Glen Iorsa, as I stated in the *Athenæum*, July 22, 1865. The new inch Ordnance Map of Arran gives one outlet, but unfortunately to the north, instead of to the south. I will not refer to my letter on the two outlets to two valleys from the Norwegian Lesjeskaugen Lake, which you did me the honour to publish last September, and with which Prof. Stanley Jevons agreed. But I quote the above cases to show that even the highest authorities make mistakes as regards lakes and their outlets. I cannot, however, suppose any mistake in Prof. Bell's account of the two outlets to two valleys from Shoal Lake, published in NATURE, vol. ix. p. 363, by Prof. Dawson. I would then, in deference to these authorities, modify my dictum by saying, that if by a rare possibility a lake may be found to exist on a water-parting having at opposite ends two outlets to two different valleys, I should still doubt the possibility of a lake at its one lower end having a multiplicity of outlets converging to one valley or water-flow, as in the case of the Victoria Nyanza. And this owing to the extreme improbability that the erosion at each outlet should continue at precisely the same rate.

The outlet of every lake in the wide, wide world is always being lowered from erosion, as are valleys themselves. Valleys exist only in the dissolution of hills. They are mere water-flows. They are the perpetually changing effects of atmospheric disintegration, and the erosion of rain and rivers, and consequently every water-parting is a valley-parting.

Alresford, March 14 GEORGE GREENWOOD

A Beech pierced by a Thorn Plant

ON the road from this to Belfast there is a thorn hedge with beech trees at intervals, and thorn plants have grown right through the middle of the trunks of two of the beeches. I do not know whether this is sufficiently uncommon to be worth mentioning in NATURE. JOSEPH JOHN MURPHY

Old Forge, Dunmurry, co. Antrim

KINETIC THEORY OF THE DISSIPATION OF ENERGY

IN abstract dynamics an instantaneous reversal of the motion of every moving particle of a system causes the system to move backwards, each particle of it along its old path, and at the same speed as before when again in the same position—that is to say, in mathematical language, any solution remains a solution when t is changed into $-t$. In physical dynamics, this simple and perfect reversibility fails on account of forces depending on friction of solids; imperfect fluidity of fluids; imperfect elasticity of solids; inequalities of temperature and consequent conduction of heat produced by stresses in solids and fluids; imperfect magnetic retentiveness; residual electric polarisation of dielectrics; generation of heat by electric currents induced by motion; diffusion of fluids, solution of solids in fluids, and other chemical changes; and absorption of radiant heat and light. Consideration of these agencies in connection with the all-pervading law of the conservation of energy proved for them by Joule, led me twenty-three years ago to the theory of the dissipation of energy, which I communicated first to the Royal Society of Edinburgh in 1852, in a paper entitled

"On a Universal Tendency in Nature to the Dissipation of Mechanical Energy.

The essence of Joule's discovery is the subjection of physical phenomena to dynamical law. If, then, the motion of every particle of matter in the universe were precisely reversed at any instant, the course of nature would be simply reversed for ever after. The bursting bubble of foam at the foot of a waterfall would reunite and descend into the water: the thermal motions would reconcentrate their energy and throw the mass up the fall in drops reforming into a close column of ascending water. Heat which had been generated by the friction of solids and dissipated by conduction, and radiation with absorption, would come again to the place of contact and throw the moving body back against the force to which it had previously yielded. Boulders would recover from the mud the materials required to rebuild them into their previous jagged forms, and would become reunited to the mountain peak from which they had formerly broken away. And if also the materialistic hypothesis of life were true, living creatures would grow backwards, with conscious knowledge of the future, but no memory of the past, and would become again unborn. But the real phenomena of life infinitely transcend human science, and speculation regarding consequences of their imagined reversal is utterly unprofitable. Far otherwise, however, is it in respect to the reversal of the motions of matter uninfluenced by life, a very elementary consideration of which leads to the full explanation of the theory of dissipation of energy.

To take one of the simplest cases of the dissipation of energy, the conduction of heat through a solid—consider a bar of metal warmer at one end than the other and left to itself. To avoid all needless complication, of taking loss or gain of heat into account, imagine the bar to be varnished with a substance impermeable to heat. For the sake of definiteness, imagine the bar to be first given with one half of it at one uniform temperature, and the other half of it at another uniform temperature. Instantly a diffusing of heat commences, and the distribution of temperature becomes continuously less and less unequal, tending to perfect uniformity, but never in any finite time attaining perfectly to this ultimate condition. This process of diffusion could be perfectly prevented by an army of Maxwell's "intelligent demons"* stationed at the surface, or interface as we may call it with Prof. James Thomson, separating the hot from the cold part of the bar. To see precisely how this is to be done, consider rather a gas than a solid, because we have much knowledge regarding the molecular motions of a gas, and little or no knowledge of the molecular motions of a solid. Take a jar with the lower half occupied by cold air or gas, and the upper half occupied with air or gas of the same kind, but at a higher temperature, and let the mouth of the jar be closed by an air-tight lid. If the containing vessel were perfectly impermeable to heat, the diffusion of heat would follow the same law in the gas as in the solid, though in the gas the diffusion of heat takes place chiefly by the diffusion of molecules, each taking its energy with it, and only to a small proportion of its whole amount by the interchange of energy between molecule and molecule; whereas in the solid there is little or no diffusion of substance, and the diffusion of heat takes place entirely, or almost entirely, through the communication of energy from one molecule to another. Fourier's exquisite mathematical analysis expresses perfectly the statistics of the process of diffusion in each case, whether it be "conduction of heat," as Fourier and his followers have called it, or the diffusion of substance in fluid masses (gaseous or liquid) which Fick showed to be subject to Fourier's formulæ. Now, suppose the weapon of the ideal army to be a club, or, as it were, a molecular cricket-bat; and suppose for convenience the mass of each demon with his weapon to be several times greater than that of a molecule. Every time he strikes a molecule he is to send it away with the same energy as it had immediately before. Each demon is to keep as nearly as possible to a certain station, making only such excursions from it as the execution of his orders requires. He is to experience no forces except such as result from collisions with molecules, and mutual forces between parts of his own mass, including his weapon: thus his voluntary movements cannot influence the position of his centre of gravity, otherwise than by producing collision with molecules.

The whole interface between hot and cold is to be divided into small areas, each allotted to a single demon. The duty of each demon is to guard his allotment, turning molecules back or allowing them to pass through from either side, according to certain definite orders. First, let the orders be to allow no molecules to pass from either side. The effect will be the same as if the interface were stopped by a barrier impermeable to matter and to heat. The pressure of the gas being, by hypothesis, equal in the hot and cold parts, the resultant momentum taken by each demon from any considerable number of molecules will be zero; and therefore he may so time his strokes that he shall never move to any considerable distance from his station. Now, instead of stopping and turning all the molecules from crossing his allotted area, let each demon permit a hundred molecules chosen arbitrarily to cross it from the hot side; and the same number of molecules, chosen so as to have the same entire amount of energy and the same resultant momentum, to cross the other way from the cold side. Let this be done over and over again within certain small equal consecutive intervals of time, with care that if the specified balance of energy and momentum is not exactly fulfilled in respect to each successive hundred molecules crossing each way, the error will be carried forward, and as nearly as may be corrected, in respect to the next hundred. Thus, a certain perfectly regular diffusion of the gas both ways across the interface goes on, while the original different temperatures on the two sides of the interface are maintained without change.

Suppose, now, that in the original condition the temperature and pressure of the gas are each equal throughout the vessel, and let it be required to disequalise the temperature but to leave the pressure the same in any two portions A and B of the whole space. Station the army on the interface as previously described. Let the orders now be that each demon is to stop all molecules from crossing his area in either direction except 100 coming from A, arbitrarily chosen to be let pass into B, and a greater number, having among them less energy but equal momentum, to cross from B to A. Let this be repeated over and over again. The temperature in A will be continually diminished and the number of molecules in it continually increased, until there are not in B enough of molecules with small enough velocities to fulfil the condition with reference to permission to pass from B to A. If after that no molecule be allowed to pass the interface in either direction, the final condition will be very great condensation and very low temperature in A; rarefaction and very high temperature in B; and equal temperature in A and B. The process of disequalisation of temperature and density might be stopped at any time by changing the orders to those previously specified (2), and so permitting a certain degree of diffusion each way across the interface while maintaining a certain uniform difference of temperatures with equality of pressure on the two sides.

If no selective influence, such as that of the ideal "demon," guides individual molecules, the average result of their free motions and collisions must be to equalise the distribution of energy among

* The definition of a "demon," according to the use of this word by Maxwell, is an intelligent being endowed with free will, and fine enough tactile and perceptive organisation to give him the faculty of observing and influencing individual molecules of matter.

them in the gross; and after a sufficiently long time from the supposed initial arrangement the difference of energy in any two equal volumes, each containing a very great number of molecules, must bear a very small proportion to the whole amount in either; or, more strictly speaking, the probability of the difference of energy exceeding any stated finite proportion of the whole energy in either is very small. Suppose now the temperature to have become thus very approximately equalised at a certain time from the beginning, and let the motion of every particle become instantaneously reversed. Each molecule will retrace its former path, and at the end of a second interval of time, equal to the former, every molecule will be in the same position, and moving with the same velocity, as at the beginning; so that the given initial unequal distribution of temperature will again be found, with only the difference that each particle is moving in the direction reverse to that of its initial motion. This difference will not prevent an instantaneous subsequent commencement of equalisation, which, with entirely different paths for the individual molecules, will go on in the average according to the same law as that which took place immediately after the system was first left to itself.

By merely looking on crowds of molecules, and reckoning their energy in the gross, we could not discover that in the very special case we have just considered the progress was towards a succession of states in which the distribution of energy deviates more and more from uniformity up to a certain time. The number of molecules being finite, it is clear that small finite deviations from absolute precision in the reversal we have supposed would not obviate the resulting disequalisation of the distribution of energy. But the greater the number of molecules, the shorter will be the time during which the disequalising will continue; and it is only when we regard the number of molecules as practically infinite that we can regard spontaneous disequalisation as practically impossible. And, in point of fact, if any finite number of perfectly elastic molecules, however great, be given in motion in the interior of a perfectly rigid vessel, and be left for a sufficiently long time undisturbed except by mutual impacts and collisions against the sides of the containing vessel, it must happen over and over again that (for example) something more than nine-tenths of the whole energy shall be in one half of the vessel, and less than one-tenth of the whole energy in the other half. But if the number of molecules be very great, this will happen enormously less frequently than that something more than 6-10ths shall be in one half, and something less than 4-10ths in the other. Taking as unit of time the average interval of free motion between consecutive collisions, it is easily seen that the probability of there being something more than any stated percentage of excess above the half of the energy in one half of the vessel during the unit of time, from a stated instant, is smaller the greater the dimensions of the vessel and the greater the stated percentage. It is a strange but nevertheless a true conception of the old well-known law of the conduction of heat to say that it is very improbable that in the course of 1,000 years one half the bar of iron shall of itself become warmer by a degree than the other half; and that the probability of this happening before 1,000,000 years pass is 1,000 tines as great as that it will happen in the course of 1,000 years, and that it certainly will happen in the course of some very long time. But let it be remembered that we have supposed the bar to be covered with an impermeable varnish. Do away with this impossible ideal, and believe the number of molecules in the universe to be infinite; then we may say one half of the bar will never become warmer than the other, except by the agency of external sources of heat or cold. This one instance suffices to explain the philosophy of the foundation on which the theory of the dissipation of energy rests.

Take however another case in which the probability may be readily calculated. Let a hermetically-sealed glass jar of air contain 2,000,000,000,000 molecules of oxygen, and 8,000,000,000,000 molecules of nitrogen. If examined any time in the infinitely distant future, what is the number of chances against one that all the molecules of oxygen and none of nitrogen shall be found in one stated part of the vessel equal in volume to 1-5th of the whole? The number expressing the answer in the Arabic notation has about 2,173,220,000,000 of places of whole numbers. On the other hand the chance against there being exactly 2-10ths of the whole number of particles of nitrogen, and at the same time exactly 2-10ths of the whole number of particles of oxygen in the first specified part of the vessel is only 4021×10^9 to 1.

[*Appendix.—Calculation of Probability respecting Diffusion of Gases.*]

For simplicity I suppose the sphere of action of each molecule to be infinitely small in comparison with its average distance from its nearest neighbour: thus, the sum of the volumes of the spheres of action of all the molecules will be infinitely small in proportion to the whole volume of the containing vessel. For brevity, space external to the sphere of action of every molecule will be called free space: and a molecule will be said to be in free space at any time when its sphere of action is wholly in free space; that is to say, when its sphere of action does not overlap the sphere of action of any other molecule. Let A, B denote any two particular portions of the whole containing vessel, and let a, b be the volumes of those portions. The chance that at any instant one individual molecule of whichever gas shall be in A is $\frac{a}{a+b}$, however many or few other molecules there may be in A at the same time; because its chances of being in any specified portions of free space are proportional to their volumes; and, according to our supposition, even if all the other molecules were in A, the volume of free space in it would not be sensibly diminished by their presence. The chance that of n molecules in the whole space there shall be i stated individuals in A, and that the other $n-i$ molecules shall be at the same time in B, is

$$\left(\frac{a}{a+b}\right)^i \left(\frac{b}{a+b}\right)^{n-i}, \text{ or } \frac{a^i b^{n-i}}{(a+b)^n}$$

Hence the probability of the number of molecules in A being exactly i, and in B exactly $n-i$, irrespectively of individuals, is a fraction having for denominator $(a+b)^n$, and for numerator the term involving $a^i b^{n-i}$ in the expansion of this binomial; that is to say it is—

$$\frac{n(n-1)\;.\;.\;.\;.\;(n-i+1)}{1.2\;\;.\;.\;.\;.\;\;i} \left(\frac{a}{a+b}\right)^i \left(\frac{b}{a+b}\right)^{n-i}$$

If we call this T_i we have

$$T_{i+1} = \frac{n-i}{i+1}\frac{a}{b}\,T_{i+1}$$

Hence T_i is the greatest term if i is the smallest integer which makes

$$\frac{n-i}{i+1} < \frac{b}{a}$$

this is to say, if i is the smallest integer which exceeds

$$n\frac{a}{a+b} - \frac{b}{a+b}$$

Hence if a and b are commensurable the greatest term is that for which

$$i = n\frac{a}{a+b}$$

To apply these results to the cases considered in the preceding article, put in the first place

$$n = 2 \times 10^{12}$$

this being the number of particles of oxygen; and let $i = n$. Thus, for the probability that all the particles of oxygen shall be in A, we find

$$\left(\frac{a}{a+b}\right)^{8 \times 10^{12}}$$

Similarly, for the probability that all the particles of nitrogen are in the space B, we find

$$\left(\frac{b}{a+b}\right)^{2\times10^{12}}$$

Hence the probability that all the oxygen is in A and all the nitrogen in B is

$$\left(\frac{a}{a+b}\right)^{2\times10^{12}}\times\left(\frac{b}{a\times b}\right)^{8\times10^{12}}$$

Now by hypothesis

$$\frac{a}{a+b}=\frac{2}{10}$$

and therefore

$$\frac{b}{a+b}=\frac{8}{10}$$

hence the required probability is

$$\frac{2^{26\times10^{12}}}{10^{10^{13}}}$$

Call this $\frac{1}{N}$, and let log denote common logarithm. We have $\log N = 10^{13} - 26\times10^{12}\times\log.\,2 = (10 - 26\log.\,2)\times10^{12} = 2173220\times10^{6}$. This is equivalent to the result stated in the text above. The logarithm of so great a number, unless given to more than thirteen significant places, cannot indicate more than the number of places of whole numbers in the answer to the proposed question, expressed according to the Arabic notation.

The calculation of T_i when i and $n-i$ are very large numbers is practicable by Stirling's Theorem, according to which we have approximately

$$1.2\ldots\ldots i = i^{i+\frac{1}{2}}\,\epsilon^{-i}\sqrt{2\pi}$$

and therefore

$$\frac{n(n-1)\ldots\ldots(n-i+1)}{1.2\quad\ldots\ldots\quad i}=\frac{n^{n+\frac{1}{2}}}{\sqrt{2\pi i}\,(i+\frac{1}{2})(n-i)^{n}}$$

Hence for the case

$$i = n\frac{a}{a+b}$$

which, according to the preceding formulæ, gives T_i its greatest value, we have

$$T_i=\frac{1}{\sqrt{2\pi nef}}$$

where

$$e=\frac{a}{a+b}\text{ and }f=\frac{b}{a+b}$$

Thus, for example, let $n = 2\times10^{12}$;

$$e=\cdot2,\ f=\cdot8$$

we have

$$T_i=\frac{1}{800000\sqrt{\pi}}=\frac{1}{1418000}$$

This expresses the chance of there being 4×10^{11} molecules of oxygen in A, and 16×10^{11} in B. Just half this fraction expresses the probability that the molecules of nitrogen are distributed in exactly the same proportion between A and B, because the number of molecules of nitrogen is four times greater than of oxygen.

If n denote the molecules of one gas, and n' that of the molecules of another, the probability that each shall be distributed between A and B in the exact proportion of the volume is

$$\frac{1}{2\pi ef\sqrt{nn'}}$$

The value for the supposed case of oxygen and nitrogen is

$$\frac{1}{2\pi\times\cdot16\times4\times10^{12}}=\frac{1}{4021\times10^{9}}$$

which is the result stated at the conclusion of the text above.

WILLIAM THOMSON

LIVINGSTONE'S WORK IN AFRICA

THE daily papers have published some extracts from a letter of the late Dr. Livingstone to Mr. H. M. Stanley, which have been kindly furnished by the enterprising proprietor of the *New York Herald*; we reproduce here so much of the letter as bears on the geographical work done by Livingstone.

"The Chambezi was crossed long ago by the Portuguese, who have thus the merit of its discovery in modern times. The similarity of names led to its being put down in maps as 'Zambesi' (eastern branch) and I rather stupidly took the error as having some sort of authority. Hence my first crossing it was as fruitless as that of the Portuguese. It took me twenty-two months to eliminate this error.

"The Cazembe who was lately killed was the first who gave me a hint that Chambezi was one of a chain of rivers and lakes which probably forms the Nile; but he did it in rather a bantering style that led me to go back to the head waters again and see that it was not the mere 'chaff' of a mighty potentate. There is Omar Island in the middle of Bangueldo, with 183° of sea horizon around. The natives, slowly drawing the hand around, said—'That is Chambezi flowing round all this space and forming Bangweolo before it winds round that headland and changes its name to Luapula.' That was the moment of discovery and not the mere crossing of a small river.

"The late Cazembe I found sensible and friendly. His empire has succumbed before a very small force of Arab slaves and Banyamwezi. Pereira, the first Portuguese who visited the Cazembe eighty years ago, said that he had 30,000 trained soldiers, sacrificed twenty human victims every day, and that the streets of his capital were watered daily. I thought that my late friend had 30,0(00), diminished by two 00's, and sacrificed five or six pots of pombe daily; but this may have been only a court scandal—the streets of his village were not made. So I was reminded of the famous couplet about the Scotch roads:—

"'If you had seen these roads before they were made,
You would lift up your hands and bless General Wade.'

"I have been the unfortunate means of demolishing two empires in Portuguese geography—the Cazembes and that of the Emperor Monomotapa. I found the last about ten days above Tette. He had too few men to make the show Cazembe did, but I learnt from some decent motherly-looking women attached to his Court Zembere (?) that he had 100 wives. I have wondered ever since and have been nearly dumfoundered with the idea of what a nuisance a man with 100 wives in England would be. It is awful to contemplate, and might be chosen as a theme for a Young Men's Debating Society. I wish someone would visit Mtesa, or Uganda, without Bombay as an interpreter. He (Bombay) is by no means a sound author. The King of Dahomey suffered eclipse after a common-sense visit, and we seldom hear any more of his atrocities. The mightiest African potentate and the most dreadful cruelties told of Africans owe a vast deal to the teller.

"You and I passed the islet Kasenge, where African mothers were said to sell their infants for a loin-cloth each. This story was made to fit into another nice little story of 'a mother bear' that refused to leave her young. A child that cuts its upper front teeth before the under is dreaded as unlucky and likely to bring death into the family. It is called an Arab child, and the first Arab who passes is asked to take it. I never saw a case, nor have the Arabs I have asked seen one either, but they have heard of its occurrence. The Kasenge story is, therefore, exactly like that of the Frenchman who asserted that the English were so fond of hanging themselves in November you might see them swinging on trees along the road. He may have seen one; I never did. English and American mothers have been guilty of deserting infants; but who would turn up the whites of his eyes and say, as our mothers at Kasenge did, these people are no better than, or not so good as, she-bears?

"This lake, so far as I have seen it, is surrounded by

an extremely flat country, though all 4,000 ft. above the level of the sea. When first discovered I was without paper, but borrowed a little from an Arab, and sent a short account home. I had so much trouble from attendants that I took only the barest necessaries. Yet no sooner was the discovery announced at the coast than the official description was forthwith sent to the Bombay Government, that 'the lake is like Nyassa, Tanganyika, and the Albert Nyanza, overhung by high mountain slopes, which slope down to great plains, which, during the rainy season, become flooded, so that caravans march for days through water knee-deep seeking for higher ground on which to pass the night.'

"The only mountain slopes are ant-hills, some of them 20ft. high. They could scarcely be called high unless thought of as being built on the top of the 4,000 ft. These statements are equally opposed to the truth, as the Cazembe town is built on the banks of the Luapula.

"People having a crochet for map making traced every step of the Portuguese slaving expeditions to Cazembe, and built the village in latitude 8° 43′ South—that is, in deep water, near the north end of Lake Moero, and over 50 miles from Luapula. I found it in latitude 9° 37′ South, and on the banks of a lagoon or loch, having no connection with Luapula, which river, however, falls six or seven miles west of the village of Moero.

"Now it is very unpleasant for me to expose any of these misstatements and so appear contradictious. But what am I to do? I was consulted by Sir Roderick Murchison as to this present expedition, and recommended the writer of the above as a leader. Sir Roderick afterwards told me that the offer was declined unless a good salary and a good position to fall back upon were added, as Speke and Grant had, on their pay and commission. He then urged the leadership on myself as soon as the work on which I was engaged should be published. My good, kind-hearted friend added, in a sort of pathetic strain, 'You will be the real discoverer of the source of the Nile.' I don't wish to boast of my good deeds, but I need not forget them. . . ."

SOUNDINGS IN THE PACIFIC

RECENT explorations in the Pacific Ocean indicate that its bed is singularly level. The soundings of the U.S. steamer *Tuscarora*, Capt. George T. Belknap, between Cape Flattery and Oonalaska, were described in NATURE, vol. viii. p. 150. Upon the conclusion of that cruise, which included also soundings from Cape Flattery to San Francisco, a month was spent in the latter harbour, and on December 5 a survey was begun between that port and San Diego on the same coast, especially between depths of 100 and 1,500 fathoms. The latter depth or a greater one is reached precipitately along the entire coast of California, at distances of 20 to 70 miles from shore. Off the Golden Gate, in the latitude of San Francisco Bay, at a distance of 30 miles, there is 100 fathoms; at 55 miles' distance, there is a sudden descent from 400 fathoms to a depth of two miles; at 100 miles out, 2,548 fathoms failed to reach bottom.

Soundings between San Diego, California, and Honolulu, Sandwich Islands, show that this part of the Pacific is a basin with precipitous sides and a comparatively level bottom. The distance between these points, surveyed by the *Tuscarora*, is 2,240 miles. The work was accomplished between January 6 and February 3, favourable weather being experienced during almost the entire voyage.

In the first 100 miles west from San Diego, there appear to be two valleys and two peaks. The first valley is from 622 to 784 fathoms depth; the first peak 445 fathoms, the second valley 955 fathoms, the second peak 566 fathoms. Thence a precipitous fall takes place, giving in lat. 31° 43′ N., long. 119° 28′ W., at 115 miles from San Diego, a depth of 1,915 fathoms. After that there is a gentle slope with comparatively unimportant interruptions, at the rate of three feet to the mile, to the point of greatest depth, 3,054 fathoms, at a distance of about 400 miles east of Honolulu. The sharpest elevation is a rise about midway between the United States and the Sandwich Islands, in lat. 26° 30′ N., long. 127° 37′ W., the highest portion of which is 2,159 fathoms below the surface. At the next cast of the lead, the valley to the west of this elevation took 2,650 fathoms. The fall of the side of the basin east of Honolulu is even more remarkable than the descent off the American coast. Fifty miles from Honolulu, soundings gave 498 fathoms; at 40 miles farther east, in lat. 21° 43′ N., long. 156° 21′ W., the depth was 3,023 fathoms. Between the last-mentioned point and that of greatest depth a hill rises, on whose summit there are only 2,488 fathoms of water.

These soundings coincide very nearly with the determinations of the depth of the Pacific made on theoretical grounds by the United States Coast Survey in 1854. Those calculations were based on the movements of tidal waves occasioned by earthquakes in Asia. The wave that reached San Francisco had a length of 210 to 217 miles, an oscillation of 35 minutes, and a velocity of 6·0 to 6·2 miles per minute. This would give a depth of 2,200 to 2,500 fathoms. Similar data with regard to the wave that reached San Diego (having a length of 186 to 192 miles) were calculated as giving an average depth of 2,100 fathoms. The average depth of the present soundings is about 2,400 fathoms.

The bottom is generally a soft, yellowish-brown ooze, better suited in this respect, as well as in being more level, than the route surveyed toward Oonalaska, for a telegraphic cable. Other considerations of an economic character, such as prospects of connection with other telegraph lines, may also serve to overbalance the shortness of the more northern route, and there is much better prospect of fair weather for laying a cable and keeping it in repair in the lower latitudes.

Surface-temperatures rose from 59° F. near San Diego, to 74° F. near Honolulu; temperatures at 105 fathoms between the same places rose from 50° F. to 63° F. These, of course, indicate the equatorial current. At 300 fathoms the temperature was constant at 43° F. At bottom, the temperature was everywhere 35° F., except in a single instance where it was 1° colder. The uniformity of temperature below 1,600 fathoms was noticeable.

One wire has been used in all these soundings, which were made every 40 miles, and the apparatus still works excellently.

M. CHARLES SAINTE-CLAIRE DEVILLE'S WEATHER PROGNOSTICATIONS

THE prognostications delivered by M. Charles Sainte-Claire Deville, in his communication of March 2, before the French Institute, were wonderfully fulfilled, at least for Paris, the cold period having had its beginning on the 9th, and its end on the 13th, as was predicted. Public attention was all the more attracted because the cold was manifested by a heavy fall of snow, which was the first of the year. Having recently visited M. Ch. Sainte-Claire Deville, the learned physicist was kind enough to explain everything connected with his theories.

M. Ch. Sainte-Claire Deville has very often published similar prognostications which were always successful, but never in so striking a way. He has been a constant compiler of meteorological records for nearly twenty years; and being the Inspector-General of the French Meteorological Stations, as well as a member of the French Academy of Sciences, he has consequently at his command an immense number of trustworthy observations.

He has discovered that there is monthly a large thermometrical oscillation, which he calls dodecuple, from the

the Greek word δώδεκα, twelve; that dodecuple oscillation generally takes place in the second week of the month, but it is not equally marked every month, and besides it is not true to say that it is always exhibited by a depression of the mean temperature.

The November dodecuple oscillation decidedly exhibits a warming effect. February, March, and May have, on the contrary, a cooling effect. For centuries May and November were observed and noted as the "Saints de Glace" of the spring and Martinmas summer. But other oscillations, viz. February and March, which are generally very cold, were unnoticed.

The range of the oscillations, as well as their exact position *in time*, are different for different years, very probably because there is more than one single law in operation to produce them. Happily M. Charles Sainte-Claire Deville has discovered an indication which enables him to foresee which oscillations are to be the largest or the smallest.

Each dodecuple thermometrical oscillation is preceded by a similar dodecuple barometrical oscillation. The difference of time between both oscillations is variable, but the ordinary value is *five days*. Consequently, having noted a large barometrical dodecuple oscillation on March 2, he was certain that by the 8th the regular thermometrical dodecuple oscillation for March should appear very decidedly. The deviation of the thermometrical oscillation is uncertain, to the extent of four or five days.

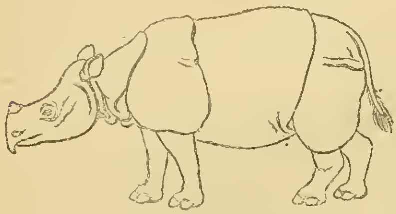
Everything is empirical in this wonderful method of announcing future oscillations of the thermometer by the careful observation of the barometer.

M. Charles Sainte-Claire Deville is of opinion that the phenomenon is owing to the presence of certain cosmical streams of meteoric bodies which may chance to be distributed in an irregular manner in the celestial space. These do not always keep just in the same place, owing to multifarious perturbations; they also vary in breadth, thickness, &c. All these assumptions are merely theoretical, but the existence of the dodecuple period in itself is based on pure observation, and cannot be questioned like the explanation offered for its origin.

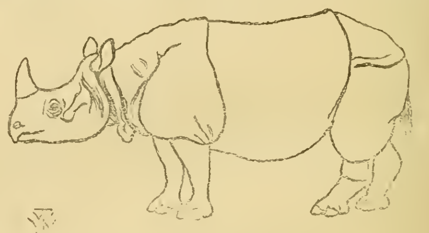
W. DE FONVIELLE

ON THE ARRANGEMENT OF THE SKIN-FOLDS IN THE ONE-HORNED RHINOCERI

IN the two accompanying woodcuts Mr. T. W. Wood has very carefully and accurately mapped out for us the manner in which the peculiar skin-folds, so conspicuous in both the Indian one-horned rhinoceri, are arranged over the surfaces of their bodies. The sketches were both taken from the specimens now living in the Zoological Gardens, the Indian animal (*Rhinoceros unicornis*) being a fully adult male, presented by Mr. A. Grote in 1864, and the Javan (*R. sondaicus*), the not quite full-grown example, of the same sex, just purchased. A fortnight ago (NATURE, vol. ix. p. 363) we mentioned some of the most important points by which the two species



R. sondaicus.



R. indicus.

are distinguished, laying stress on what is rendered so much more evident by the sketches we now give, namely, the peculiar manner in which the lateral shoulder-fold—which in the Indian species does not run up the middle line of the back, but is lost over the upper part of the scapula before it reaches the post-scapular transverse fold, as it is continued longitudinally backwards—in *Rhinoceros sondaicus* is carried perpendicularly upwards along the middle of the scapular shield, quite to the back, so as to cut off an extra, independent, saddle-shaped, small, median segment, which covers the nape of the neck. The peculiar notch in the post-scapular transverse fold, and the less extent of the longitudinal fold in the gluteal shield in the Javan species, is also very apparent. Another point which is well indicated is the difference in the shape of the upper lip in the two animals, it being short and blunt in *R. indicus*, whilst it is long, pointed, and semi-prehensile in *R. sondaicus*.

The head of the Javan rhinoceros is also proportionately smaller, whilst the skin-folds along the inferior surface of its neck are more symmetrical and numerous, being arranged so as to appear very like the surface of a coarse three-cord braid. Its skin, especially over the back, is covered with hair to a degree which would hardly have been expected, as in the Indian species there is but little hair to be seen. The ears are also fringed, much in the same way that they are in *Rhinoceros lasiotis* and *R. sumatranus*, the two Asiatic two-horned species.

The two sketches are made of one size to facilitate comparison, but it must be borne in mind that the Javan animal never reaches anything like the bulk of its Indian ally. It is also almost certain that its skin never becomes so coarsely tuberculated.

In rhinoceri kept in confinement there is nothing to be learnt from the shape or length of the horns, because that depends so much on the opportunities which their owners have had of rubbing them down. In the wild state the continual employment of the horn or horns in tossing and dividing comparatively yielding substances, such as loose earth and wood, causes them to become pointed, long, and polished, because they wear at the sides almost entirely. But in captivity the seasoned wood, iron, and stone of the cages only break off the tips and leave the sides comparatively unworn, or very unequally so; this is why museum specimens of horns are generally so very unlike those found on exhibited living animals.

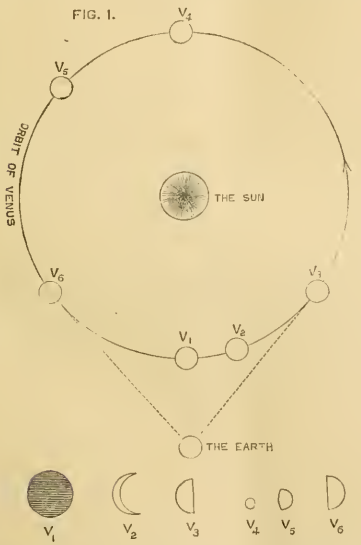
Those who noticed the illustrations we gave two months ago (NATURE, vol. ix. p. 227) of the huge *Brontotherium ingens* discovered by Prof. Marsh, will be struck, on looking at the Javan rhinoceros, with the general similarity in the proportions of the head in the two animals. The nose is undoubtedly different, but there is the same extreme shallowness of the frontal and interorbital region, combined with great zygomatic breadth. In Brontotherium the two expanded symmetrical nasal processes were probably covered with tough skin, like those on the face of the wart-hog, to replace in function the coreless but none the less well-developed horn of the rhinoceros.

THE COMING TRANSIT OF VENUS

I.

In days of old it was supposed that the earth held the central position of the solar system, and that moon, sun, and planets moved round it, each in its own orbit. The moon was supposed to be nearest to us, then came Venus, then Mercury, after that the sun, then Mars, Jupiter, and Saturn. We now know that of all these the moon is the only one which revolves round the earth, and that all planets go round the sun in the following order :—Mercury, Venus, the earth, Mars, Jupiter, Saturn. These are all the planets which were known to the ancients. Since Mercury and Venus were formerly supposed to be lower than the sun, and all the others higher, the name of *inferior planets* was given to the former, and *superior planets* to the others. These terms are still retained by astronomers, though the ideas that gave rise to these terms are long since exploded. Fig. 1 shows the phenomena exhibited by an inferior planet in the course of its journey round the sun. V is the planet Venus in the different parts of its orbit. E is the earth, which is shown in the figure always in one position, although of course it

FIG. 1.

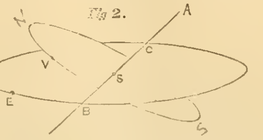


also describes an orbit round the sun. We are naturally led by a study of the diagram to three points of interest concerning the motions of an inferior planet.

The first is that the planet can never seem to be far distant from the sun. Venus moves round the sun in the direction shown by the arrow. The earth rotates in the same direction. We are supposed to be looking down upon the solar system from some point in the northern heavens. It will be noticed that when the planet leaves the point V_1 she will seem to recede from the sun more and more, until she reaches the position V_3. She can never be farther from the sun than this, and is then said to be at her greatest eastern elongation. She then approaches the direction in which the sun is seen, until she is lost in the brightness of his rays. During all this time she is seen best in the early morning before sunrise, setting before the sun. When Venus has passed this position her distance from the sun appears to an observer upon the earth to increase until she reaches V_6, her greatest western elongation, when she again begins to approach the sun.

The next point to be noticed is that she is sometimes a great deal closer to the earth than at other times; and when she is most near to the earth she appears to be larger. At her closest approach to the earth she is only about 26,000,000 of miles away; but when farthest off her distance is 158,000,000 of miles. Her apparent size is

Fig 2.

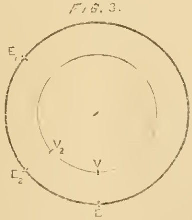


therefore much greater in the first case than in the second. These differences are shown at the lower part of Fig. 1.

The third point to be mentioned is that she exhibits phases just as the moon does. In any position that hemisphere alone is illuminated which is directed to the sun; so that in the position V_3, when we can only see one-half of that hemisphere, she will have the appearance of a half-moon. So in the position V_2 she has a crescent form, and at V_5 a gibbous form. The apparent size and shape of the planet in its different positions are shown in the lower part of Fig. 1.

The question now arises, what will happen when Venus is between us and the sun? In the first place, since her illuminated hemisphere is turned away from us, she will appear to be black; so that we shall have no chance of seeing her, unless she be seen as a black spot upon the bright surface of the sun. We would naturally expect that this should happen every time that the planet is at its least distance from us. A simple consideration shows that this need not be the case. The orbits of Venus and the earth do not lie in the same plane. In other words, we cannot represent accurately the paths of Venus and the earth by a drawing upon a sheet of paper. The orbit of Venus would have to be tilted up above the plane of the earth's orbit. Both of these planes pass through the sun, but they are inclined to each other at a certain small angle. This will be seen by a glance at Fig. 2, where V represents the orbit of Venus, E that of the earth. The line

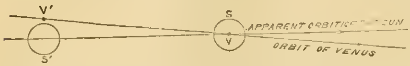
FIG. 3.



AB, which passes through the sun S, is called the line of nodes; and it is quite clear that in order to see Venus as a black spot upon the sun both the earth and Venus must lie approximately on this line of nodes. Now it generally happens that when Venus is at her least distance from the earth, these two planets occupy some such places as V and E, so that she seems to be above the sun; and, not being illuminated, she is invisible. Only twice in a century does she reach the node, so nearly at the same time as the earth, as to be seen as a black spot upon the sun. Such a phenomenon

is called a transit of Venus. If it happen that Venus seems to pass across the centre of the sun she takes about eight hours to complete the passage. The earth occupies the position A always in June, and the position B in December. If there be a transit of Venus when the earth is at B, Venus is said to be at the *descending* node, because then she is descending from the northern portion of her orbit to the southern. When Venus is at C she is at her *ascending* node.

FIG. 4

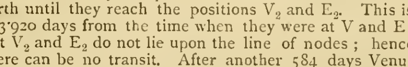


It has been said that there are, roughly speaking, two transits of Venus in a century. The following table shows all the transits of which we know anything :—

1631. Predicted by Kepler, but not observed.
1639. Predicted and observed by Horrox.
1761. Predicted by Halley ; observed by many.
1769. Observed generally.
1874.
1882.

It will be noticed that the transits occur in pairs, eight years apart ; the reason of this can easily be rendered clear. The earth takes 365·256 days to go round the sun ; Venus takes only 224·7 days. Suppose then that at any particular date Venus and the earth are at the node simultaneously, viz. at V and E, Fig. 3, a transit of Venus over the sun's diameter will be seen. When Venus has completed a revolution the earth will have moved away to E_1, and Venus will not overtake the earth until they reach the positions V_2 and E_2. This is 583·920 days from the time when they were at V and E ; but V_2 and E_2 do not lie upon the line of nodes ; hence there can be no transit. After another 584 days Venus will again be in conjunction with the sun, but still not on the line of nodes. But the fifth conjunction occurs after 2919·6 days ($5 \times 583·920$) ; and the earth completes eight revolutions in 2922·05 days. Thus it appears that, at this conjunction of Venus with the sun, the earth and Venus are very near to their old positions V and E. Hence they are almost on the line of nodes. In this case we can without difficulty examine the possibility of a transit. If we suppose the motion of the earth to be stopped, the apparent motions of the sun and Venus may be represented as in Fig. 4, where a portion of the orbit of Venus and of the ecliptic are shown near the nodes. When the sun and Venus are on the line of nodes simultaneously S represents the sun and V Venus. At the fifth conjunction the sun will not quite have reached S, but will be $2\frac{1}{2}$ days behind at S′ ; Venus will then be at V′. Now in this case there can be no transit visible, for here Venus is quite out of range of the sun. But if in the original transit the sun was a little past the node as at S (Fig. 5), then eight years after he will be at S′, and there will be

FIG. 5



another transit. It follows from this that there will be a pair of transits eight years apart, only when in the first one Venus does not pass close to the sun's centre. This equality of eight revolutions of the earth, with thirteen of Venus, is very interesting, because this fact was shown by the present Astronomer Royal to account for an inequality in the earth's motion due to the attracting influence of Venus. The result of a short calculation informs us that for positions of Venus and the earth near the line of nodes, Venus is at one conjunction 22′ 16″ distant from her position at the conjunction which occurred eight years previously,* this distance being measured at right angles to the ecliptic. Now the sun's diameter is 32′. This shows why, generally, there are two transits eight years apart.

The first prediction of a transit of Venus was made by Kepler,† and was calculated from his Rudolphine tables. In 1631, the year predicted, astronomers of Europe were eagerly on the watch for so rare a spectacle. But the calculation was in error, so that it took place when the sun was below the horizon in Europe, and was consequently invisible.

After this no astronomers seem to have interested themselves about the possibility of such an occurrence, with one exception. Jeremiah Horrox, a curate of the village of Hoole, near Liverpool, was much devoted to astronomical pursuits. ‡ He possessed some tables for calculating the places of the planets ; but his observations did not agree at all with them. He had, however, before discovering the faults of Lansberg's tables, calculated from them the future positions of the planets. This work, with corrections deduced from his own observations, led him to predict a transit of Venus, visible in England, for the year 1639. He acquainted his friend Crabtree, of Manchester, with the results of his calculation, and then prepared himself for the observation. He considered the best method to be the employment of a telescope to throw an image of the sun on a white sheet of paper in a darkened room. A circle was drawn, of about 6 inches diameter, upon the paper, to make the sun's image exactly fill the circle. A plumb-line would give him the direction of the vertical, and by marking successive positions of the planet on the sun's disc, he would be able to calculate many of the elements of Venus. Such an observation is of course peculiarly well suited for determining the diameter of the planet, the inclination of its orbit, the position of the node, and the true time of passing this node. His calculations showed that the transit ought to commence on the afternoon of November 24 (old style) ; but to guard against disappointment, and because of discrepancies in various tables, he kept a watch from the 23rd. On returning from some clerical duties on the 24th (Sunday) he was gratified by beholding a black spot on the sheet of paper, which indicated the presence of Venus on the sun's disc. He made three observations before sunset and has left us a drawing to illustrate the observations. §

It is curious to find an astronomer supporting the opinions of the astrologers ; but in his treatise we find that the chance of a clouded atmosphere caused him much anxiety, for Jupiter and Mercury were in conjunction with the sun almost at the same time as Venus. This seemed to him to forbode great severity of weather. He adds, "Mercury, whose conjunction with the sun is invariably attended with storm and tempest, was especially to be feared. In this apprehension I coincide with the opinion of the astrologers, because it is confirmed by experience ; but in other respects I cannot help despising their more than puerile vanities." But we must not laugh at Horrox for his opinion. In our own day there is a considerable number of diligent astronomers who believe that the cyclones in the Indian Ocean, certain other winds, the growth of vines, and various other

* For at the fifth conjunction the earth is 2·45 days distant from her place at the original conjunction. This is equivalent to 2° 24′ 59″, when viewed from the sun, from which subtract 2′ 44″ (= the retrogression of the node of Venus in eight years), and we have 2° 22′ 15″ = the angular distance of the earth from its corrected original position, as seen from the sun. The ratio of this to the angular distance of Venus from her original position as seen from the earth $= \frac{\text{dist. of Venus from earth}}{\text{dist. of earth from sun}} = \frac{277}{723}$. Multiplying 2° 22′ 15″ by 723, and dividing by 277, we have 6° 11′ 17″. Multiplying this by ·06 = tan 3° 23′ 31″, which is the inclination of the orbit of Venus, we have 22′ 16″ = the latitude of Venus at the fifth conjunction.

† 'Admonitiuncula ad Curiosos rerum Cœlestium," Leipsic, 1626.

‡ See NATURE, vol. viii. p. 113,

§ Venus in Sole Visa.

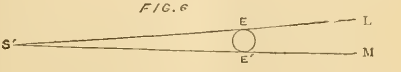
phenomena, are in part regulated by the positions of Venus and Jupiter with respect to the sun.*

Mr. Horrox's observations have been of great value in perfecting the tables of Venus. He was further led by a kind of analogy, much in vogue at the time, to deduce from his observations a value of the sun's distance from the earth. It will readily be understood that if we could find out what size, in angular measure, the earth would seem to have if viewed from the sun, we should have a means of determining how much greater the distance from the earth to the sun is than the diameter of the earth. For, suppose S (Fig. 6) to be the position of an observer placed upon the sun, S L, S M the directions in which he must look to see the opposite sides of the earth, so that the inclination of these lines is known. All we have to do now is to draw a circle of any size and move it about between the lines S L, S M, until it just fills the interval, as at E E′. If now we measure with a ruler how much greater S E is than E E′ we shall know the distance from the earth to the sun, the earth's diameter being taken as the unit of measurement; and if we multiply this by the diameter of the earth measured in miles we shall know the distance from the earth to the sun, in miles. All that we require to know is the size of the angle E S E′. Horrox estimated the probable value of this angle in the following manner. From the observations of Tycho Brahé it appeared that during the transit of Venus the apparent diameter of the planet would be 12′ 18″; while Lansberg found 12′ 21″; and Kepler 6′ 51″. Horrox found from his measurements that it was only 1′ 16″. The error of ordinary observations arises from the apparent enlargement of the planet's disc through irradiation. Gassendi had in the same manner, during the transit of Mercury in 1631, reduced the apparent diameter of Mercury to scarcely 20″. From these data it can be found that the apparent diameters of Venus and Mercury as seen from the sun would be 21″ and 34″ respectively. Proceeding to the other planets he arrived at the general conclusion that each of them would, if viewed from the sun, have an apparent diameter of about 28″. Applying this to the case of the earth, he showed that the distance of the earth from the sun must be 7,500 diameters of the earth (it may be well here to state that the latest measurements show the apparent diameter of the earth as viewed from the sun to be about 18″, and the distance = 11,400 diameters). This analogy by Horrox gave a much closer approach to the truth than any previous conjectures.

Before taking leave of Horrox, we must say a few words to his memory. He died at the early age of 23. During his short career he showed a remarkable aptitude for the acquisition of knowledge, and for the striking out of new ideas. He lived at a time when the scientific spirit of the age was leading up to the theory of gravitation, and many passages in his writings show that he had even then grasped the grand idea of the theory, and that he was well fitted to become its constructor and its expounder. His researches on the lunar and planetary theories indicate the magnitude of his talents.

We have already mentioned some of the uses to which careful observations of a transit of Venus may be applied; viz. the correction of the elements of the planet's orbit. But the observation also leads us to a knowledge of the distance of the sun from the earth, and in a manner much more direct and logical than that employed by Horrox. There is an opinion very prevalent that a transit of Venus affords the best means of determining this distance. So

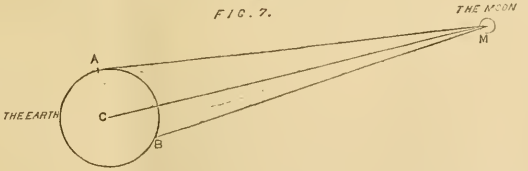
FIG. 6



far as our present knowledge goes we are hardly justified in such a statement until after the observations that shall be made in the present year.

Before entering upon the method by which we measure the sun's distance, let us devote a few lines to explaining what is meant by the word *parallax*, which is continually employed in such discussions. Let a man stand in a street exactly north of a lamp-post. The lamp-post will seem to be south of him. Now let him cross over to the other side of the street. The lamp-post will now be in some other direction, such as south-west. This movement of the direction of the lamp-post is the effect of parallax. Now let us suppose, by a stretch of imagination, that a man observes the moon from the centre of the earth. He will see it in the direction C M (Fig. 7). If now he goes to A he will see it in the direction A M. The angle A M C through which the moon appears to have been moved is the parallax of the moon as observed from A.

FIG. 7.



It will be noticed that the parallax is an error introduced into the observed position of the moon, and which must be allowed for if we wish to get the position as seen from C. Moreover, the parallax at B is different from what it is at A. But at no point on the surface of the earth can the parallax be greater than at A. And if we know the parallax of the moon at A, we can deduce that at B from a knowledge of the relative positions of A, B, and C. Hence it is useful to have a distinct name for the parallax at A. Now it will be noticed that a line drawn from C to A is the vertical line at A; hence the moon M will appear to be on the horizon to an observer at A; and hence the moon has its greatest parallax when on the horizon. For this reason the parallax at A is called the moon's *horizontal parallax*. Further, since the equatorial diameter of the earth is greater than the polar, the parallax will be greater, when the moon is on the horizon, to an observer at the equator than to an observer at one of the poles. Hence the greatest parallax we can have occurs when the moon is on the horizon and the observer is at the equator; this value of the parallax is the *equatorial horizontal parallax*. In the same way the sun has an equatorial horizontal parallax, and if we knew its value we could find out the sun's distance from the earth as explained above (Fig. 6).

GEORGE FORBES

(*To be continued.*)

* See the researches of Messrs. De la Rue, Stewart, and Loewy on the connection of sun-spot frequency with planetary positions, "Phil. Trans."; also the writings of Mr. Meldrum, Mr. E. J. Stone, Prof. Balfour Stewart, M. Poey, and others, on the connection between terrestrial phenomena and sun-spot frequency.

THE "CHALLENGER" EXPEDITION

III.

St. Vincent, Cape de Verde Islands

St. Vincent, one of the Cape de Verde Islands, noted in the old gazeteers for its wood, water, wild goats, turtles, and saltpetre, was visited by the *Challenger* in July and August last. From a record of this visit we gather the following particulars about the island itself and of the plants growing there. The island is small, not more than twelve miles by six, comparatively flat in the centre, but surrounded by higher land. This range of high land is divided by a series of deep valleys, forming ridges which are again divided into transverse valleys. Most of the hills are from 700 to 1,200 ft. high, but one in the south is over 2,200 ft. high. St. Vincent is sometimes visited by long periods of drought, extending occasionally to a year's duration, during which time the whole island has a parched, sterile appearance. The most abundant plant in the island is *Lavandula rotundifolia* Bth., which forms small thick bushes; there is also on the summits of the higher hills *Euphorbia tuckeyana*, Steud., and on the sandy plains as seen from the vessel in Porto Grande, reaching inland from the shore, were dense masses of bushes of *Tamarix gallica.* In one spot, springing up from amongst these bushes, was the well-known tamarind tree (*Tamarindus indica* L.), so valuable both in the East and West Indies, for the sake of the agreeable acid pulp contained in the pod, which when preserved in sugar forms "Tamarinds" of commerce. Side by side with the tamarind grew *Acacia albida* Del., and *Terminalia catappa* L., the first being one of the many spiny acacias found on the African continent, where it forms a large straggling branching tree, with straight, stout spines, sometimes ¾ in. long. The *Terminalia* is a native of India, but has been found in Upper Guinea, though probably not indigenous. The seeds are almond-shaped, white, and of an agreeable taste. In the plains *Tribulus cistoides* L., a spreading prostrate or decumbent plant, occurs in great abundance, as also a small grass. Nearly all the vegetation, however, had a shrivelled, dried-up appearance, with the exception of the lavender, upon which a few fresh green leaves were to be seen. The effect of rain in changing the aspect of vegetation on this island is said to be almost instantaneous, not only in bringing out the young foliage of perennial plants, but also in causing a thick carpet of seedlings to spring up. Though the hill slopes and the lower parts of the valleys are in some parts of the island covered with a thick grass, the drought causes it to become so dry that goats and cattle frequently die from sheer starvation.

On the Green Mountain, at an altitude of about 200 ft. above the level of the sea, the gardens contained pumpkins, sugar-cane, a small kind of date-palm, and maize; cotton bushes also grew in the neighbourhood. At another 500 ft. there were Euphorbias and the woody Composites. At 1,000 ft. there were *Echium stenosiphon* Webb, in flower; and at 1,300 ft. occurred patches of moss and marchantia, while at 1,700 ft. *Statice jovi-barba* Webb was abundant. The *Lavandula rotundifolia*, which is found at the very top of the mountain, has here a very different aspect from that before described, inasmuch as it is green and vigorous-looking. In the south-west of the island, at a height of 900 ft., was discovered a single plant of *Sarcostemma daltoni* Dcne, which grows on the cliffs at St. Jago, almost down to the sea. On the top of the Green Mountain the land is much cultivated with potatoes, tomatoes, pumpkins, maize, and similar plants. The position is so favourable to the growth of the tomato that it appears to have run wild. The origin of many of the introduced weeds which grow on the mountain is no doubt traceable to the imported seeds of the vegetables just mentioned.

At an elevation of about 2,000 ft. was a group of agaves planted in the form of a double circle; many of them had flowering spikes about 10 ft. high. The marked differences of aspect caused respectively by the trade-winds and the sun, at altitudes suitable for plant growth, are points of much interest, illustrations of which may be had in the fact that *Aizoon canariense* L., which grows on the windward and shady side of Bird Rock, nearly down to the sea-level, does not commence till 700 feet or 800 feet on the leeward sides of the main island; the Euphorbias and woody Composites are found at about the same elevation, while on the other side they reach nearly down to the sea. On the windward slopes of the mountains, on the southern side of the island, the vegetation commences at a higher elevation, being kept back by the wind becoming heated and dry from its passage across the hot central plain.

Sinapidendron vogelii Webb, a cruciferous undershrub, with yellow flowers, grows on the cliffs on the weather side of the island; and *Samolus valerandi* L., known to us as the brookweed or water pimpernel, an erect plant, from 8 in. to 10 in. high, growing in marshy places or near springs, was also seen, but only in a single isolated patch near a small stream. This plant is remarkable for its very wide geographical range, being found in almost every country where the soil is wet and gravelly, and though seen only in this one spot in St. Vincent, it grows abundantly in St. Jago by the stream in St. Domingo Valley.

As seen from the sea, the rocks of St. Vincent present a singular appearance, owing to the presence of a thick incrustation at water-mark of masses of calcareous algæ, which either follow the forms of the rocks, or occur in rounded masses, their delicate tints of white, light pink, or cream colour, considerably heightening the effect. These incrustations are frequently bored by *Lithodomus candigerus* and other molluscs, and small sponges and Bryozoa occupy the cavities between them and the rocks.

St. Paul's Rocks

The isolated rocks known as St. Paul's Rocks lie to the north of the equator about 1°, and in longitude 29° 15′ W., nearly midway between the South American and African coasts. They are in truth mere rocks, not more than a quarter of a mile long, and rising to a height of from 50 to 60 ft. above the sea. They are described by travellers as being quite bare of land-vegetation even to the exclusion of lichens, the only vegetation in fact being numerous species of algæ.

From an examination made of the rocks during the two days' stay of the *Challenger*, it seems that the species of algæ are by no means numerous, fourteen species being all that were found; so powerful indeed is the wash of the waves that it seems to be too much even for these marine plants to retain their positions. The water also deepens very rapidly round the rocks, so that it is not likely many species would be found there.

A similar incrustation of calcareous algæ is seen upon the rocks as at St. Vincent. It here forms a deep pinkish white band at tide mark, and is riddled through and through by a small annelid. In some places the colour of the incrustation is white, and above this is a dark red-coloured algæ, covering the rocks for several feet. At the bottom of the small bay formed by the circlet of rocks and extending out in the sea to a depth of twenty fathoms, is a thick growth of a green-coloured sea-weed (*Caulerpa clavifera* Ag.), together with another species of smaller growth. The former is loosened from the bottom by the action of the waves, and is gathered up by the noddies (*Sterna stolida*) to build their nests.

A few diatoms and oscillatoriæ occur in stagnant pools, among them being *Navicula didyma*, *Rhabdonema adriaticum* and *Biddulphia pulchella.* A careful examination of the guano found in the hollows of the rocks showed that no diatoms were present, but fossil fragments of incrus-

tation formed of a kind of nullipore, combined with pebbles and broken shells, occur in the singular veins of conglomerate traversing the rock.

NOTES

WE are glad to hear that Government have consented, though tardily, to give effect to the wishes of the country, by offering to defray the expenses of the funeral of Dr. Livingstone in Westminster Abbey. The *Times* states that a merchant in the city of London, in view of the inability of Dr. Livingstone's family to bear the expense of the ceremonial, had already volunteered to be at the charges of this melancholy tribute of respect, but it obviously would have been unbecoming the dignity of the nation which has been honoured by the achievements of the illustrious traveller for the last honours to have been rendered him at the cost of any private person. The Southampton Town Council has resolved to receive, with fitting honours, the remains of Dr. Livingstone, which are expected to arrive at that port very shortly.

AT an influential meeting held at Edinburgh on Monday, it was resolved to extend on a large scale the University buildings and to remodel those already existing, so as to suit them to modern requirements. We are glad to notice that the importance of Science in University teaching was insisted on at the meeting, and we hope that in the extended and remodelled University scientific teaching and research will be accorded a prominent place. Of the 100,000*l.* required, 55,000*l.* have been already subscribed At Dundee, on the same evening, Dr. Lyon Playfair, speaking on the same subject, urged the importance of placing the Edinburgh University in a position in which it would be able to teach, in a thoroughly practical manner, the sciences and the professions resting upon them. He dwelt on the great importance of scientific education, and said that any nation which bestowed more science and skill on any one of their manufactures than we did must inevitably beat us in the race. He pointed to the advantages which Germany had derived from bestowing special attention to scientific instruction, and said that in Manchester we now saw the remarkable spectacle of an inland trading town of England in which Germany occupied much of the field of industry.

THE French Government have only done an act of justice in conferring a pension of 12,000 francs upon M. Pasteur in consideration of his services to science and industry.

COLONEL STUART WORTLEY has been appointed by the Commissioners of Patents to the Curatorship of the Patent Museum at South Kensington, vacant by the death of Sir Francis Pettit Smith.

SIGNOR AUGUSTO RIGHI has been appointed Professor of Natural Philosophy in the Instituto Technica Reale of Bologna.

THE Council of the Society of Arts has decided to offer a prize, consisting of a gold medal or 20 guineas, for the best essay "On the Cultivation and Manufacture of Indian Teas."

A MEETING of the local general committee of the British Association was held in the rooms of the Chamber of Commerce Bradford Exchange, on March 31, to receive a report as to the reception fund. It appeared that the total receipts were 3,248*l.* 16*s.* 8*d.*, and the expenditure 3,097*l.* 7*s.* 2*d.*, leaving a balance of 155*l.* 9*s.* 6*d.* in the bank, subject to the expenses connected with the winding up of the committee's duties. It was agreed that the balance remain in the hands of the local executive committee until all expenses are paid, and that the amount which may remain be given to the Bradford Philosophical Society, an institution having an object kindred to tha of the British Association.

M. LEVERRIER has been appointed president of the section of Science at the meeting of the Delegates of Learned Societies, which will be held at Sorbonne.

FROM the sixth quarterly report on the Sub-Wealden Exploration we learn that during the last two months a depth of 359 ft. has been bored, making a total of 671 ft. The borings are still in the Kimmeridge clay. In this deposit indications of petroleum have been noticed, and at depths of from 600 ft. to 650 ft. it was particularly observable. Occasional veins of carbonate of lime have been met with crossing the cores obliquely, but the report states that all the beds yet passed through are horizontal. One of the most important results of the exploration has been the discovery of gypsum and other beds which are likely to prove commercially productive. Attached to the report is a list of the fossils which have been found. The committee report that they have sufficient funds to continue the work to a depth of 1,000 ft., and should it be deemed desirable to go beyond that depth, a conference will be held to consider the question before soliciting further contributions. The present balance in hand is 576*l.* 4*s.* 4*d.*

IT is said MM. Croce Spinelli and Sivel will be awarded a prize for their last aeronautical ascent, in which they took with them oxygenised air.

ANOTHER aeronautical ascent took place on Thursday week from Lavillette gasworks in a new balloon called "Michel le Brave," which is to be sent to Roumania. The measurement is 1,500 cubic metres. It was sent up with six persons and descended at Vic-sur-Aisne in a regular storm; large trees were uprooted, but no bodily harm was received by the balloonists. It is intended to have several other ascents next spring.

THE greatest alarm has been caused in North Carolina and Tennessee by the appearance of what seems to be volcanic phenomena in the former of these states. The scene of the reported disturbance is Bald Mountain, in the south-western part of M'Dowell County. Rumblings were heard during several days, apparently coming from the interior of the mountain, and one letter, dated March 20, states that near the summit of the peak an area of nearly an acre was agitated by subterranean upheavals, and from which smoke and vapour issued. The people of the surrounding district are reported as being in the greatest consternation, ceasing from work and living in common, and evidently quite expecting that the final catastrophe is impending.

SEISMIC commotions of some magnitude have been felt in Algeria, at Algiers, and surrounding places. The centre of commotion seems to have been somewhere in the vicinity of Cherchel, where the barracks have suffered much. The first shock was felt on March 28 at 11.10 A.M.

AN Alpine club has been established in Paris under the presidency of M. de Billy. The rules will be similar to those of English, Swiss, Italian, and Austrian Alpine clubs. It is intended to issue a periodical containing the papers read before the Association. More than 100 members have been enrolled.

THE sittings of the Bureau des Longitudes are now being held at the Collége de France.

THE Mexican Axolotls, which have for some time been exhibited in one of the handsome vases in the entrance-hall of the Brighton Aquarium, spawned about a month ago. As the parents showed some disposition to devour their eggs, the latter were removed to one of the troughs of the salmon-hatching apparatus, where the young axolotls may now be seen, having just been hatched after a period of 29 days in the egg.

A SUPPLEMENTARY credit of 4,000*l*. has been voted by the Versailles National Assembly for paying a part of the expenses incurred by the observation of the Transit of Venus. Six members belonging to the ultra-clerical party have given a negative vote on a division. It is said they are not believers in the Copernican theory, and have no faith in the astronomical observations.

THE Rev Henry Moule, after a series of experiments extending over twenty years, has devised a process of manufacturing an illuminating gas from Kimmeridge clay.

THE educational means of Harvard University have recently been increased by the addition of an institution which will make that University one of the most complete in the United States. This Institution is known as the "Bussey Institution," after Mr. Benjamin Bussey of Roxbury, Mass., who about thirty years ago left to the University a magnificent sum of money and a small estate for the purpose of promoting the scientific study of agriculture and horticulture. The money was allowed to accumulate for many years, and has since been increased by 100,000 dollars left by Mr. James Arnold, Merchant, of New Bedford. The estate has been to some extent laid out for the purpose intended, and several suitable buildings, including a laboratory, have been erected, and the Harvard authorities have devised a course of instruction and investigation on a broad and thoroughly scientific basis. The appointments already made include:—An instructor in Farming, a professor of Agricultural Chemistry, a professor of Horticulture, a professor of Applied Zoology, an instructor in Entomology, a director of the Arnold Arboretum, and a librarian and curator of Collections. The institution is intended both for instruction and investigation, though we are glad to see that students' fees are not necessary to the support of the institution. The permanent funds provided by Mr. Bussey will enable the President and Fellows to maintain the Institution as a scientific station, like the Astronomical Observatory or the Museum of Comparative Zoology at Harvard College, until the time shall come when there shall be a demand for its privileges as a school. The experiments and investigations made at the Bussey Institution will be published from time to time in a Bulletin, the first number of which is before us. It contains four papers by F. H. Storer, professor of Agricultural Chemistry in Harvard University, one containing analyses of some commercial fertilisers, another of American "shorts" and "middlings," a third On the Agricultural Value of the Ashes of Anthracite, and a fourth containing a Record of Trials of various Fertilisers on the ground of the Bussey Institution. The only other paper is a useful one by Dr. Slade, professor of Applied Zoology, On the Humane Destruction of Animals.

THE French Society of Geography, we learn from *La Nature*, has just received news of a French expedition which has been exploring Terra del Fuego. On December 7, last year, the expedition landed on the coast of that island, and proceeded into the interior. The explorers found a large lake of 25 kilomètres in circumference, surrounded by luxuriant vegetation, and literally covered by an army of wild fowl, among which the most abundant were ducks and geese. These regions are inhabited by rude but hospitable tribes; the women especially are very affable and obliging. One of them, in exchange for some pieces of sugar and common handkerchiefs, gave the leader of the expedition an object to which she attached an immense value, and which she preserved as a relic,—the lid of a sardine box.

WITH a view of properly exhibiting the geological and metallurgical resources of America at the forthcoming exposition at Philadelphia, an association has been organised, embracing such names as those of Prof. Leslie, Prof. Genth, Prof. Raymond, Prof. Wyman, Prof. T. Sterry Hunt, George H. Cook, and others, to whom is to be intrusted by the Board of Centennial Commissioners the duty of collecting whatever will best answer the purpose in question.

THE Paris Jardin d'Acclimatation has succeeded in "breaking-in," some zebras so far as to induce them quietly to draw a carriage, and one permits children to ride round the gardens on its back.

DR. HAYDEN, the head of the Geological and Geographical Survey of the U.S. Territories, has commenced the publication of a bulletin to communicate such announcements of new facts made by any member of his party as it is desirable to bring promptly to the notice of the scientific community in advance of their publication in his reports. The first number of this Bulletin, bearing date January 21, is occupied by a list of the members and collaborators of the survey for 1873, and a list of the publications, from which we learn that six volumes of the reports have appeared from 1867 to 1873, and that seven volumes of miscellaneous publications will be published in octavo form, the most elaborate being the hand-book of the Ornithology of the North-western Territories, by Dr. Coues. Several quarto volumes will also be sent out, of which there have been actually published one by Prof. Leidy, on the extinct vertebrata of the Western formations, and one on the Acrididæ of North America, by Prof. Cyrus Thomas. This quarto series, it is expected, will include ten volumes, among them memoirs on the vertebrata of the cretaceous and Tertiary formations, by Prof. Cope; one each, on the fossil plants, by Prof. Newberry and Prof. Lesquereux; on the fossil invertebrates, by Prof. Meek; and the volume on general geology, by Prof. Hayden. Thirteen maps have been published for the survey, those of the Yellowstone region being especially valuable. The body of the bulletin is occupied by a report on the stratigraphy and Pliocene vertebrate palæontology of Northern Colorado, by Prof. Cope, in which he presents the parallelism of the formations recently investigated by him with those earlier known and in other parts of the West. He concludes that, although these formations have generally been considered as Tertiary, the geological evidence shows them to be strictly mesozoic, as in the great lignite formations on the Missouri River. During the past season twenty-one new species of vertebrates were obtained in the Pliocene sandstone at the head of the watershed between the South Platte River and the Lodge-pole Creek.

THE *Belgique Horticole*, for February, publishes a complete list of botanical gardens throughout the world, with the names of their curators and of the professors of botany at the different towns.

THE Science and Art Department has issued a catalogue of apparatus for instruction in geology, mineralogy, animal physiology, elementary botany, general biology, principles of mining, and physical geography.

THE *Brisbane Courier* of December 30, 1873, publishes the following official telegram from Mr. Walter Hill, the Government botanist, dated from Cardwell on the 27th and received by the Queensland Secretary for Lands:—"Since November 20 we have examined the banks of the Mulgrave, Russell, Mossman, Daintree, and Hull Rivers, and have been more or less successful in finding suitable land for sugar and other tropical and semi-tropical productions. The ascent of the summit of Bellenden Kerr was successfully made by Johnstone, Hill, and eight troopers. At 2,500 ft. in height we observed an undescribed tree with crimson flowers, which excels the *Poinciana regia*, *Colvillia racemosa*, *Lagersstroma regia*, and the *Jacaranda mimosifolia*. At 4,400 ft. a tree-fern, which will excel in grandeur all others of the Alboreous class. A palm-tree at the same height which will rival any of the British-Indian species in gracefulness. On

the banks of the Daintree we saw a palm-tree cocoa, which far exceeds the unique specimens in the garden of the same genera from Brazil in grandeur and gracefulness. While cutting a given line on the banks of the river Johnstone for the purpose of examining the land, an enormous fig-tree stood in the way, far exceeding in stoutness and grandeur the renowned forest giants of California and Victoria. Three feet from the ground it measured 150 ft. in circum erence; at 55 ft., where it sent forth giant branches, the stem was nearly 80 ft. in circumference. The River Johnstone, within a limited distance of the coast, offers the first and best inducements to sugar cultivation."

WE are glad to observe signs of life in Dundee, says the *Scottish Naturalist.* That town, long noted for its commercial enterprise, has had nearly an equal, but not enviable, celebrity for its poverty and deadness in regard to the study of natural science. But now we trust that that reproach will soon be wiped away, and that the members of the recently founded Dundee Naturalists' Society, a copy of whose constitution is before us, will do good work, and show their fellow-citizens that there are other and more valuable *dona Dei* in the fields, woods, and mountains of the interesting county of Forfar, than that wealth for which the inhabitants of the town of the *donum Dei* are deservedly remarkable. The Society has already upwards of forty members, which number will probably soon be considerably increased. We recommend to the Society the formation of a good local museum of the natural productions of Forfarshire.

IN the forty-first volume of the *Journal of the Asiatic Society of Bengal*, Mr. G. E. Dobson has drawn attention to a particularly interesting feature in the osteology of the Rhinolophine Bats. In the genera *Phyllorhina*, *Triænops* and *Cœlops*, he finds that in the innominate bone the ilium sends forward a process from its upper part, which meets and anchyloses with an extension of the ileo-pectineal spine to form a second foramen above that around which the obturator muscles arise. This peculiarity has not been observed in any other mammal.

THE additions to the Zoological Society's Gardens during the last week include a St. John's Monkey (*Macacus sancti-johannis*) from China, and a Java-Chevrotain (*Tragulus javanicus*) presented by Captain Nutsford; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. W. Webster; three Passenger Pigeons (*Ectopistes migratorius*) from North America, purchased; an Egyptian Monitor (*Monitor niloticus*) six feet long; and a Tuberculated Lizard (*Iguana tuberculata*) from the West Indies, deposited.

SCIENTIFIC SERIALS

American Journal of Science and Arts, March.—This number commences with an interesting paper, by Prof. Leconte, On the Great Lava Flood of the West, and on the Structure and Age of the Cascade Mountains. The flood, commencing in Middle California in separate streams, became in Northern Oregon and Washington absolutely universal; the whole country, mountain and valley, being buried several thousand feet. Its extent cannot be less than 200,000 to 300,000 square miles; its average thickness is probably 2,000 ft., and extreme thickness 3,700 ft. From the structure of the Cascade Range (which extended throughout the entire region of the flood) and palæontological evidence, the author thinks the flood began to occur during or after the Miocene; and the process of flooding probably continued, by successive fissure-flows of lava, chiefly in the Cascade and Blue Mountain Ranges, until the Post-Tertiary; the liquid matter having been squeezed out by horizontal and vertical pressure, while water, percolating through the hot mass, generated volcanoes that continued the up-building process.—Dr. Blake of San Francisco has a paper On the Connection between Isomorphism, Molecular Weight, and Physiological Action. One of the conclusions arrived at is, that among compounds of the more purely metallic elements, the quantity of substances in the same isomorphous group required to produce analogous changes in living matter, is less as the atomic weight of the electro-positive element increases.—Mr. Carey Lea describes some experiments made to determine whether it is a general law that when a metallic compound reducible by light is placed in contact with an oxidisable body (or one capable of uniting with Cl, Br, or I, as the case may be), the capacity of reduction of the compound by any particular part of the spectrum is influenced by the *colour* of the body placed in contact with it. But he did not succeed in thus generalising Vogel's results; which, however, he does not regard as contradicted or disproved.—Some experiments by Prof. Wright on the oxidation of alcohol and ether by ozone, seem to indicate that the vinegar process might be materially accelerated by passing ozonised air through the apparatus.—Prof. Marsh communicates a notice (bearing on the genealogy of the modern horse) of new equine mammals from the Tertiary formation; and we further note papers On Recent Dredging Operations in the Gulf of St. Lawrence (Mr. Whiteaves); On Fossils figured in the Illinois State Geological Report (Mr. Meek); On Dissociation of certain Compounds at very low Temperatures (Mr. Leeds), &c.

Der Naturforscher, February.—We may first note, in this number, an account of some valuable researches by MM. Pettenkofer and Voit, as to the significance of the carbohydrates in nutrition. The authors conclude that carbohydrates, in the animal system, always pass entirely into carbonic acid and water, and do not produce fat; but they save (*ersparen*) the fat produced from albumen, and this in proportion to the quantities of the albumen-fat and the carbohydrate. There is also, in the biological department, a succinct statement of Prof. Haeckel's "Gastraea" theory.—In geology, some observations by M. G. Laube appear to indicate that the transport of *débris* and stones by ice in East and West Greenland is by no means a common thing; and a note by M. Albert Heim describes and explains the formation of certain huge cauldron-like cavities in solid rock in the Gletschergarten at Lucerne.—From an examination of plant-remains found in amber, Prof. Caspary has inferred that Prussia, in the Amber period, must have been much warmer than now; certain Arctic Ericaceæ, supposed to be of the period, probably flourished on lofty mountains.—M. Merget's recent observations on thermo-diffusion of gas in leaves, and those of M. Reinke on the function of leaf-teeth, are also given; while MM. Fliche and Grandeau study the relation between chemical composition of the ground and vegetation of *Pinus pinaster.* This plant, while a flint-loving species, yet absorbs a considerable quantity of lime; and in soils with much lime, the increased absorption of this salt is accompanied with a decrease in the other ash constituents, especially potash (this being probably the cause of the bad condition of the tree in such soil).—In the department of physics, we have several notes from English sources: On the Elements present in the Sun (Lockyer); On the Affinities of the Magnetic Metals, and On Molecular Phenomena in Glowing Iron (Barrett); On Propagation of Sound in Fog (Reynolds), &c. And in chemistry, there is a note by M. Thomsen, treating of the influence of temperature on chemical phenomena of heat; also a popular summary of M. Ebermayer's researches as to the presence of ozone in the air.—Astronomy is represented by papers on the star shower of November last, and on the direction of the large axes of cometary orbits.

Bulletin de l'Académie Royale de Belgique. No 1, 1874.—In this number M. de Wilde makes some contributions to the theory of bleaching of vegetable fibres which contain incrusting and other matters. He considers that there is substitution of chlorine for hydrogen in the alkaline liquid, which has served to dissolve the incrusting matter, and that chlorine acts, besides, in decomposition of the water, formation of hydrochloric acid, and fixation of oxygen in the organic matter.—The same author communicates notes on the preparation of acetylene, the action of hydrogen on acetylene and ethylene under the influence of platinum black, and the action of the electric effluvia on some gases and gas-mixtures. In the last he confirms MM. Thenard's observations; and acetylene, he finds, is condensed by the effluvia into a liquid which solidifies rapidly, becoming yellow; the solid detonates under the action of heat. Sulphurous anhydride and oxygen combine directly to form sulphuric anhydride.—Continuing his researches on glyceric derivatives, M. Henry describes an octobromide obtained by action of bromine on tetrabromide of dipropargyle; and a paper by M. Spring, describing new syntheses of hyposulphurous acid and of trithionic acid, is of theoretical importance as showing the relations between the sulphates and hyposulphates, and between the latter and trithionates.—

M. Gosselet furnishes a detailed account of the southern band of Devonian limestones in the district Entre-Sambre-et-Meuse; and M. Selys de Longchamps makes some additions to a synopsis of the Cordulina.—A programme of five questions for medal competition is announced, the subjects being briefly these: disturbing causes in determination of the electromotive force and inferior resistance of a battery element; relations of heat to the phenomena (especially periodic) of vegetation; embryonal development of Tunicata; composition and mutual relations of albuminoid substances; coal system of the Liège valley.

Archives des Sciences Physiques et Naturelles, Feb. 15, 1874.—In this number M. Dufour gives a detailed account of his researches on the variation of temperature which accompanies diffusion of gases through a porous partition. After describing the apparatus (in which a porous vessel, with thermometer and other tubes inserted in its gutta-percha stopper, was enclosed in a cylindrical glass vessel, and this, enveloped in loose cotton, in a larger earthen vessel), the author studies first the influence of the dry or humid state of gases coming into contact with the porous wall, without diffusion; next, variation of temperature where there is no change of pressure; and third, variation where there is such change. With constant pressure, there is fall of temperature on the side where the denser gas is; and rise on the other side. Each current seems to have a heating effect where it enters the porous wall and a cooling one where it issues. With change of pressure, where this rises within the vessel, through endosmose of a lighter gas, the temperature slightly increases, sinking again as the pressure tends to equilibrium. Where exosmose of a lighter gas causes diminution of pressure in the vessel, the reverse occurs.—From observations of the partial solar eclipse of May 26 last, at three Italian stations, D'Aoste, Moncalieri, and Florence, Prof. Denza finds no sensible influence on the declination needle, either as regards its regular diurnal movement, or the absolute value of its displacement. He is confirmed in the conclusion, previously formed (on data of former eclipses), that no connection has hitherto been demonstrated between the two orders of cosmic facts, eclipses and phenomena of terrestrial magnetism.—M. Charles Lory communicates a note on some facts of structure in the central chains of the Alps.—The *Bulletin Scientifique* gives, as usual, a valuable series of notes on recent progress in Physics, Geology, Zoology, and other branches.

SOCIETIES AND ACADEMIES

London

Royal Society, March 26.—On the Motions of some of the Nebulæ towards or from the Earth, by William Huggins, D.C.L., LL.D., F.R.S.

The observations on the motions of some of the stars towards and from the earth, which I had the honour to present to the Royal Society in 1872, appeared to show, from the position in the heavens of the approaching and receding stars, as well as from the relative velocities of their approach and recession, that the sun's motion in space could not be regarded as the sole cause of these motions. "There can be little doubt but that in the observed stellar movements we have to do with two other independent motions—namely, a movement common to certain groups of stars and also a motion peculiar to each star." *

It then presented itself to me as a matter of some importance to endeavour to extend this inquiry to the nebulæ, as it seemed possible that some light might be thrown on the cosmical relations of the gaseous nebulæ to the stars and to our stellar system by observations of their motions of recession and approach.

Since the date of the paper to which I have referred, I have availed myself of the nights sufficiently fine (unusually few even for our unfavourable climate) to make observations on this point. The inquiry was found to be one of great difficulty, from the faintness of the objects and the very minute alteration in position in the spectrum which had to be observed.

At first the inquiry appeared hopeless, from the circumstance that the brightest line in the nebular spectrum is not sufficiently coincident in character and position with the brightest line in the spectrum of nitrogen to permit this line to be used as a fiducial line of comparison. The line in the spectrum of the nebulæ is narrow and defined, while the line of nitrogen is double, and each component is nebulous and broader than the line of the nebulæ. The nebular line is apparently coincident with the middle of the less refrangible line of the double line of nitrogen. *

The third and fourth lines of the nebular spectrum are undoubtedly those of hydrogen, but their great faintness makes it impossible to use them as lines of comparison under the necessary conditions of great dispersive power, except in the case of the brightest nebulæ.

The second line, as I showed in the paper to which I have referred, is sensibly coincident with an iron line, wave-length 495·7; but this line is inconveniently faint, except in the brightest nebulæ.

In the course of some other experiments my attention was directed to a line in the spectrum of lead which falls upon the less refrangible of the components of the double line of nitrogen. This line appeared to meet the requirements of the case, as it is narrow, of a width corresponding to the slit, defined at both edges, and in the position in the spectrum of the brightest of the lines of the nebulæ.

In December 1872 I compared this line directly with the first line in the spectrum of the Great Nebulæ in Orion. I was delighted to find this line sufficiently coincident in position to serve as a fiducial line of comparison.

I am not prepared to say that the coincidence is perfect; on the contrary, I believe that if greater prism power could be brought to bear upon the nebulæ, the line in the lead spectrum would be found to be in a small degree more refrangible than the line in the nebulæ.

The spectroscope employed in these observations contains two compound prisms, each giving a dispersion of 9° 6′ from A to H. A magnifying-power of 16 diameters was used.

In the simultaneous observation of the two lines it was found that if the lead line was made rather less bright than the nebular line, the small excess of apparent breadth of this latter line, from its greater brightness, appeared to overlap the lead line to a very small amount on its less refrangible side, so that the more refrangible side of the two lines appeared to be in a straight line across the spectrum. This line could be therefore conveniently employed as a fiducial line in the observations I had in view.

In my own map of the spectrum of lead this line is not given. In Thalén's map (1868) the line is represented by a short line to show that, under the conditions of spark under which Thalén observed, this line was emitted by those portions only of the vapour of lead which are close to the electrodes.

I find that by alterations of the character of the spark this line becomes long and reaches from electrode to electrode. As some of those conditions (such as the absence of the Leyden jars, or the close approximation of the electrodes when the Leyden jars are in circuit) are those in which the lines of nitrogen of the air in which the spark is taken are faint or absent, the circumstance of the line becoming bright and long, or faint and short inversely, as the line of nitrogen suggested to me the possibility that the line might be due not to the vapour of lead but to some combination of nitrogen under the presence of lead vapour. As, however, this line is bright under similar conditions when the spark is taken in a current of hydrogen, this supposition cannot be correct.

A condition of the spark may be obtained in which the strongest lines of the ordinary lead spectrum are scarcely visible, and the line under consideration becomes the strongest in the spectrum, with the exception of the bright line in the extreme violet.

I need scarcely remark that the circumstance of making use of this line for the purpose of a standard line of comparison is not to be taken as affording any evidence in favour of the existence of lead in the nebulæ.

Each nebula was observed on several nights, so that the whole observing time of the past year was devoted to this inquiry. In no instance was any change of relative position of the nebular line and the lead line detected.

It follows that none of the nebulæ observed show a motion of translation so great as 25 miles per second, including the earth's motion at the time. This motion must be considered in the results to be drawn from the observations; for if the earth's motion be, say, 10 miles per second from the nebulæ, then the nebula would not be receding with a velocity greater than 15 per second; but the nebula might be approaching with velocity as great as 35 miles per second, because 10 miles of this velocity would be destroyed by the earth's motion in the contrary direction.

The observations seem to show that the gaseous nebulæ as a

* Proceedings of the Royal Society, vol. xx. p. 392.

* Proceedings of the Royal Society, vol. xx. p. 380.

class of bodies have not proper motions so great as many of the bright stars. It may be remarked that two other kinds of motion may exist in the nebulæ, and if sufficiently rapid, may be detected by the spectroscope. 1. A motion of rotation in the planetary nebulæ which might be discovered by placing the slit of the instrument on opposite limbs of the nebulæ. 2. A motion of translation in the visual direction of some portions of the nebulous matter within the nebula, which might be found by comparing the different parts of a large and bright nebula.

Sir William Herschel states that "nebulæ were generally detected in certain directions rather than in others, and the spaces preceding them were generally quite deprived of stars; that the nebulæ appeared some time after among stars of a certain considerable size, and but seldom among very small stars; that when I came to one nebula I found several more in the same neighbourhood, and afterwards a considerable time passed before I came to another parcel." *

Since the existence of real nebulæ has been established by the use of the spectroscope, Mr. Proctor † and Prof. D'Arrest ‡ have called attention to the relation of position which the gaseous nebulæ hold to the Milky Way and the sidereal system.

It was with the hope of adding to our information on this point that these observations of the motions of the nebulæ were undertaken.

In the following list the numbers are taken from Sir J. Herschel's "General Catalogue of Nebulæ." The earth's motion given is the mean of the motions of the different days of observation.

No.	h.	H.	Others.	Earth's motion from Nebulæ.
1179	360	—	M. 42	7 miles per second.
4234	1970	—	Σ. 5	12 ,, ,,
4373	—	IV. 37.	—	1 ,, ,,
4390	2000	—	Σ. 6	2 ,, ,,
4447	2023	—	M. 57	3 ,, ,,
4510	2047	IV. 51.	—	14 ,, ,,
4964	2241	IV. 18.	—	13 ,, ,,

Chemical Society, April 2.—Prof. Odling, F.R.S., in the chair.—A paper on Sulpho-cyanide of Ammonium and Sulphocyanogen, by Dr. T. L. Phipson, and a note On a Reaction of Gallic Acid, by H. R. Procter, were read by the Secretary. Mr. Procter finds that a mixture of gallic acid and potassium arsenate, when exposed to the air, acquires a beautiful green colour.—Mr. W. Noel Hartley then read a memoir On Cobalt Bromides and Iodides, in which he described the method of preparation and properties of these compounds; they closely resemble the corresponding chlorides. Fine specimens of the different salts were exhibited by the author.—Mr. E. Neison read a paper On the Distillation of Sodium Ricinoleate, and Mr. C. H. Piesse a note On the Solubility of Plumbic Chloride in Glycerin.—Mr. Kingzett read a voluminous communication On Ozone as a Concomitant of the Oxidation of the Essential Oils, Part I., and from his experiments he infers that the compound produced during the oxidation of oil of turpentine is neither ozone nor hydrogen peroxide, but a hydrated oxide of turpentine. The last paper was On the Action of Chloride of Benzyl on Camphor, Part II., by Dr. D. Tommasi.

Royal Microscopical Society, April 1.—F. H. Wenham, vice-president, in the chair.—A paper On the Structure of the Lepisma Scale, by Dr. Anthony, was read to the meeting, in which the author showed that the two sets of markings were upon opposite sides of the scale, the ribs being upon the under side.—Mr. Wenham gave a demonstration of his method of measuring the angular apertures of objectives, and explained his mode of stopping out the extraneous rays which were so frequently a cause of error.—Mr. S. J. McIntire read a paper describing the proboscis of a moth (believed to be a South African species) which was furnished with a means of perforating the nectaries of flowers. A mounted specimen was exhibited under one of the Society's instruments in the room, and drawings in illustration of the paper were placed upon the table.

Linnean Society, April 2.—Mr. J. Gwyn Jeffreys, F.R.S., in the chair.—On the Morphology of the Skulls in the Woodpeckers (*Picidæ*) and the Wrynecks (*Yungidæ*), by Mr. W. Kitchen Parker, F.R.S. The present paper is one of a series in hand in which the writer has endeavoured to work out thoroughly the facial characters of certain types of birds in harmony with the views given by Prof. Huxley in his well-known paper on the Classification of the Feathered Types (Zool. Proc. April 11, 1867). His own mode of research is much more like that followed by the distinguished author of that paper than that pursued by ornithologists proper. Without undervaluing their excellent labours, there are many things which are seen first and first understood by the embryologist and not by the zoologist as such. Prof. Huxley, in the paper just referred to, separated the forms now under consideration into his group Coleomorphæ, and gives (p. 467) a very valuable summary of their characters. It was sought in that paper to bring into more or less zoological contiguity such birds as have a similar structure of the facial, and especially of the palatal, bones. Those group-terms, the Schizognathæ (p. 426), the Dromæognathæ (p. 425), &c., are very important, although some of them are of very wide application. It was the first thought of the author of this paper that the woodpeckers would easily find a place amongst the *non-passerine* aërial birds; but examination of their palatal structures soon dispelled this opinion. They are more allied to the Passerinæ than most of the Zygodactyles; but it is to the *embryos* of that type, and not to the adult, that they are related. The Passerinæ themselves are well termed ægithognathous (p. 450); this huge group is under hand at present. Most of the non-passerine birds that seem to come nearest to the woodpeckers have a very solid palate; they are desmognathous; others, as the humming-birds and goatsuckers (*Caprimulgus*), are schizognathous; whilst the swift (*Cypselus*) is as perfectly ægithognathous as the swallows. But the woodpeckers retain that non-coalescent condition of the palatal structure which we see in the lizards, very unlike that great fusion of parts towards the mid-line which occurs in most of the higher birds. They also have an unusally arrested condition of the palatal part of the upper jaw-bone (maxillary), which is characteristic of the lizard and unlike the bird-class generally, and bones superadded to the palate, vomers, septomaxillaries, &c.; these are persistently in paired groups, more in number, and altogether more evidently embryonic and Lacertian, than the homologous parts of other birds. The writer therefore seeks to introduce a new morphological term for these birds as a group, having relation to their face, namely, the term Saurognathæ; for none of Prof. Huxley's terms are appropriate for this type of palate. The writer has worked out these parts in the nestling of *Yunx torquilla*, in four stages of *Gecinus viridis*, in the young of *Picus minor*, and in the adult of *P. major*, *P. analis*, *Hemilophus fulvus*, and *Picumnus minutus*.

MANCHESTER

Literary and Philosophical Society, March 3.—*Physical and Mathematical Section*.—Alfred Brothers, F.R.A.S., president of the Section, in the chair.—Results of Rain-Gauge Observations at Eccles, Manchester, during the year 1873, by Thomas Mackereth, F.R.A.S.

March 10.—Ordinary Meeting.—E. W. Binney, F.R.S., vice-president, in the chair.—The chairman said that at a meeting of the Society on January 9, 1872, in presenting to the notice of the members specimens of fossil woods from the lower coal measures of Lancashire, he stated "that from some examples in his cabinet he was led to believe that Cotta's *Medullosa elegans* was merely the rachis of a fern or a plant allied to one." Prof. Renault, of Paris, to whom we owe so much for his researches in fossil botany, read a memoir before the French Academy on January the 26th last, which has since been printed in the *Comptes Rendus*, that completely confirms this opinion.—Further Observations and Experiments on the Influence of Acids on Iron and Steel, by William H. Johnson, B.Sc. At the last meeting of the Society Prof. Reynolds, in an interesting paper On the Effect of Acid on the Interior of Iron Wire, appears to think that Mr. Johnson did not attribute to hydrogen any portion of the remarkable change produced in iron and steel by immersion in acid. That immersion in acid is the primary cause no one, Mr. Johnson thinks, will dispute; but that hydrogen plays an important part in producing these changes and is the cause of the bubbles, the author showed in a paper read before the Society, March 4, 1873. The supposition that the absorption of hydrogen is the sole cause of the change in the breaking strain, diminution in toughness, &c., attendant on the immersion of iron in hydrochloric or sulphuric acids, and that there is no absorption of

* Philosophical Transactions, 1784, p. 448.
† "Other Worlds than Ours," pp. 280–290.
‡ "Astronomische Nachrichten," No. 1908, p. 190.

these acids into the interior of the iron, does not account for a number of phenomena that have been observed so often and so carefully as to leave no doubt of their invariable recurrence if the conditions of experiment be only properly observed. It seems to the author that the only satisfactory way of explaining all the phenomena is to suppose that when a piece of iron is immersed in acid two actions go on, viz.: an absorption of the nascent hydrogen into the interior of the iron, which hydrogen may subsequently be given off by gentle heat or immersion in a liquid, &c. Secondly, an absorption of the acid itself, possibly in a very concentrated form, by the insterstices between the fibres or crystals of the metal. It will however be said, the acid must act on the walls of the cavity and form a salt of iron with liberation of hydrogen. This may go on to a small extent, but in opposition to this view we may bring the experiments of Prof. Bequerel on solutions separated by a cracked tube (*Comptes Rendus*, lxxvi.), where he shows that no precipitate is formed on placing a cracked tube filled with nitrate of lead in a solution of potassium sulphate within the crack, thus making it probable that chemical interchanges do not take place in very minute spaces. By this theory we may easily explain the decrease in toughness after immersion in acid. For toughness implies a certain ease of mobility of the particles. When a piece of iron is bent the particles of one side are compressed, thus diminishing the minute cavities between the fibres, while those of the other side are stretched, and the minute cavities elongated. If we fill these cavities with a liquid this mobility of the particles is prevented, for the cavities cannot now be diminished in size and the compression of the one side cannot now take place, consequently the piece tears or breaks off just like a piece of frozen rope. It will also explain the acid reaction of the moistened fracture, and further, as hydrochloric acid is much more volatile and of less specific gravity than sulphuric acid, it is only natural to expect that the effect of immersion in hydrochloric acid will pass off more rapidly than of immersion in sulphuric. This experience fully confirms. The author then gives details of a number of experiments and their results bearing on the point under discussion.—Results of certain Magnetic Observations made at Manchester during the year 1873, by Prof. Balfour Stewart, F.R.S.

GLASGOW

Geological Society, March 12.—A paper was read On some Polyzoa from the carboniferous limestone shales near Glasgow, by Prof. Young, F.G.S., and Mr. John Young, vice-president. The authors described a new genus which they had established under the name of *Rhabdomeson*, and which includes at least two species hitherto referred to *Ceriopora*, namely, *C. gracilis* and *C. rhombifera*. The authors also described and exhibited specimens of other two species of polyzoa, the one having the habit of a *Fenestella*, the other of a *Glauconome*, but both showing the remarkable peculiarity of a series of eight denticles projecting horizontally over the cell aperture. For the fenestrated species, they proposed to constitute a new genus—*Stellipora*. The other they retained, meantime, in the genus *Glauconome*.—Mr. Robert Graig read a paper, the first of a series, On the Fossils found in the carboniferous beds around Beith and Dalry, with special reference to the position of their first appearance in the beds. These beds, he remarked, are highly fossiliferous, and occur in the following general order:—(1) Lower limestone, resting upon volcanic ash, 17 fathoms; (2) coal and ironstone measures, resting upon the lower limestone, above 100 fathoms; (3) upper limestone, taking the Swindridge or Highfield "post" as the lower stratum, about 65 fathoms. Mr. James Dairon read a paper on a new species of Retiolites (*Retiolites fibratus*) found by him last summer in the Moffat shales of the Lower Silurian system of the South of Scotland.

PARIS

Academy of Sciences, March 30.—M. Bertrand in the chair. M. de Quatrefages presented to the Academy the second part of his work (written in conjunction with M. Hamy, assistant naturalist in the Muscum) entitled "*Crania ethnica*. The skulls of the human races." The author made additional remarks on fossil human races, calling attention in particular to the race of Cro-Magnon. The characters of this race are well exemplified in the male and female remains discovered at Cro-Magnon in 1868. The male skull is remarkable for its capacity, gauging, according to M. Broca, not less than 1,590 cent. cubes, a number sensibly above the mean of all European populations. With the Cro-Magnon remains the authors class several other specimens of human fossils from the same valley of Vézère, from Bruniquel (caves of Lafaye and Forges), from the south towards the Pyrenees (the cave of Aurignac), and from the cave of Gourdon near Montréjeau. The same race is traced in the Menton skeleton and beyond the Alps in the Cantalupo skulls and in that from Isola del-Liri. In France again male skulls of the same race have been excavated in Mâconnais and Grenelle, while Liège has furnished the celebrated Engis skull. During the quaternary epoch it appears therefore that the Cro-Magnon race had its head-quarters in the south-west of France, particularly in the valley of Vézère, where the intellectual development can be traced from station to station, possibly to the confines of civilisation. The authors think it probable that the earliest representatives of the race will be found in Africa.—M. Pasteur made some verbal observations on M. A. Guerin's recent communication on the pathogenetic rôle of ferments in surgical maladies.—On an apparatus invented by M. Moncoq for the operation of transfusion of blood, by M. Bouley.—On the hydrometric service of the basin of the Seine, by M. Belgrand.—MM. Daubrée and Brongniart presented a report on M. Renault's memoir, entitled "Study of the Genus *Myelopteris*." The reporters consider the conclusions arrived at of sufficient importance to warrant the publication of the memoir in the collections from foreign *savants*.—On the integration of equations to the partial derivatives of the second order, by M. A. Picart.—On the artificial production of the phenomena of gaseous thermo-diffusion of leaves by means of moist porous and pulverulent bodies, by M. Merget. The author concluded by observing that the dynamical utilisation of thermo-diffusive forces would resolve in a simple manner the problem of the direct transformation of solar heat (energy?) into mechanical work.—On some general facts which arise from comparative androgenesis, by M. A. Chatin.—Observations on the disposition of the fibro-vascular bundles in leaves, by M. J. L. de Lanessan.—On a method of photographic enlargement for astronomical observations, by M. C. Zenger. The method proposed is likely to be of service in photographing the forthcoming transit of Venus. The author uses a mirror of long focus instead of a lens to produce the sun's image, and to prevent errors of irradiation and inflexion, proposes to photograph the planet at its moment of passage across a point *h* of a particular meridian of the sun, The enlarging process suggested corrects aberration in the original photograph.—On an electro-automatic whistle for locomotives, by MM. Lartigue and Forest.—On the employment of luminous signals in geodesic operations, by M. Laussedat.—The analysis (mathematical) of an armed and closed electro-magnetic circuit proves that electric induction does not traverse conducting masses, by M. P. Volpicelli.—On the movement of air in pipes, by M. C. Bontemps.—On the action of ammonia on acetone, by MM. Œchsner and Pabst. The authors believe that the reaction gives rise to Staedeler's *acetonine*.—On Egyptian blue, by M. H. de Fontenay.—Experimental researches on the influences which changes of barometrical pressure exert on the phenomena of life, 13th note, by M. P. Bert.

CONTENTS

PAGE

THURSDAY, APRIL 16, 1874

THE ADAPTATION OF OUR UNIVERSITIES TO THE WANTS OF THE AGE

It has given us special pleasure during the last few years to record the efforts made in several of our British Universities and Colleges to adapt their teaching and their appliances for teaching to the present state of knowledge. We have seen what has been done by means of a fraction of the splendid revenues of Oxford, what the princely munificence of her Chancellor is providing for Cambridge, and what public subscriptions aided by judicious liberality on the part of Government have enabled Glasgow to achieve. Let us see what is now being attempted by a University which, though for its years rich in usefulness and fame, even relatively to those just mentioned, is, so far as funds are concerned, in a state approaching to indigence.

A short paragraph in our last number called the attention of our readers to the important step which has just been taken by the University of Edinburgh, with the view of thoroughly adapting its lecture-rooms and laboratories at once to the enormously increased numbers of its teachers and students, and to the ever-growing demands of physical and biological science.

Increase of numbers of teachers and taught would of itself demand a proportionate increase of space, which in Edinburgh must be considerably more than two to one as regards lecture-rooms alone. But when we consider the improvements which have been introduced into the modes of teaching, the imperative necessity for *practical* instruction in addition to lectures and demonstrations; nay more, the desirability of enabling professors not merely to teach what is known, but also, by original research conducted by themselves and their more promising students, to endeavour to extend the boundaries of Science: we see how immense are the issues involved in the step which Edinburgh has just taken.

That it will be successful, no one who knows Scotland and Scotsmen can for a moment doubt. But Scotland is a comparatively poor country—receiving back from the Treasury a much smaller fraction of her taxation than more favoured portions of the empire—and Edinburgh University is, relatively to the number of her students, by far the poorest of even the poor Scottish Universities. It is to be hoped, therefore, that Government aid will be forthcoming, as in the recent case of Glasgow, to eke out the efforts of those who, with as good a cause as could be wished for, and hearty desire to advance it, yet cannot entirely rely on the results of their unaided exertions. All former Edinburgh *alumni*, scattered as they are broadcast over the world, especially in England and in India, must be prepared to acknowledge, by such contributions as they can afford to make, the value of the instruction they have received. Let no one abstain from giving because of the smallness of the sum he can afford; every mite is of importance—let him rather rejoice that he has the opportunity, which appears to occur but once in a century, of contributing to so noble an object.

The story of her last successful endeavour to meet wants to a certain extent akin to those now felt is well told in the following extract from the Programme of the Acting Committee :—

"One hundred years ago, an Appeal was made to the public on behalf of the University of Edinburgh. The number of students was then stated as 'betwixt six and seven hundred,' the inadequacy of the collegiate buildings to the size and importance of the University was pointed out, and it was declared that while in Edinburgh great improvements were going forward on all hands, 'the University fabric alone' remained 'in such a neglected state, as to be generally counted a dishonour to the City of Edinburgh, and to this part of the kingdom.'

"The result of that Appeal was a liberal public subscription, opened in March 1768, which, with the aid of Government, provided the handsome edifice now existing. That building for a long period amply sufficed for all the teaching purposes of the University. But the lapse of a century has produced great changes. During that period the population of the metropolis has been more than trebled; increased facilities for travelling have brought the University within easy reach of all parts of the country; the advantages of a University education have become much more appreciated; the advancement of Science has widely extended the field of academic teaching; and the renown alike of teachers and graduates, whose names will ever be associated with the University of Edinburgh, has increased its fame and reputation throughout the world.

"Thus, the buildings of the University again prove to be wholly inadequate to its necessities. This inadequacy is felt in various ways.

"The number of students attending the University in 1768 was 'betwixt six and seven hundred,' and the number of Professors was 21. In the present Session (1873-4) the number of students is between 1,900 and 2,000, and that of the Professors is 35. The Class-room accommodation has thus become wholly insufficient. The students at present attending the Chemistry, Anatomy, and Natural History Classes number about 300 in each case. The Lecture-rooms are consequently much overcrowded, and great personal discomfort is thus occasioned to both the teachers and the taught.

"But apart from the present buildings being insufficient as regards the students in attendance, the nature of the modern system of teaching in several branches has rendered the existing accommodation altogether unsuitable.

"Since the present University buildings were erected, the whole subject of Practical Chemistry has been added to the course of study. Within the last ten years large and commodious laboratories have been provided in connection with many of the European Universities, and it would be most unfortunate if the University of Edinburgh, which was the first British school to introduce practical instruction in Chemistry into the medical curriculum, were not enabled to carry on satisfactorily this important branch of medical and scientific training.

"Again, the instruction formerly given in Anatomy consisted almost entirely of lectures and demonstrations delivered in the class-room. The changes in Medical education during the last thirty years render it necessary that each student should now pursue for himself the study of Practical Anatomy. The rooms at present in use were not constructed for that purpose, and are lamentably inadequate for the work to be done in them.

"But besides the departments of Chemistry and Anatomy, increased accommodation, in the form of Laboratories, and rooms suited for microscopic and other practical investigation and instruction, is required for the Chairs of Materia Medica, the Institutes of Medicine, Natural History, and Pathology. Nor is it less urgent that much additional accommodation for the apparatus and the Physical Laboratory of the Chair of Natural Philosophy should be provided."

Take these in turn—the last-mentioned first. The Physical Laboratory has been but six years in existence ; simply because it was impossible sooner to find any accommodation for it. One small room was obtained capable of holding a dozen students (at very high pressure). The success of the first year was so great that in the next session more than half of the applicants had to be refused admission ; and as the demand grew, the working time allowed each student per day had to be further and further restricted, till, in the session just concluded, the lowest admissible limit (*one hour per day*) had at first to be adopted, and yet several applications for admission had to be refused. In spite of these drawbacks, much sound work has been done, and many of the Laboratory students have already obtained excellent posts connected with Astronomy, Telegraphy, Engineering, Sugar-refining, &c., mainly on account of the training they have received. The good thus done is to be measured, not by the mere fact of the success of these men in life, but by the fact that their success introduces into practical observatories, workshops, &c., men who have learned the reasons for the manipulations they employ, and who can therefore meet an emergency in ways which no rule-of-thumb teaching could possibly have suggested.

In Anatomy and Chemistry, practical teaching has long been established, and is afforded to every medical student and to such others as study these subjects as parts of a general scientific training. But it is necessary that a great deal more should be done in this direction, especially in the way of affording to advanced students opportunities of cultivating their own powers, and furthering Science by original research. The present arrangements render this possible only to a very limited extent.

Although practical instruction in Physiology, Pathology, and Pharmacology have not formed for so long a period as in Anatomy and Chemistry an integral part of a medical curriculum, yet the University authorities have recognised its importance and have introduced it as far as the meagre space at their disposal would admit. But the increasing demand for a practical training has overcrowded these rooms and made it imperative that additional accommodation should be provided, not only for tuition but for self-training and discovery.

Thus all the practical departments in both the physical and biological sciences urgently demand additional houseroom.

In conclusion, we would again call attention to the fact that one of the great reasons for the present appeal is to be found in the immense success of the University ; its mere numerical growth has far exceeded the accommodation provided. But we would also specially note the fact that, although the scheme has just been launched, the contributions already received or promised amount to the very handsome, though of course utterly inadequate, sum of 60,000*l*. At least 40,000*l*. more, with the equivalent which may reasonably be expected from Government, are required to give us yet another University, furnished at least with buildings which will enable it to preserve for another century its well-deserved but hardly-won fame.

But it must not be forgotten that buildings alone, however perfect, are not sufficient for the work desired. The further extension of the teaching staff must inevitably follow. But questions of this nature, as well as the annual supply of funds for the purchase of apparatus and materials, will, we hope, be effectively treated by the Royal Commission on Science, whose Report on the Scottish Universities, and whose proposals for their adequate endowment, are, in the North at least, anxiously expected.

SCHORLEMMER'S "CHEMISTRY OF THE CARBON COMPOUNDS"

A Manual of the Chemistry of the Carbon Compounds; or, Organic Chemistry. By C. Schorlemmer, F.R.S., Lecturer on Organic Chemistry in the Owens College, Manchester. (London: Macmillan and Co, 1874.)

JUDGING from the rapidity with which text-books on Organic Chemistry have made their appearance of late, it might reasonably be inferred that a good treatise on that subject is much wanted. The student who turns eagerly to the present manual in the hope that the eminent author will help him out of some of his difficulties, and that he will find the subject treated in a novel manner, will however, we fear, feel somewhat disappointed.

The classification adopted by the author deals first with the compounds of carbon with oxygen, sulphur, and nitrogen ; compounds which form the connecting link between inorganic and organic chemistry.. He considers, justly, that a knowledge of the compound radicals into which these elements enter is essential to a proper understanding of a large number of other carbon compounds. He then describes the large group of fatty substances, subdivided again according to the quantivalence of their radicals, as well as the carbohydrates, terpenes, and camphors. The next division comprises compounds richer in carbon than the fatty substances, and which are not converted into such by the addition of hydrogen. These are again subdivided into several groups, including that of the aromatic compounds, which has been most fully investigated, and the group of compounds containing two or more aromatic nuclei linked together by carbon, and the glucosides. Lastly, we have a division of artificial and natural bases (alkaloids), of colouring and bitter principles, of compounds contained in bile and other secretions of the animal body, and of albumenoids and proteids.

It will be seen from this brief synopsis that the author deviates for the most part from the arrangement which has found favour with many modern writers on Organic Chemistry. Rather than treat of well-defined families of organic bodies, such as hydrocarbons, alcohols, ethers, aldehydes, ketones, acids, &c., he prefers to retain groups of homologous series, together with their derivatives. To the student this arrangement has the decided drawback that it involves much repetition in examining chemical changes, and, what is more important, it does not enable him to take in at a glance in what consists the similarity or dissimilarity between classes of bodies of analogous structure, and derived from a homologous parent stock ; nor is it so easy to see where one or several links in the various homologous series are miss-

ing. The reward of grappling with the intricacies of organic bodies to which each worker is entitled who adduces new facts—no matter to how limited an extent—consists just in the intellectual treat of supplying perhaps some of these many missing links. There can be no question which system of classification will assist him to do this most speedily.

A student's perplexity will not be diminished on following our author into the vexed question of formulæ. We take it for granted that chemical formulæ have been devised to express the phenomena produced by the action of chemical force. That they express at present the final results rather than the agencies and forces which have been at work to produce them may likewise be taken as correct. They are, at the very best, poor representations only of the chemical changes which we witness daily. Whether it will ever be possible to prove that the atoms or groups of atoms of which chemical compounds are supposed to consist really stand to each other in certain definite relations, because they exhibit certain analogies under the influence of the chemical force which holds them together or loosens them, may well remain matter for speculation. As long as no differences of opinion respecting chemical facts are involved, views may differ on the mode of expressing them by formulæ, provided always that the choice between two different modes of expression falls upon the one which recalls the greatest number of analogies in the most simple and rational manner, and can therefore become more fruitful in new discoveries. Several rational formulæ are possible for one and the same compound according as different relations are to be expressed. A knowledge of the order or position of the atoms is out of the reach of experimental demonstration. If the so-called position-theory of the carbon atoms in certain organic compounds can assist us, however, in elucidating certain relations and analogies, and if this theory is leading rapidly to numerous new discoveries, then, by all means, let us avail ourselves of it. It seems that constitutional, or, as they are sometimes called, structural formulæ excite the ire of some of our critics of chemical literature inversely to the understanding they display of them, and the very name constitutional formula, or the sight of a graphic representation thereof, inflames their fury as violently as a red cloak excites an infuriated bull. However much ridicule may attach in the eyes of some people to constitutional or structural representation, it is pleasant to observe that the chemists who now dispense with it altogether form the exception rather than the rule.

Mr. Schorlemmer makes an especially liberal use of structural formulæ, showing the relative position and units of combining capacity of carbon atoms, with the view mainly of explaining isomeric bodies. Every student of organic chemistry will thank him for this, for, on perusing the journal of the Berlin Chemical Society, for instance, one cannot help being struck with the remarkable impulse which the conception of structural representation of the chemical composition of bodies has given to the study of organic chemistry in Germany. Chemists find it, no doubt, difficult to disengage themselves entirely from some of the various theories that have held sway during the last twenty years, and hence we look with leniency upon the want of uniformity of formulæ and chemical nomenclature displayed in this book. On pp. 3, 4, and 5, for instance, the brace is used in a double sense, showing the formation of molecular bodies by the direct combination of element with element as in $\left.\begin{matrix}H\\H\end{matrix}\right\}, \left.\begin{matrix}H\\Cl\end{matrix}\right\}, \left.\begin{matrix}K\\I\end{matrix}\right\}$; and again by uniting two or more elements with a polyvalent element, as in $\left.\begin{matrix}H\\H\\H\end{matrix}\right\}N$, without any connection existing between the monad elements themselves other than through the polyad element. Such names as Tin chloride, $SnCl_4$, Platinum chloride, $PtCl_4$, and others, must create the impression that these are the only compounds which tin, &c. forms with chlorine. The different atomic groups in structural formulæ are sometimes separated by points, sometimes by lines (forks, prongs, or whiskers, as some fastidious critics have called them). In the absence of these various graphic representations free use is made of molecular formulæ; indeed it strikes us that the author has been often over-cautious, and has not attempted constitutional formulæ where such representation would appear of particular interest to the student, as, for instance, in the case of the isomers of aldehyde, of aldines, &c.

Certain groups of atoms contained in a great number of organic bodies, such as nitroxyl, NO_2, sulphuryl, SO_2, phosphoryl, PO, *may* be viewed otherwise than as monad, dyad, or triad compound radicals. Why, for instance, should PO in phosphorous acid be a triad radical when one of the hydrogen atoms is not replaceable, but "remains together" with the PO group? or in hypophosphorous acid, where two atoms of hydrogen remain linked to PO? Considering the liberality displayed by the author regarding formulæ, we shall be pleased to see him shake off the trammels which still encumber his inorganic compounds. We cannot see why NO_2 should combine with OH to form nitric acid, and with H to form nitrous acid, or why SO_2 should form the compound radical in $SO_2\left\{\begin{matrix}Cl\\Cl\end{matrix}\right.$ and in sulphuric acid $SO_2\left\{\begin{matrix}OH\\OH\end{matrix}\right.$, and also in sulphurous acid $SO_2\left\{\begin{matrix}H\\OH\end{matrix}\right.$. Our author writes ethyl nitrite $C_2H_5O.NO$, and not $C_2H_5NO_2$, "because in the former the N is linked to the ethyl by means of an atom of oxygen, whilst in the isomeric nitro ethane $C_2H_5N\left\{\begin{matrix}O\\O\end{matrix}\right.>$ the nitrogen is linked directly, and the oxygen atoms satisfy each other." We need scarcely say that this latter compound may also be viewed differently. We might greatly extend the list of similar incongruities, taking our examples especially from the organic silicon and boron compounds, which, more than anything else, show that the same idea of grouping elements that is now so freely admitted to prevail for carbon compounds must logically hold good also for inorganic bodies.

The nomenclature first proposed by Hofmann and adopted by our author of designating the different parallel hydro-carbon seri s by the terminations, ane, ene, ine, one, une has some inconveniences which perhaps are less apparent to the teacher than to the student of organic chemistry, who must be sorely puzzled to distinguish, for instance, between ethine and phosphine, stibine, oxytetraldine, &c.; and it is with regret we see some authors

go even further, and substitute, for instance, iodethane for the familiar ethyl iodide, &c.

As constitutional or structural formulæ are intended to assist the student in the study of organic chemistry, we should have preferred if the well-understood abbreviations for compound radicals, advocated by some of our most eminent chemists, such as Et. for ethyl, Ay. for amyl, had been used. We observe, on p. 53, that Cfy. and Cfdy. are used for the compound cyanogen radicals; why should not constitutional formulæ generally be simplified by the use of abbreviations? The task of deciphering certain complex organic formulæ is already heavy enough, and some such shorthand expressions as the above will soon become all but indispensable. We do not for a moment blame the author alone for these sins of omission and commission. Our nomenclature and terminology are in such a state of confusion that a bold reformer should be welcomed rather than discouraged by every lover of our science.

We notice a few slips: On p. 7 "$C_n H_2 + _2$" should be $C_n H_{2n} + _2$; on p. 13 "monad and triad radicals cannot be isolated;" but at top of p. 14 we are told that "methyl combines with methyl, and we obtain ethane or ethyl hydride." Why methyl, &c., should not exist in a free or molecular state as much as hydrogen we are unable to see. On p. 67, the oxygen in the formula for guanidine should be omitted. On p. 72, "methyl iodide $2CH_3$" should be $2CH_3I$. On p. 111, "The vapour of ether is 2·557 times heavier than water." On p. 112 "triacetyl chloride" should be trichloracetyl chloride. On p. 135, "$C_6 H_{12} N$" is given in the equation, instead of $C_6 H_{12} N_2$. On p. 309, "$C_2 H_3 NH_2$" should be $C_2 H_5 NH_2$; and others which we will not mention.

We freely admit many commendable features in Mr. Schorlemmer's new book, which will render it extremely useful, especially to the student engaged in tracing the various isomerides, but we cannot help thinking that in some respects it does not come up to some works on organic chemistry which we already possess.

OUR BOOK SHELF

Dahomey as it Is: being a Narrative of Eight Months' residence in that country, with a full account of the notorious Annual Customs and the Social and Religious Institutions of the Ffons; also an Appendix on Ashantee, and a Glossary of Dahoman Words and Titles. By J. A. Skertchly. (London: Chapman and Hall, 1874).

MR. SKERTCHLY left England in 1871 for the purpose of making zoological collections on the West Coast of Africa. On his arrival at Whydah he was induced to go up to Abomey, the capital of Dahomey, for the purpose of instructing the king, Gelelé, in the use of some guns that had arrived, on the promise that he would be back at Whydah in eight days. The king, however, detained Mr. Skertchly as an unwilling guest for eight months, treating him with the greatest consideration and kindness, and creating him a prince of the country. The greater part of Mr. Skertchly's work is occupied with a description of the protracted annual "customs," as they are called, of Dahomey, which consist of elaborate and harmless trivial ceremonies, mixed up with much that is revolting and cruel; the details of these Mr. Skertchly describes in minute and often tiresome detail. We do not think there was any need for Mr. Skertchly making so large a book on what he saw, especially as the Dahomans and their "customs" are pretty well known through previous travellers. He often questions the accuracy of Burton, who is quite able to defend himself if he feels aggrieved at Mr. Skertchly's criticisms. The author succeeded, during his stay at Abomey, in doing but little in the way of collecting, and in this work there is scarcely any details as to the natural history of the country. He has evidently a considerable admiration both for the Dahomans and Ashantees, especially for the former, whom he considers not nearly so cruel as the latter, though both equally brave and remarkably well-disciplined as soldiers. In a short Appendix on the Ashantees, he prophecies that our recent expedition to the Gold Coast would find them formidable enemies, which prophecy can hardly be said to have been fulfilled. He defends the Dahomans from the charge of intentional cruelty in the barbarously performed human sacrifices which form so important a part of their customs, and we think he succeeds; the victims, who are all either criminals, or prisoners of war, are sent as messengers to deceased kings. The work is illustrated with a number of gorgeously coloured plates, which no doubt show faithfully the dresses and manners of the people, though some of the pictures which exhibit the method of sacrificing the human victims are simply revolting, and ought to have been confined to the author's portfolio.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Fertilisation of the Fumariaceæ

I BEG permission to make a few remarks on Mr. J. Traherne Moggridge's statement (NATURE, vol. ix. p. 423) that the flowers of *Fumaria capreolata* are at first pale or nearly white, and only attain their brightest colouring, becoming even crimson, after the ovaries are set. He then adds:—"If the reverse had been the case there is little doubt that we should have regarded the bright colouring as specially adapted to attract insects." But does Mr. Moggridge know that these flowers are visited chiefly by diurnal insects? It has often been observed that flowers which are visited by moths are commonly white or very pale; but if they are odoriferous, they may be of any tint, even very dark or green. If therefore the flowers of the above Fumaria are visited by moths, it would be an injury to the plant had the flowers been from the first of a fine crimson. I have often seen bees sucking the flowers of the fumariaceous genera, *Corydalis*, *Dielytra*, and *Adlumia*; but many years ago I watched perseveringly the flowers of *Fumaria officinalis* and *parviflora*, and never saw them visited by a single insect; and I concluded from reasons which I will not here give (as I cannot find my original notes), that they were frequented during the night by small moths. Insects are not necessary for the fertilisation of *Fumaria officinalis*; for I covered up a plant, and it produced as many seeds as an uncovered one which grew near. On the other hand, with some species of *Corydalis*, the aid of insects is indispensable. With respect to the flowers of *F. capreolata* becoming brighter coloured as they grow old, we see the same thing in some hawthorns, and with the double rocket in our gardens. But is it surprising that this should sometimes occur with flowers, seeing that the leaves of a multitude of plants assume, as they become oxygenised, the most splendid tints during the autumn?

Down, Beckenham, Kent, April 6 CHARLES DARWIN

IN the vegetable kingdom we meet very commonly with gaily-coloured chemical products, essentially connected with the normal processes of development (the chlorophyll of most non-parasitic plants, the splendid rose pigments of Florideæ, the many lively-coloured pigments of lichens and fungi), and originating from venomous infection by insects (red-coloured galls of oak-leaves) or from decomposition (red pigments in autumnal leaves). In all these cases these colours appear to us to be merely an accidental quality of the chemical products, and we do not feel induced to start the question of what use any particular colour may be to the plant producing it. But it is quite otherwise with the gay colours of flowers. Bright colours in flowers which especially attract our attention and admiration are in most cases beneficial to the plant itself which produces

them, by attracting in like manner also the attention of insects, which, visiting the flowers for their own profit, at the same time unconsciously bring to the plant the great advantage of cross-fertilisation. Hence we understand that bright-flowered varieties, whenever produced by any cause, might be preserved by natural selection, and at last remain the only survivors among all the concurrents of the same species. Thus, the occasional appearance of gaily-coloured varieties granted as a matter of fact, and the peculiarities of colour supposed to be hereditable, we are enabled by Darwin's theory to explain the variety of colours met with in flowers. But we should always bear in mind that we are at present quite ignorant of the chemical processes by which certain colours are produced in the flowers, and of the physical or organic causes by which these chemical processes were effected when they first appeared and are effected in every subsequent generation. Reflecting on the first origin of the adaptation of flowers to the cross-fertilisation by insects, and considering that the oldest and most primitive phanerogamous plants which still exist, the Gymnospermæ, are exclusively fertilised by the wind (are *anemophilous*), whilst the enormous majority of Angiospermæ is provided with flowers adapted to cross-fertilisation by insects (*entomophilous*), we cannot doubt that the original manner of fertilisation of phanerogamous plants was fertilisation by the wind, and that the first plants which adapted their flowers to cross-fertilisation by insects were anemophilous ones, either Gymnospermæ or the next descendants of them. Nevertheless the flowers of many Gymnospermæ (Abietinæ) present a beautiful colour, which attains its culmination during the disseminating of the pollen.* This beautiful colour is apparently neither of any use to these plants, which are regularly cross-fertilised by the wind, nor can have been inherited from ancestors to which it was useful. We may therefore also in this case, without hesitation, regard the colour as a merely accidental phenomenon, which, secondarily produced by the more active chemical processes during the time of flowering, disappears again in the same degree as the intensity of development decreases in the cones. Probably the gaily-coloured perianths of the entomophilous Angiospermæ have originated in a similar manner.

Independently of possible physical effects, natural selection is evidently without any influence as to colours, unless animals are attracted or repelled by them. Consequently not only the first origin of bright-coloured flowers, but also the change of colour in the flowers after the ovaries are set, is altogether foreign to the effects of natural selection. It is as indifferent to an entomophilous plant whether its flowers, after having been fertilised, grow paler or darker, as it is to an anemophilous plant whether its flowers are attractive to insects or not. In most cases, indeed, flowers change while fading into paler and less conspicuous colours, but often also their colour remains unaltered or even grows more conspicuous. Old flowers of *Melampyrum pratense*, for instance, which, not having been cross-fertilised by insects, regularly fertilise themselves, are always reddish-yellow, whilst younger ones are yellow.

As to *Fumaria capreolata*, alluded to in Mr. Moggridge's letter (NATURE, vol. ix. p. 423) I have never had the opportunity of observing its flowers myself, but from Hildebrand's account ("Jahrb. f. wissensch. Bot." vii. p. 452) I believe that it is restricted to regular self-fertilisation, cross-fertilisation by insects not, indeed, being impossible, but taking place very exceptionally; for it has lost, probably from permanent disuse, the elasticity of the cap formed by the inner petals, which in other fumitories secures cross-fertilisation in case of the repeated visits of insects. If this presumption of mine be right, it would the more explain Mr. Moggridge's observation; for in this case the colour of the flowers of this fumitory, inherited from ancestors to which it was quite useful, would be almost useless to this degenerated descendant, and therefore almost withdrawn from the influence for natural selection.

HERMANN MÜLLER

Lippstadt, April 4

* See Strassburger's memoir in "Yenaische Zeitschrift," vi. band, 2 heft, pp 249-261.

Conference for Maritime Meteorology

SOME of your readers may have noticed in the Report of the Proceedings of the Meteorological Congress at Vienna that it was decided to be advisable to convene a fresh Conference for maritime meteorology, in order to reconsider the decisions of the Brussels Conference in 1853.

The matter was handed over to the Permanent Committee, and by them delegated to a sub-committee composed of the following members:—

Prof. Buys Ballot (Holland)
Prof. Mohn (Norway)
Capt. E. Mouchez (France)
Dr. G. Neumayer (Germany)

with myself.

The sub-committee have nearly decided on a form of programme for the proceedings, and there are hopes that the Conference will meet in London in the month of August or so. Endeavours will probably be made to induce H.M.'s Government to issue the invitations, and thereby to give an official character to the Conference.

ROBERT H. SCOTT

Herbert Spencer and *à priori* Truths

ABSENCE from town has delayed what further remarks I have to make respecting the disputed origin of physical axioms.

The particular physical axiom in connection with which the general question was raised, was the Second Law of Motion. It stands in the *Principia* as follows:—

"*The alteration of motion is ever proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed.*

"If any force generates a motion, a double force will generate double the motion, a triple force triple the motion, whether that force be impressed altogether and at once, or gradually and successively. And this motion (being always directed the same way with the generating force), if the body moved before, is added to or subducted from the former motion, according as they directly conspire with or are directly contrary to each other; or obliquely joined, when they are oblique, so as to produce a new motion compounded from the determination of both."

As this, like each of the other laws of motion, is called an axiom;* as the paragraph appended to it is simply an amplification, or re-statement in a more concrete form; as there are no facts named as bases of induction, nor any justifying experiment; and as Newton proceeds forthwith to draw deductions, it was a legitimate inference that he regarded this truth as *à priori*. My statement to this effect was based on the contents of the *Principia* itself; and I think I was warranted in assuming that the nature of the laws of motion, as conceived by Newton, was to be thence inferred.

The passages quoted by the *British Quarterly Reviewer* from Newton's correspondence, which were unknown to me, show that this was not Newton's conception of them. Thus far, then, my opponent has the best of the argument. Several qualifying considerations have to be set down, however.

(1) Clearly, the statements contained in the *Principia* do not convey Newton's conception; otherwise there would have been no need for his explanations. The passages quoted prove that he wished to exclude these cardinal truths from the class of hypotheses, which he said he did not make; and to do this he had to define them.

(2) By calling them axioms, and by yet describing them as principles "*deduced* from phenomena," he makes it manifest that he gives the word axiom a sense widely unlike the sense in which it is usually accepted.

(3) Further, the quotations fail to warrant the statement that the laws of motion are proved true by the truth of the *Principia*. For if the fulfilment of astronomical predictions made in pursuance of the *Principia* is held to be the evidence "on which they chiefly rest to this day," then, until thus justified, they are unquestionably hypotheses. Yet Newton says they are not hypotheses.

Newton's view may be found without seeking for it in his letters: it is contained in the *Principia* itself. The scholium to Corollary VI. begins thus:—

"Hitherto I have laid down such principles as have been received by mathematicians, and are *confirmed* by abundance of experiments. By the two first Laws and the two first Corollaries, Galileo discovered that the descent of bodies observed the duplicate ratio of the time, and that the motion of projectiles was in the curve of a parabola; experience *agreeing* with both," &c.

Now as this passage precedes the deductions constituting the *Principia*, it shows conclusively, in the first place, that Newton did not think "the whole of the *Principia* was the proof" of the

* It is true that in Newton's time, "axiom" had not the same rigorously defined meaning as now; but it suffices for my argument that, standing unproved as a basis for physical deductions, it bears just the same relation to them that a mathematical axiom does to mathematical deductions.

laws of motion, though the Reviewer asserts that it is. Further, by the words I have italicised, Newton implicitly describes Galileo as having asserted these laws of motion, if not as gratuitous hypotheses (which he says they are not), then as *à priori* intuitions. For a proposition which is *confirmed* by experiment, and which is said to *agree* with experience, must have been entertained before the alleged verifications could be reached. And as before he made his experiments on falling bodies and projectiles, Galileo had no facts serving as an inductive basis for the Second Law of Motion, the law could not have been arrived at by induction.

Let me end what I have to say on this vexed question by adding a further reason to those I have already given, for saying that physical axioms cannot be established experimentally. The belief in their experimental establishment rests on the tacit assumption that experiments can be made, and conclusions drawn from them, without any truths being postulated. It is forgotten that there is a foundation of preconceptions without which the perceptions and inferences of the physicist cannot stand—*preconceptions which are the products of simpler experiences than those yielded by consciously-made experiments.* Passing over the many which do not immediately concern us, I will name only that which does,—the exact quantitative relation between cause and effect. It is taken by the chemist as a truth needing no proof, that if two volumes of hydrogen unite with one volume of oxygen to form a certain quantity of water, four volumes of hydrogen uniting with two volumes of oxygen will form double the quantity of water. If a cubic foot of ice at 32° is liquefied by a specified quantity of heat, it is taken to be unquestionable that three times the quantity of heat will liquefy three cubic feet. And similarly with mechanical forces, the unhesitating assumption is that if one unit of force acting in a given direction produces a certain result, two units will produce twice the result. Every process of measurement in a physical experiment takes this for granted; as we see in one of the simplest of them—the process of weighing. If a measured quantity of metal, gravitating towards the earth, counterbalances a quantity of some other substance, the truth postulated in every act of weighing is, that any multiple of such weight will counterbalance an equi-multiple of such substance. That is to say, each unit of force is assumed to work its equivalent of effect in the direction in which it acts. Now this is nothing else than the assumption which the Second Law of Motion expresses in respect to effects of another kind. "If any force generates a motion, a double force will generate a double motion," &c., &c. ; and when carried on to the composition of motions, the law is, similarly, the assertion that any other force, acting in any other direction, will similarly produce in that direction a proportionate motion. So that the law simply asserts the exact equivalence of causes and effects of this particular class, while all physical experiments *assume* this exact equivalence among causes and effects of all classes. Hence, the proposal to prove the laws of motion experimentally, is the proposal to make a wider assumption for the purpose of justifying one of the narrower assumptions included in it.

Reduced to its briefest form the argument is this:—If definite quantitative relations between causes and effects be assumed *à priori*, then, the Second Law of Motion is an immediate corollary. If there are not definite quantitative relations between causes and effects, all the conclusions drawn from physical experiments are invalid. And further, in the absence of this *à priori* assumption of equivalence, the quantified conclusion from any experiment may be denied, and any other quantification of the conclusion asserted.

HERBERT SPENCER

MR. SPENCER's letter in NATURE, vol. ix. p. 420, is likely to give to such of your readers as have not followed the controversy in which he is engaged a false notion of the issues therein. Mr. Spencer writes as though the views of the nature of physical truth that were objected to by Prof. Tait and myself amounted to the ascription of our knowledge of sundry physical laws to organised ancestral instead of individual experiences. In one portion of his reply to me he intimates the same, as, for instance, where he says of me:—

"His argument proceeds throughout on the assumption that I understand *à priori* truths after the ancient manner as truths independent of experience; and he shows this more than tacitly where he 'trusts' that he is attacking one of the last attempts to deduce the laws of nature from our inner consciousness. Manifestly a leading thesis of one of the works he professes to review is entirely unknown to him—the thesis that forms of thought, and consequently those intuitions which those forms of thought involve, result entirely from the effects of experiences organised and inherited" ("Replies to Criticisms," p. 332).

But, in his "First Principles," Mr. Spencer expresses himself far too clearly for him to be able to assign the above as his views at that time on these so-called *à priori* truths. Speaking of the indestructibility of matter, one of the three truths in question, he says:—

"The annihilation of matter is unthinkable for the same reason that the creation of matter is unthinkable—and its indestructibility thus becomes an *à priori* cognition of the highest order—*not one that results from a long continued registry of experiences gradually organised into an irreversible mode of thought;* but one that is given in the form of all experiences whatever."

For the second of the truths he claims a similar authority; while for the third—the Persistence of Force—he claims a yet higher warrant:—

"Deeper than demonstration—deeper even than definite cognition—deep as the very nature of mind is the postulate at which we have arrived (*i.e.* the Persistence of Force). *Its authority transcends all other whatever; for not only is it given in the constitution of our own consciousness*, but it is impossible to imagine a consciousness so constituted as not to give it." ("First Principles," p. 192).

Had Mr. Spencer confined himself to defending such an *à priori* origin of physical truths as he now seems inclined to put forward, I should never have compared his theories to those of the Ptolemaists. But I can leave it with confidence to the readers of NATURE to decide between us as to whether the above passages do not show that at the time when they were written Mr. Spencer understood *à priori*, as there applied, in a manner very like the "ancient manner," and whether he did not maintain that these *à priori* truths were indeed "truths independent of experience."

THE AUTHOR OF THE ARTICLE ON HERBERT SPENCER IN THE BRITISH QUARTERLY REVIEW

[The Editor, very properly wishing, I doubt not, to end the controversy, has sent to me the foregoing letter in proof. My comment on it is very brief.

Had the reviewer read the "Principles of Psychology," placed at the head of his article apparently for form's sake only, he would, not, I think, have made the above rejoinder.

That view of the *à priori* origin of physical truths which the Reviewer now seems to think defensible is the view implied in "First Principles" and the view set forth in the "Principles of Psychology," published years before. Tacitly throughout that work, and explicitly near the end, in a chapter on "Reason," the doctrine is that the "forms of thought" themselves are the products of experience. If the nervous system as a whole and in all its structures has been evolved by converse between the organism and the environment, the fundamental principles of its action, the very "forms of all experiences" have been evolved. Experience itself grew into definiteness gradually. And if the very form of our thought, the very frame-work of our consciousness, has been thus moulded, the inability to conceive a mode of thinking fundamentally different, is simply the result of inability to invert the fundamental action of the structures by which we think.—H. S.]

On the Word "Axiom"

IN reference to the controversy between Mr. Spencer and his reviewer about Sir I. Newton's calling his laws of motion "axioms," it is to be observed that there is a certain ambiguity in the word. "Axiom" is from ἀξιόω (I demand), and would thus signify a first principle to be taken for granted. It does not, of course, carry with it the meaning of a necessary judgment which cannot be contradicted. Whatever may be considered the ground of Euclid's "axioms" so called, Euclid himself did not apply that name to them; but the first nine he called "common notions," and the last three (which are peculiar to geometry) he placed among the postulates (ὁμολογήματα), and heads them with "let it be granted." Now it is clear, from Newton's own words, that in calling his Leges motûs "axioms," he does not imply that they are *necessary* judgments, but that he requires them first of all to be granted (however established) in order to the following reasoning. In other words, they are postulates, like Euclid's last three "axioms." In our modern use of the words "axiom," "axiomatic," there is always implied the *ground* why a proposition is demanded as granted, viz., because its necessity is self evident; but this wider use is not required by etymology, or (I think) in interpreting all ancient writings.

F.M.S.

A Beech pierced by a Thorn Plant

THE word *pierced* makes the difference between an impossibility and a fact which is not uncommon in nature. The thorn mentioned in your last impression by Mr. Murphy has grown between two beech stems, which were so close that from their annual increase they grew together, and in so doing they enclosed the thorn, which could no more have *pierced* the beech than it could have pierced a block of marble. If young trees are twisted together they will grow together. Years ago I placed a bar of iron in an interstice between two stems so twisted, in another interstice below it I placed a part of the drag-chain of a waggon. According to Mr. Murphy the two iron appendages "have grown right through the middle of the trunks of the two beeches." They are at least as firmly fixed as if they had done so.

The tree with the iron branches is close to the lodge on Brookwood Hill. Should any of your readers consider it to be worth inspection, the lodge-keeper will show it to them.

April 11 GEORGE GREENWOOD

Mars

I BEG to offer my thanks to Mr. Knobel for his obliging correction (vol. ix. p. 396) with regard to the contrasted tint of the snow-poles of Mars. His observations had quite escaped my recollection.

I have also to mention a correction with which I have been favoured by the Earl of Rosse. It appears that an erroneous hour had been affixed to the drawing of Mars made at Parsonstown on September 14, 1862, and engraved in Mem. R.A.S., vol. xxxii., pl. v., and that an explanation is thus offered of one of the discrepancies commented on by Prof. Kaiser.

Cheltenham, April 9 T. W. WEBB

Bright Shooting-star

A SHOOTING-STAR, equal in apparent brightness to the planet Jupiter, was seen here by me this evening at $9^h 18^m$. It traversed a path of 24° in two seconds, beginning at R.A. 242°, D + 47°, and ending at R.A. 278°, D + 50°. No perceptible train remained after the disappearance of the nucleus, which, however, emitted numerous sparks when in motion. The radiant point of this meteor was probably near β Boötis, and identical with No. 36 in Mr. R. P. Greg's table of radiant positions in the "Monthly Notices R.A.S.," vol. xxxii. p. 350. This is given at R.A. 223°, D + 40° by Greg and Herschel, and at R.A. 224°, D + 38° by Schiaparelli and Zezioli. The meteor described above was not therefore a member of the well-marked meteoric streams of April 18–20. At stations eastward it was probably a much brighter object than observed here, and these brief details may be useful, taken in conjunction with others, in determining its height and velocity.

Cotham Park, Bristol, April 11 WILLIAM F. DENNING

THE LATE DR. LIVINGSTONE

OUR readers are no doubt familiar through the daily press with all that has transpired during the past week in reference to the all-absorbing topic of the late Dr. Livingstone and the home-bringing of his remains. The coffin containing these arrived at Southampton yesterday morning, and was received by the Corporation, Livingstone's family and friends, the President and fellows of the Royal Geographical Society, and many others, with all solemnity and with every mark of genuine respect. The body of the great explorer was accompanied to the station by a long and distinguished procession, and was conveyed in a special train to London, to be buried in Westminster Abbey on Saturday at 1 P.M.

The proposed position of the grave in the Abbey is near that of Major Rennel, the father of English geography, and the friend and adviser of Mungo Park. There was some hesitation between this position and the one near the grave of Sir John Chardin, the Persian traveller.

The President of the French Geographical Society, Vice-Admiral Baron de la Ronciere le Noury, is coming over from Paris, for the express purpose of being present at the funeral.

The Government grants a sum which Sir Bartle Frere "trusts will be sufficient for all purposes." Still we are glad to have Sir Bartle Frere's assurance that in the end there will be "no shortcoming on the part of the Government."

Dr. Livingstone's vocation was not a money-making one; he did not even live to hear that the world ranked him among its greatest men; the end of all his labours was a sad one. This country, all civilised countries we may say, will attend to the appeal which has been made on behalf of his family.

As was to be expected, Scotsmen have taken the initiative in raising a monument to one of the greatest of their fellow-countrymen; at a meeting held at Edinburgh, on Tuesday, it was resolved, in recognition of the "heroic services rendered to science and civilisation by the late Dr. Livingstone," that a national statue be erected to his memory in the capital of his native country. This is right and it is honourable to his fellow-countrymen, though the memory of Livingstone will need no "labour of an age in piled stones" to render it immortal. Indeed a true idea of the full height of his greatness is only as yet beginning to dawn gradually upon us, and it will be some time ere we are able adequately to estimate it. No doubt, therefore, the thought contained in Tennyson's sad strain must have occurred to many a one during the last few weeks—

"I would that my tongue could utter
The thoughts that arise in me;"

and perhaps with still greater force those others—

"Oh for the touch of a vanished hand
And the sound of a voice that is still."

What honours would we have heaped upon his head had he only lived to reach his native shore!

NATIONAL MUSEUMS IN BRAZIL

THE working of the National Museums in Brazil seems to be conducted on similar principles to those recently advocated for the management of the Government Museums in this country. From a thick volume of 388 pp. explanatory of the topography, constitution, and resources of Brazil, issued in connection with the Brazilian Department of the late Vienna Exhibition, we gather that the most important Natural History Museum in South America, is that at Rio de Janeiro, which was founded in 1817. It is divided into four sections:—the first includes Comparative Anatomy, Physiology, and Zoology; the second Botany, Agriculture, and the Mechanical Arts; the third Mineralogy, Geology, and the Physical Sciences; and the fourth Numismatics, Archæology, &c. Each section has its separate director, who has assistants, and the whole Museum is presided over by a Director-in-Chief. "The Museum has, besides, several corresponding members in the National and Foreign Scientific Societies, and there are two naturalists travelling through the Empire, for the purpose of making collections.

"The principal object of the National Museum is, to collect and study all the natural products of the country, and to deliver public lectures on the science of its province, spreading among the people theoretical and practical knowledge, in a simple style, adapted to their comprehension.

"The Museum," it is stated, "now keeps up a correspondence with European establishments of the same description, and willingly exchanges duplicates of its collections for those of foreign museums.

"The Government intends to create in the provinces several museums independent of that in the capital of the empire, that they may exchange among one another the respective products of each one, receiving at the same time from the central one, not only the necessary instructions for the classification and study of the collections, but its superabundant duplicates."

POLARISATION OF LIGHT*

VII.

AMONG the phenomena of polarised light which may be observed either with a Nicol's prism or even with the naked eye, one of the most curious, and perhaps not yet fully explained, is that of Haidinger's brushes. If the eye receives a beam of polarised light a pale yellow patch in the form of an hour-glass, the axis of which is perpendicular to the plane of vibration, is perceived. On either side of the neck of the figure two protuberances of a violet tint are also seen to extend. After a little practice these figures or "brushes" may readily be observed. If the day be cloudy a Nicol must be used and directed to a tolerably bright cloud. The brushes are better defined in one position than in others; but if the Nicol be turned round, the brushes will be seen to revolve with it. If on a clear day we look in a direction at 90° from that of the sun, where the skylight is most completely polarised. the brushes may be seen with a naked eye. Jamin has suggested in explanation of this phenomena that the substances of the eye act like a pile of glass plates, or rather spheres, which affect in different degrees (1) the rays of the same colour whose vibrations are differently inclined to the plane of incidence, and (2) the rays of different colours whose vibrations are similarly inclined. This will cause one colour to predominate in a general direction parallel, and its complementary to predominate in a plane perpendicular, to that of vibration. Helmholtz, however, connects the phenomenon with some double refraction due to the yellow spot in the eye, with the area of which that of the brushes is coincident.

It was explained above that in Iceland spar there is a particular direction, viz. that of the line joining the two opposite obtuse angles of the natural crystal, in which there is no double refraction, and in which all rays travel with the same velocity. This direction (that is to say, this line and all lines parallel to it) bears the name of the optic axis. There are many other crystals having the same property in one and only one direction, in other words having a single optic axis. There is, moreover, another class of crystals having two such axes. Crystals of the first class or uni-axal crystals are again divided into two groups, viz. positive, in which the extraordinary ray is more refracted than the ordinary, and negative, in which the ordinary ray is the more refracted. It will be remembered that the ray which travels slowest is the most refracted. Among the former may be mentioned

UNI-AXAL CRYSTALS.

Positive.

Apophyllite.	Stannite.
Boracite.	Superacetate of copper and lime.
Ditopaz.	Sulphate of potash and iron.
Hydrate of magnesia.	Tungstate of zinc.
Hyposulphate of lead.	Zircon.
Ice.	
Quartz.	
Red Silver.	

Negative.

Apatite.	Honey stone.
Arseniate of copper.	Idocrase.
Arseniate of lead.	Mellite.
Arseniate of potash.	Mica.
Beryl.	Molybdate of lead.
Carbonate of lime and magnesia.	Nepheline.
	Octaedrite.
Carbonate of lime and iron.	Phosphate of lime.
Chloride of calcium.	Phosphate of lead.
Chloride of strontium.	Rubellite.
Cinnabar.	Ruby.
Corundum.	Sapphire.
Emerald.	

* Continued from p. 386.

Crystals are usually divided into six systems, in each of which there is a fundamental aad a variety of derived forms. The fundamental form of each system is based upon the number, magnitude, and inclination of the crystallographic axes or lines drawn through a point in the interior of the crystal, and terminating in its angles. The optic axes do not of necessity coincide with any of these.

(1.) The regular system, which is based upon a system of three equal rectangular axes. Any form derived from this will be perfectly symmetrical with reference to the three axes, and will present no distinguishing feature in relation to any of them. Crystals belonging to this system have no optic axis, nor any doubly refracting property.

(2.) The quadratic system, based upon a system ot three rectangular axes, whereof two are equal, but the third greater or less than the other two. Crystals belonging to this system have one optic axis coinciding with the last-mentioned crystallographic axis.

(3.) The hexagonal system, having three equal axes lying in one plane inclined at 60° to one another, and a fourth axis at right angles to the other three. Crystals of this system have one optic axis coinciding with the fourth crystallographic axis. Iceland spar belongs to one of the derived forms of this system.

(4.) The rhombic system, having three rectangular but unequal axes.

(5.) The monoclinic system, which differs from the rhombic in this, that one of the three axes is oblique to the other two, which are still rectangular to one another.

(6.) The triclinic system in which all the axes are oblique.

All crystals belonging to the last three systems have two optic axes. In the rhombic system they lie in a plane containing two of the three crystallographic axes; in the monoclinic, they lie either in the plane containing the oblique axes, or in a plane at right angles thereto. In the triclinic no assignable relation between the optic and the crystallographic axes has been determined.

The phenomena of colours and their variations hitherto described have been produced by a beam of light, all the rays of which were parallel in their passage through the crystal or other substance under examination. There is, however, another class of phenomena due to the transmission of a convergent or divergent beam of polarised light, which we now proceed to consider.

It was shown above that the retardation due to any doubly refracting crystal, and consequently the colour produced by it is dependent on the thickness; and that with a crystal of constantly increasing thickness, the colours go through a complete cycle, and then begin again. Suppose then a divergent beam to fall perpendicularly upon a uni-axal crystal plate cut at right angles to the optic axis; the central rays will fall perpendicularly to the surface; but the rays which form conical shells about that central ray will fall obliquely. The rays forming each shell will fall with the same degree of obliquity on different sides of the central ray, those forming the outer shells having greater obliquity than the inner. Now the more obliquely any ray falls upon the surface the greater will be the thickness of the crystal which it traverses; and this will still be the case even though it suffers refraction, or bending towards the perpendicular on entering the crystal. Each incident cone of rays will consequently still form a cone when refracted within the crystal, although less divergent than at incidence, in its passage through the plate; and the successive refracted cones will be more and more oblique, as were the incident cones, but in a less degree, as we pass from the more central to the more external members of the assemblage forming the beam of light.

Let A B C D (Fig. 21) represent the crystal plate, O P the

direction of the optic axis and of the central ray, O n, O n′ those of any two other rays. The ray O P will not be divided; but O n will be separated by the double refraction of the plate into two, n s, n r, the one ordinary, the other extraordinary; and these will emerge parallel to one another, and may be represented by the lines s t, r v. Similarly the effect of double refraction on O n′ may be represented by n′ s′, n′ r′, s′ t′, r′ v′. Suppose now that the process were reversed, and that two monochromatic rays, one ordinary, the other extraordinary, reach the plate at s and r in the directions t s, v r, respectively; these would meet at n and travel together to O. Suppose, further, that the difference in length of s n and r n is equal to one wave-length, then, since one of them is an ordinary and the other an extraordinary ray, their vibrations will be perpendicular to one another, and if the polariser and analyser be crossed, the point n viewed from O will appear dark. Similarly, if two rays arrive in the directions t′ s′, v′ r′, at the points s′ r′ respectively, they will meet at n′ and proceed together to O; and if the difference of the paths s′ n′, r′ n′ be two wave-lengths, the point n′ will also appear dark. A pair of rays reaching the crystal at points between the pairs before-mentioned, will emerge at a point n″ between n and n′, and will present a difference of phase equal to a half wave-length. On principles explained in an earlier part of these lectures, such a point n″ will appear bright. On either side of n″, that is towards n and n′, the light will gradually fade. The same alternations of light and darkness will recur at intervals as we proceed along any straight line drawn outwards from the central ray. And inasmuch as the obliquity of the ray is the same for every point equidistant from the centre O, it follows that the phenomena of light and darkness will be the same throughout each circle drawn about the centre O. In other words, the centre will be surrounded by rings alternately bright and dark. The diameters of the ring depend, as was seen above, on the wave-length of the particular light used, and will consequently be different for different coloured rays. If, therefore, white light be used, the different coloured rings would not coincide, but would be disposed in recurring series as we proceed outwards from the centre.

Another effect would, however, also be produced. Suppose the polariser and analyser to be so placed that, the field being regarded as a map, the vibrations in the one being E. and W., those in the other N. and S.; then of the two rays emerging at the most northern or the most southern point of any ring the vibrations of one would be towards the axis, or N. and S.; those of the other would be across it, or E. and W. And of these one would be extinguished by the polariser, the other by the analyser; and the same will be the case for every ring. Hence, throughout a N. and S. line crossing the entire field the light will be extinguished; and a similar effect will obviously occur along an E and a W. line. Hence, when the polariser and analyser are crossed, the entire system of rings will be intersected by a black cross, two of whose arms are parallel to the plane of vibration of the polariser and two to that of the analyser, and the rings in the quadrants on each side of an arm are of complementary tints. When the analyser is turned round through a right angle from its former position, only one set of vibrations (say those executed in a direction E. and W.) will be extinguished, and consequently along one pair of arms of the cross the ordinary rays will pass undisturbed, along the other the extraordinary; that is to say, the cross will be white. When the polariser and analyser occupy any other position than those noticed above, there are two crosses inclined at an angle equal to that between the planes of vibration, each arm of which separates complementary rings.

Various forms of polariscopes have been devised for showing the crystal rings. The simplest of these is the tourmalin forceps, which consists of two plates of tourmalin fixed in cork discs; the latter are encircled in wire in such a way that they may be turned round in their own planes. The wire after encircling one disc is bent round so as to form a handle; it then encircles the other; and the elasticity of the wire allows the pair of discs to be opened and shut like a pair of pincers. If a crystal plate be inserted between the two, and the whole held close to the eye, the rays from parts of the field at different distances from the centre will reach the eye, having traversed the crystal with different degrees of obliquity; and a system of rings and brushes will be formed.

Another method consists in applying to Norremberg's polariscope a pair of lenses, one below the crystal with the crystal in the focus, the other above it. The first ensures that the rays shall traverse the crystal with different degrees of obliquity; the second brings within the range of vision rays which would otherwise fail to reach the eye, and at the same time converging them into a cone with a smaller vertical range, renders the ring smaller than when seen with the simple tourmalins. An additional lens of greater focal length, *i.e.* of less power, is

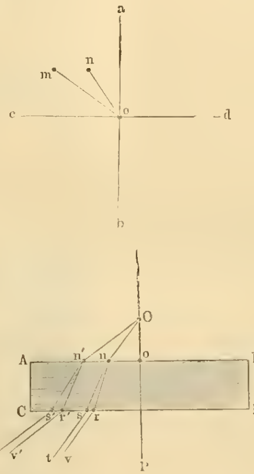


FIG. 21.

often added in order to adjust the whole to individual eyesight.

Fig. 22 gives the general appearance of the addition to the apparatus of Norremberg described above, and Fig. 23 the course of a system of rays brought to a focus on the lens a b, and again converged by a second lens c d.

But by far the most successful arrangement for enlarging the field of view so as to comprise the complete system of rings even with bi-axal crystals having widely inclined optic axes, is the system of lenses due in the first instance to Norremberg. The disposition of the parts is shown in Fig. 24; and the general appearance of the instrument as constructed by Hofmann of Paris, and called by him the "Polarimicroscope," is also given, Fig. 25. In this instrument the lenses which converge the rays upon the crystal plate can be taken out, and replaced by others giving parallel light; it can then be used as an ordinary polariscope.

Mention has been made above of the effect of the circular polarisation of quartz in the colours produced by a beam of parallel rays of polarised light. It remains for us to examine the modification which the rings and

brushes undergo from the same cause. It has been explained that a ray of plane-polarised light in traversing a crystal of quartz in the direction of its axis is divided into two, the vibrations of which are circular, one right-handed, the other left. If the ray traverses the crystal in a direction perpendicular to the axis, and if the original vibrations are neither parallel nor perpendicular to the axis it is also divided into two, whereof the vibrations are not circular but rectilinear. It was suggested, first by Sir G. Airy, that these circular and rectilinear vibrations are limiting cases of elliptical; and both theory and experiment tend to confirm the suggestion, by showing that if the ray be incident on the crystal in any direction

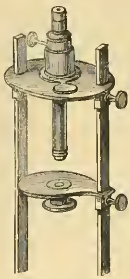


Fig. 22.

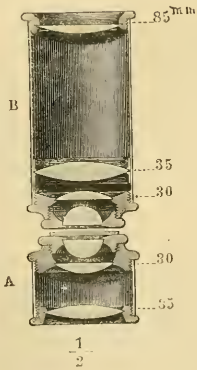


Fig. 24.

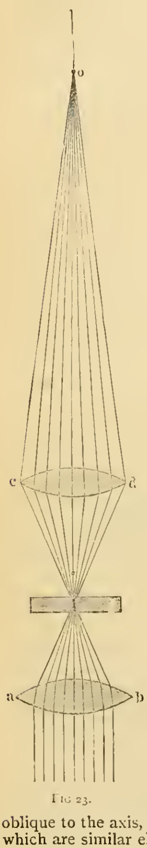


Fig. 23.

oblique to the axis, it is divided into two, the vibrations of which are similar ellipses having the longer diameter of the disc coincident with the shorter of the other, and the motion in the two oppositely directed. The longer diameters of the ellipses coincide with the directions of vibration of the ordinary and extraordinary rays in the case of an ordinary positives crystal; and are consequently directed, the one toward the centre of the figure, the other in a direction at right angles to the first.

The exact, or even appproximate determination of the figures produced is a complicated question, and requires mathematical analysis for its solution, but a general idea of their nature may nevertheless be easily formed. When the polariser and analyser are either parallel or crossed, circular rings are formed, and towards the outer parts of the field traces of the black cross are seen, which grow stronger as we proceed outwards from the centre, that is, towards the parts where the rays are more oblique, and where the polarisation more nearly approaches to rectilinear. But in the centre, and near to it, where the polarisation is circular, or nearly so, the effects will resemble those produced by parallel rays, viz. the rays of different colours will emerge plane-polarised in different planes, and will be variously affected by the angle between polariser and analyser. In no position can they all be extinguished, and consequently in the centre all traces of the black cross will disappear.

When the planes of vibration of the polariser and the analyser are inclined at any other angle than 0° or 90°, the arms of the cross are less strongly marked, and the curvature of the rings becomes less uniform, increasing in the four points where they are crossed by the arms, and diminishing in the intermediate quadrants. When the angle between the planes of vibration is 45°, the rings assume a nearly square form, the corners of the square lying upon the lines which bisect internally and externally the angles between the planes. If the figures are produced

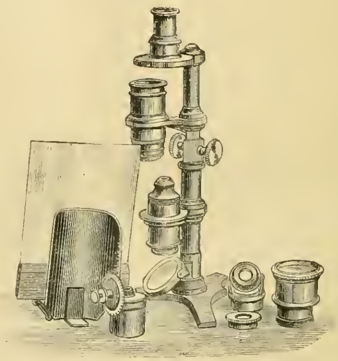


Fig. 25.

with the analyser at 45° by two quartz plates of equal thicknesses, one right-handed, the other left, it will be found that the diagonals of the squares are at right angles to one another, the remains of the black cross occupying the same position in the field in both cases.

If two plates of the same thickness, the one right-handed and the other left, are placed one over the other, a beautiful effect, called from their discoverer Airy's spirals, is produced. In the centre of the field the rotatory powers of the plates neutralise one another, and a black cross commences. As we proceed outwards, the arms of the cross cease to be black, and become tinged with red on one side, and with blue on the other. At the same time they are bent round in a spiral form, in the direction of the hands of a watch if the first plate be right-handed, and in the opposite direction if the first plate be left-handed. These spirals intersect at intervals the circular rings; the points of intersection lie in four rectangular directions, which terminate towards the outer margin of the field in four arms of a shadowy cross. The colours of the rings and spirals are more brilliant and better defined than in most other phenomena of chromatic polarisation.

W. Spottiswoode

(To be continued.)

REPORT OF PROF. PARKER'S HUNTERIAN LECTURES "ON THE STRUCTURE AND DEVELOPMENT OF THE VERTEBRATE SKULL" *

II.

IT is well known that the eggs of sharks and rays, when deposited, are enclosed in a strong horny capsule or "purse" formed as a secretion from the oviduct. In both groups these curious appendages have the form of a pillow-case, the corners being pointed in the rays, and produced into long tendril-like processes in the shark and dog-fish. The embryo remains enclosed in the purse until about six months after oviposition, and it is during this period that all the most important metamorphoses are gone through.

The youngest embryo described was nearly an inch

Fig. 3

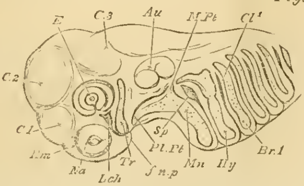


FIG. 3.—Head of Embryo Dog-fish, 11 lines long. Lch, lachrymal cleft; C 1, 2, 3, Cerebral vesicles; Hm, Cerebral hemispheres; fnp, fronto-nasal process; Sp, Spiracle. Other references as before. The visceral arches are dotted for distinction's sake.

long, an extremely active little creature, attached to a yolk-sac about $\frac{3}{4}$ of an inch in diameter. In this stage the head and branchial region are large and conspicuous, the body slender, and tapering off to a long thread-like tail. The dorsal laminæ have completely united, leaving, however, a very thin covering to the hinder division of the brain, which consists of the three primary cerebral vesicles (Fig. 3, C 1—3), bent over the end of the notochord in such a way that the second, or middle division, forms the anterior termination of the head; the "cerebral flexure" is, therefore, complete. The future hemispheres (Hm) have already appeared as small buds from the fore-

Fig. 4

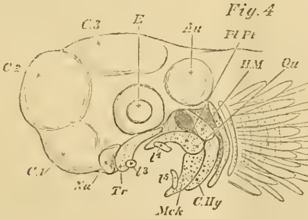


FIG. 4.—Head of Embryo Dog-fish, $1\frac{1}{6}$ in. long. References as before.

brain (C 1). The nasal, visual, and auditory organs are in an extremely rudimentary condition. On the under surface of the head is the large square mouth, bounded above by the fronto-nasal process (fnp), a shield-shaped elevation of the integument between the nasal sacs, found in the embryos of even the highest vertebrata, but persistent in the sharks and rays. Beneath the eye, and communicating by a slit running below the inferior boundary of the fronto-nasal process, is a cleft (Lch) answering to the lachrymal passage of the higher vertebrata, and formed by the shutting off of a portion of the original first visceral cleft by the growth of the pterygo-palatine arcade. This cleft, persistent in the higher animals, is a transient structure in the Elamobanchs. One of the most noticeable features in the embryo at this stage is the presence of a number of long filamentous external gills, each containing a single capillary loop; of these about ten spring from the hyoid and each of the branchial arches, while four much shorter ones project from the future spiracle, and are attached to the mandibular arch. The internal branchiæ are at present functionless, and form mere cog-like projections on the arches.

The embryo at this age is so transparent, that the visceral arches can be seen with sufficient distinctness through the skin without any dissection whatever. Even at such an early period, the anterior face-bars already begin to show signs of segmentation, there being constric-

Fig. 5.

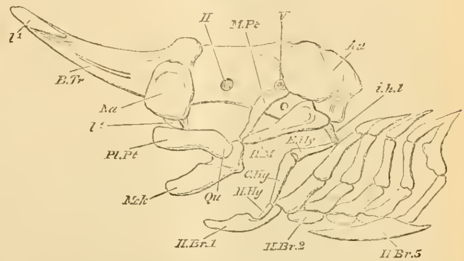


FIG. 5.—Skull of Ray. M Pt, Spiracular cartilage; ihl, inter-hyal ligament.

tions in the mandibular and hyoid arches, where division will afterwards take place. The upper part of these arches has assumed the pedate form which is taken on at a later period by the branchials. The pterygo-palatine arcade is already as large proportionally as in the adult, the true apex of the mandibular arch being reduced by its outgrowth to a mere tubercle (M Pt).

Granular subcutaneous thickenings have already appeared in relation with the face-bars; these are the extra-viscerals. In the same unchondrified condition are the parachordal and paraneural elements of the skull.

Embryos of $1\frac{1}{6}$ and $1\frac{1}{2}$ in. in length possess external gills

Fig. 6

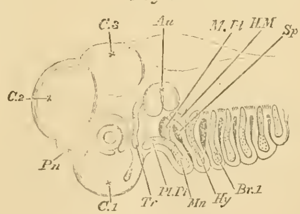


FIG. 6.—Head of Embryo Ray, $1\frac{1}{2}$ in long. Pn, Pineal gland.

two or three times as long as in the preceding stage those on the mandibular arch having already shrunk and begun to form the pseudo-branchia; the internal gills are still functionless. The eye is completely formed. The investing mass and the nose and ear capsules are chrondified, but the two halves of the former are still separate, and the roof and walls of the cranium membranous. To make out clearly the relations of the facial arches, it is now necessary to dissect away the skin (see Fig. 4); it is then seen that the process of segmentation has advanced greatly, the arches behind the mouth being split up as in the adult, and differing from those of the full-grown shark only in form. The trabeculæ have become flat-

* Continued from p. 426.

tened out from above downwards, but are still separate, and the lower-jaw arch, besides being divided into paleto-quadrate and Meckel's cartilage, has approached still more nearly to the adult character by the conversion into fibrous tissue of its apex (Figs. 2 and 3, M Pt).

The third stage described was a ripe embryo, about two inches long, having nearly the form of the adult. In this condition the external gills have entirely disappeared, the internal gills now performing the whole function of respiration. The skull has assumed all the characters of the adult, except as regards a few minor details, chondrification and segmentation being perfect. The investing mass has not only completely enclosed the notochord, but has formed an arch, like that of a vertebra, over the hinder part of the brain : in this way the occipital region of the skull is formed. The roof and walls of the brain-case, membranous in the last stage, have now become cartilaginous, and are fused with the nasal sacs in front, the trabeculæ below, and the auditory capsules and occipital region behind. The trabeculæ form the whole of the flat skull-floor in front of the ear capsules, where their original apices (pharyngo-trabeculars) are still to be seen as small rounded processes; they have completely coalesced behind, but are merely in apposition between the nasal sacs. The basi-trabecular (Fig. 2, B Tr) is small, and the first pair of labials (l^1), which together with it form the "cutwater," are flat, and widely separated; the snout is consequently much blunter than in the adult. The hypo-trabeculars (cornua trabeculæ of Rathke) occur as two inturned S-shaped filaments of cartilage on either side of the basi-trabecular : no trace of them is to be found in the adult.

III.—*Skull of the Ray or Thornback* (Raia clavata).—On the whole the skull of the ray resembles very closely that of the shark ; in some respects, however, it approaches more nearly to the higher fishes, and in others, again, retains a lower or more embryonic character.

One of the chief points of difference between this type and the preceding is the much greater elongation of the skull, chiefly owing to the immense development of the basi-trabecular (Fig. 5, B Tr), which is produced to form the long, stout rostrum, the apex of which is strengthened by the first pair of labial cartilages (l^1). The region between the orbits is much pinched in, while the nasal and auditory regions are extremely broad, the nose capsules, especially, being as far apart as in the embryo shark. On the upper surface, the prominences (epiotic, pterotic, sphenotic) already described in the shark, are seen ; but instead of one, there are two fontanelles, an oval one between the nasal sacs, and a second of an oblong shape, in the more normal position, between the orbits. On the under surface of the nasal capsules are seen the second, third, and fourth labials, forming a valvular apparatus for the nostrils ; the fifth labial and the extra-branchials are absent.

The upper and lower jaws or dentigerous arches closely resemble those of the shark ; the opening of the mouth is, however more completely on the under surface of the head, as in the embryo Squaloid. In the front wall of the spiracle a semi-lunar cartilage (M Pt) is found, connected by ligament with the auditory capsule above, and with the angle of the lower jaw below, and having the same relations to the fifth and seventh nerves as the metapterygoid ligament of the shark (Fig. 2, M Pt), or the bone of the same name in the osseous fish ; this, therefore, is the true apex of the mandibular or first post-oral arch.

There is no mistaking the hyo-mandibular (H M) a cartilage having precisely the same connection and relation to the hinder division of the *portio dura* as the part similarly named in the shark, but much more slender, pointed below, and inclined forwards. The remainder of the hyoid arch, however, has taken on an entirely new character, and shows a marked advance towards the Teleostian type, being attached, not to the lower part of the hyo-mandibular, but to its upper posterior angle, by means of a band of ligamentous fibre, answering to the small styliform bone (stylo-hyal of Cuvier) which in the osseous fish connects the free portion of the hyoid with the suspensory apparatus. The gill-bearing part of the hyoid is slenderer than in the shark, and more highly segmented, being divisible into epi- cerato-, and hypo-hyals (E Hy, C Hy, H Hy) ; the basi-hyal or keystone-piece is absent.

The branchial arches differ from those of the shark chiefly in the great development of the inferior segment or hypo-branchial. The first of these (H Br. 1) is much extended, and, uniting with its fellow of the opposite side, forms a transverse bar behind Meckel's cartilage. The second, third, and fourth hypo-branchials are broad adze-shaped plates, while the fifth is coalesced with its fellow in its hinder half, and extended forwards, so as nearly to meet the corresponding piece of the first arch.

The youngest ray described was an embryo of *R. maculata*, $1\frac{1}{3}$ inch long, taken from the purse at about the seventh week from oviposition. The body proper is not larger than that of the first stage of the dog-fish, the greater length being due to the immense development of the tail. The pectoral fins, which by their expansion and union in front with the head, give to the adult ray its peculiar depressed form, are at this age small semi-elliptical lobes, one on each side of the umbilicus or point of attachment of the large yolk-sac. Six or seven long branchial filaments, expanded or spatulate at the end, are attached to the hyoid and branchial arches, but none are apparent externally on the mandibular.

The facial arches are visible in a side view with perfect distinctness, and have already advanced considerably in segmentation, the apex of the mandibular being on the point of separation so as to form the spiracular cartilage, and the proximal end of the hyoid being cleft vertically, thus separating the hyo-mandibular from the epi-hyal.

Three months after oviposition, although the yolk-sac is still as large as a small walnut, the embryo has completely taken on the adult form, the pectoral fins having enlarged greatly, and brought the gill-slits to the ventral surface ; from these the external branchiæ still project, being now in the form of long threads, almost like the hyphæ of a fungus ; the first cleft behind the mouth (tympano-eustachian) remaining on the upper surface has taken on the form of the spiracular opening.

In the skull very few embryonic characteristics are left, the chief being that the brain-case is rounder, the rostrum shorter, and the two first labials separated from it by a slight interval, instead of being in perfect apposition.

METEOROLOGY OF THE WEST INDIES

THE hurricane season, here reckoned from July 25 to October 25, went by without damage so far as the Windward and Virgin Islands are concerned, though not without disastrous examples of the phenomenon from which it derives its name elsewhere. Two cyclones of the ordinary kind have in fact visited these seas during the above period ; and although neither of them included the island of St. Thomas in its range, yet they passed sufficiently near to make us aware of their existence, and to create considerable alarm among the inhabitants.

The first of these appears to have originated about lat. 10° N. long. 55° W., on or near August 10. Taking a north-westerly direction it passed parallel with, but at a considerable distance from the Windward islands, where from August 11 to 13 the weather showed signs of great disturbance with violent squalls, that shifted to every part of the compass ; while at Martinique in particular, where

the most threatening signs appeared, the mercurial barometer sank to 29·60. On the 14th similar indications showed themselves at St. Thomas—rain, squalls, and thunder; while on the night of the 15th the barometer suddenly fell to 29·70, and a violent gust of wind from the north caused many of the natives to barricade their windows in anticipation of the worst. This state of things lasted till next day at noon, when the mercury rose and the sky cleared.

But by this time the cyclone, now only about a hundred miles to the east of the islands, had fully formed itself; and henceforth its course was only too clearly marked by the damage it caused among the shipping. From August 17 to 24 it passed north, with a westerly inclination, till it fell in with the course of the Gulf Stream, above Florida, and then followed that line, but gradually nearing the coast, up to Nova Scotia, where the ravage was tremendous, upwards of a hundred vessels having been either dismasted, or rendered total wrecks. Further north the cyclone seems to have expanded into an ordinary storm and disappeared.

These particulars I gathered from the captains of the injured vessels, some of which took refuge in this port. They are illiterate men, and not capable of furnishing exact details; but all agreed in describing the wind-current as having been from north to south by west, and so back by east to north; the lowest barometric indication I heard speak of was 29°.

The second cyclone originated in the Carribæan Sea itself, to the west of Barbadoes. Telegrams of threatening weather dated September 25 reached us at St. Thomas; and on the 26th the aspect of matters here was gloomy; the sky murky, especially to the south, with continued flashes of lightning, and a very heavy sea. But the hurricane did not touch Santa Cruz; its first long-shore visit having been made on the 28th at Haiti, where several small ships were lost, and much mischief done. Jamaica escaped; but on the 30th the whole southern coast of Cuba was ravaged from east to west, and many lives lost by sea and shore. From Cuba the cyclone continued to pass west till it reached the Mexican coast, which it skirted, then turned east, touching Havanna on October 4, Florida on the 7th, and then, following the Gulf Stream, was lost in mid-ocean. Its greatest fury was in the Gulf of Mexico itself, where the injury done to the shipping almost equalled that caused off Halifax by the gale of August 24.

Some disquietude has also been caused here at St. Thomas by the frequency of slight earthquake shocks, of which I counted five within a period of forty days. The two strongest occurred on July 22 and August 12; in both instances the movement appeared to pass from east to west; it was accompanied by a distinct rumbling sound. The shock of August 12 occurred at 8.15 P.M., and was within a few seconds followed by another, but slighter. In two instances, June 16 and August 27, a slight shock at this island had been preceded, about an hour and a half before, by a stronger one at Jamaica: so that the general direction of the movement must have been contrary to the apparent surface vibration from west to east.

I may add that the whole of this island is manifestly undergoing a gradual upheaval, as appears by the wave-worn rocks of recent date, but already two or three feet above water mark; sea-shells and corals left dry, and similar indications. Hence the artificial channel opened, for purposes of cleansing by means of the current thus established, between the south-western extremity of the harbour and the outer sea, and which is in itself a clean cut, twenty feet wide, through a narrow band of rock, has, since 1870, when it first was made, lost so much of its depth as scarcely to allow of boat-passage; and threatens at no distant period to become absolutely useless.

W. G. PALGRAVE

NOTES

THE well-known German serial, Poggendorff's *Annalen der Physik und Chemie* has now been in existence fifty years, and we are glad to see that practical recognition has just been taken of the striking fact that it has, during this long period, been under the sole editorial direction of Prof. Poggendorff, while printed and published by the same house in Leipzic. It was agreed, a short time since, by a number of friends of the learned professor, that they should relieve him of his editorial duties for one volume, and that this should be presented to him in honour of the occasion, as a "Jubelband," or Jubilee volume. The importance of the work done by M. Poggendorff and his *collaborateurs*, during half a century, through the *Annalen*, is sufficiently obvious to any who have taken an interest in the progress of physical science in recent years. The serial well reflects that enterprise, plodding industry, and philosophical insight, which mark original research in Germany; and the 156 volumes that have appeared (six of these supplementary) constitute an invaluable storehouse for any one desiring to prosecute new lines of investigation in the wide field of physics. We learn from the preface to the Jubilee volume (which we hope to notice at greater length) that the entire number of papers published in the *Annalen* hitherto is 8,850; and among the 2,167 authors who have contributed to its pages, we find the eminent names of Liebig, Magnus, Berzelius, Rammelsberg, Rose, Faraday, Brewster, Becquerel, Regnault, and many others. A work of this kind, as is truly remarked, unites those engaged in similar researches all over the world, into one large brotherhood of mutual assistance and regard. We congratulate the learned editor on the completion of such a long term of arduous and honourable service to Science, and heartily join in the wish that this Jubilee volume may be followed by many others edited by the "Jubilar" himself.

WE are given to understand that preliminary negotiations are on foot for the establishment of a central establishment for Ocean Meteorology in Germany. We may hope that when such a step is in contemplation, the work done by Herr von Freeden, who has for the last seven years conducted the Norddeutsche, lately called the Deutsche, Seewarte, at Hamburg, will meet with its full measure of recognition. The establishment in question has been maintained at the sole expense of the town of Hamburg, and has risen steadily from a small beginning to its present state of thorough efficiency, thanks, in great measure, to the energy of its director.

IN the review of Belt's "Naturalist in Nicaragua" by Mr. Wallace, p. 221, reference is made to the theory of the origin of cyclones propounded by the author in terms which might lead our readers to think that his views have been entirely unnoticed. Such is however not the case, and our attention has been drawn to Prof. Reye's work "Die Wirbelstürme, &c., in der Erd-Atmosphäre, mit Berücksichtigung der Stürme in der Sonnen-Atmosphäre" (Hanover 1872), in which Mr. Belt's views are discussed at some length, with an expression of regret that so little attention has been attracted to them.

THE Turners' Company of the City of London have acknowledged the debt which their Art owes to pure scientific research, by presenting the freedom and livery of that Company to Dr. John Phillips, F.R.S., Professor of Geology in the University of Oxford, in recognition of his introduction into architecture of the various materials which constitute the rocks of England. Mr. John Jones, a member of the livery, said the City of London was always willing to bestow its honours on successful generals, conspicuous statesmen, and devoted patriots—and the tributes were honourable to both sides—but that was the very first occasion on which they had offered

the like distinction to a patient, observant, and reflecting student of nature. In doing so they, at the same time, offered their thanks to the University of Oxford for having included physical science in its curriculum of education, and they celebrated, so to speak, the alliance in that city of art and science.

THE recent appearance of a French translation of the last edition of Prof. Haeckel's world-known "Natürliche Schöpfungs-Geschichte;" or, "History of the Creation of Organised Beings," will give a larger number of students the opportunity of mastering its valuable contents. How is it that no translation has yet appeared in our own language?

MEN of Science will be glad to learn that the Premier has recommended to the Queen for a pension of 100*l.* on the Civil List Mrs. C. L. Basevi, the mother of Captain Basevi, who lost his life on the Thibet frontier of India, whilst engaged in exploring the mountain passes, and pursuing other scientific inquiries.

DR. JOHN ANDERSON, Director of the India Museum of Calcutta, is at present in this country on two years' leave of absence. He is, however, devoting his holiday to working out the results of the Yunan Expedition, to which he was attached as naturalist three years ago. The Linnean Society has undertaken their publication, which will embrace a full description of the anatomy of the fresh-watar Dolphin of the Ganges (*Platanista gangetica*), as also of the still rarer fresh-water Cetacean of the Irawady *Orcella flumenalis.*

ON Friday, April 10, M. Leverrier gave a *soirée* at the National Observatory of Paris, in honour of the delegates of the French Scientific Societies. The weather was unfavourable, but the exhibition of scientific instruments was very successful indeed. Many new electrical apparatus were exhibited for the first time. No gaslight was used; an electrical lamp by Perrin being the only lighting medium. A lecture was delivered by M. Wolf, on phenomena of polarisation, illustrated by optical experiments by Dubosc.

THE Commissioners for the Construction of a Universal Metre are at present superintending the fabrication of the definitive standards, which will be distributed amongst the several Government delegates to the International Congress. The operations are executed at Paris, in the laboratory of the School of Mines.

M. ALLUARD, the originator and director of the Puy de Dome Observatory, has announced that an inauguration will take place next September. Invitations will be sent to England as well as throughout France. The cost of the building will be something more than 4,000*l.*, and the work is fast advancing. The Puy de Dome Observatory will be connected by an electric telegraph with another observatory built at Clermont, and which is already in operation; the difference of level between the two stations will be more than 4,000 ft. When excavating on the top of the mountain it was discovered that a large building about 80 yards in breadth had existed on the spot. It is supposed to have been a Roman fortress and temple; a number of Roman medals were discovered.

M. COLLADON, the Geneva physicist, has published an essay on the subject of turning poplars into lightning conductors. He proposes to insert in the lower part of the trunk a metallic rod, which he connects with the earth by a chain, so that the fluid cannot leave the tree to dart at any object placed within a short distance, which at present is very often the case.

M. SAINTE-CLAIRE DEVILLE, appears to have been again successful in his weather predictions. We shall give details in our next on the important question.

FRENCH officials are organising a fusion between the postal and telegraphic officials.

A REMARKABLE instance of the rapid spread of a new pest is furnished by the history of *Puccinia Malvacearum*, a fungus parasitic on various plants belonging to the natural order Malvaceæ. Its native country is probably Chili, where it was discovered by Bertero on *Althæa officinalis*. Its first appearance in Europe was in April 1873, on *Malva sylvestris*, in the neighbourhood of Bordeaux, and in August it had extended to several other plants of the same order in the botanic gardens of that town, but, singularly enough, was not found on *Althæa officinalis*, several other nearly allied genera being also exempt from its attacks. In Germany it was first discovered in October, while in this country it was detected in the summer of 1873, nearly simultaneously in many widely-dispersed localities, as Exeter, Salisbury, Chichester, Shere in Surrey, the neighbourhood of London, Eastbourne, Pevensey, Sandown in the Isle of Wight, and Lynn, and threatens to be exceedingly destructive to the hollyhocks.

TWO remarkable instances of protective mimicry have lately been described by Prof. Gerstaecker, both among parasitic Hymenoptera, and having apparently for their object to facilitate the access of the parasite to the nest of the host for the purpose of laying its eggs. *Crypturus argiolus* differs altogether in colour and marking from the allied species of Ichneumonidæ, and assumes even in the minutest details those of the wasp *Pollistes gallica*, on which it is parasitic. To so great an extent is the mimicry carried out that even variations characteristic of particular districts are reproduced, the area of distribution of both insects being very wide. In the second case it is the colour and markings of a wasp, *Vespa germanica*, that are imitated by its parasite *Conops diadematus*.

AT the east end of the Palm House at Kew there is a fine specimen of the rare *Agave univittata* coming into flower. Near it stand the still stately flowering stems of two allied plants, *Agave jacquiniana* and *Fourcroya gigantea*.

THE French conscription enables us to study annually the composition of the growing generation. Last year from about 300,000 young men passing the examination for recruiting the army, 16,000 were discharged on account of having lost their brothers or having had them wounded in the war, 11,400 as being sons or grandsons of widows, or of people above seventy years of age, 1,600 elder brothers of orphans, 16,000 as not being strong enough, 10,000 for lameness, 8,000 not tall enough, 4,000 from having defects of the bowels, 3,000 of the eyes, 2,700 organs of generation, 2,000 bad teeth, 1,000 as being mute, &c., 1,200 epileptics, 600 deaf, 80 blind, 1,000 phthisic, &c.; in all, 89,000 were left out of the contingent.

IN the report furnished us by the Secretary of the Anthropological Institute (vol. ix. p. 345) of Mr. Distant's paper On the Mental Differences between the Sexes, the author is said to have referred to the "now moderately well established fact that in primitive races the *hair* of women approximates more closely to that of man than obtains in a higher state of civilisation." Mr. Distant in his paper referred to the *brain*, not to the *hair*.

A QUICKSILVER mine is said to have been discovered at Exeter.

M. GASTON TISSANDIER is publishing at Hachette's an excellent popular work on "Photography," with numerous illustrations. One of them shows Charles, the inventor of the gas balloon, photographing the silhouette of one of his pupils on a paper sensitised with one of the salts of silver, more than twenty years before the discovery of Daguerre.

IN his recent paper On the Placentation of the Sloths, published in the Transactions of the Royal Society of Edinburgh, Prof. Turner has done much to diminish the value of placental charac-

ters in the classification of the higher mammalia. In *Cholœpus hoffmanni* the placenta is dome-like, multilobate and genuinely deciduate, more like that found in the Primates and Man than in any other order, so much so that the author remarks "from the point of view of the descent hypothesis, it is possible that between the Sloths and the Lemurs genealogical relations may exist," and "now that I have called attention to the evidence of affinity with these higher mammals it is not improbable that other features of resemblance may in time be recognised."

BESIDES the ornithological papers which the late Mr. H. D. Graham contributed to the *Naturalist*, he left in the form of manuscript notes the larger and more interesting portion of the ornithological work which he had undertaken in the islands of Iona and Mull during the latter part of his life. These, together with the papers referred to, are being prepared for publication by Mr. R. Graham, to whom the whole of Mr. Graham's ornithological correspondence was originally addressed.

WE learn from the *Times* that M. Giard, Professor of Natural History at Lille, has been making an interesting inquiry into the zoology of the French shore of the Straits of Dover. Many uncommon species of crustaceans, ascidians, and mollusca have been obtained, which will be fully described before the Scientific Congress which is to be held at Lille during the ensuing summer.

WE are glad to see that Government have at last begun to carry out their agreement with the Trustees of the Bethnal Green Museum, by laying out the vacant space around the Museum in gardens for the recreation of the people.

IN the House of Commons, on Tuesday, Mr. Cowper-Temple obtained leave to bring in a Bill to remove doubts as to the powers of the University of Scotland to admit women as students, and to grant degrees to women.

THE month of April is a famous one in the annals of the French Academy for centenary anniversaries. M. Biot was born in April 1774, almost the same day when Louis XIV. died. M. Biot was a member of the Academy of Sciences and Academy of Inscriptions. It was also in this month that Maupertuis published the first French mathematical essay in which the Newtonian theory of attraction was accepted. Lavoisier was engaged in making observations on solar heat with an immense lens at the cost of one of the richest financiers of the time.

THE last (received) number of *Annales Hydrographiques*, contains details of the navigation of the Magellan Straits by the corvette *L'Atalante*, with tabulated meteorological observations made during the 13 days of the passage.

THE continuation of Adolph Schaubach's "Deutschen Alpen" (pp. 641 to 850) is brought up to the end of the Trias. The writer is Dr. H. Emmrich.

THE last number of the *Annales des Sciences Géologiques* contains a continuation of M. Oustalet's researches on the fossil insects of the Tertiaries of France. This second instalment of 112 pages is devoted to Aix-en-Provence.

THE recently published Report of the Department of Mines of Nova Scotia shows that the total produce during the year from collieries was 1,051,467 tons. Of these 264,000 tons were sold to the United States, 6,000 to Great Britain, 214,000 were used in Nova Scotia, and the rest were sold to Quebec, New Brunswick, Newfoundland, Prince Edward Island, West Indies, and South America.

A STAINED glass window has just been placed in the parish church of Folkestone to the memory of Dr. William Harvey, the discoverer of the circulation of the blood, who was born in the town in 1578. It is the gift of the medical profession, more than 3,000 of whom have contributed towards the cost.

IN view of the great economical value of the fur seals of Alaska, and of the importance of a thorough knowledge of their habits and movements, with reference to the command of the market of the world, it is proposed by the United States Treasury Department to send some one to the North Pacific Ocean for the purpose of obtaining materials for an exhaustive report on the subject. It will be remembered that these seals, almost to the number of millions, visit the St. George and St. Paul islands of the Pribylov group every summer season for the purpose of bringing forth their young, and that on this occasion a company chartered by the United States is allowed to capture 100,000 annually. What becomes of these seals after they leave the islands is entirely unknown, although congregated there in such numbers for several months. A few are taken in the spring and fall as they pass along the coast of British Columbia and Washington Territory, but whether these are related to the Pribylov army or not is uncertain. The same species is found to a limited extent on the Asiatic side of the ocean, but no very extensive captures are made. Should this commission be appointed, it is to be hoped that some of these problems may be solved, and that we may not remain longer in ignorance of the general natural history of so important an animal, which furnishes a revenue to the United States of about 300,000 dols. a year, while a profit of almost millions is made by the company which has charge of the interest.

THE additions to the Zoological Society's Gardens during the last week include a Vigne's Sheep (*Ovis vignei*), from Asia, presented by Capt. Archibald; a Sambur Deer (*Cervus aristotelis*) and an Axis Deer (*Cervus axis*), from India, presented by the Hon. Justice Jackson; two Cut-throat Finches (*Amadina fasciatus*) and two Paradise Whydah Birds (*Vidua paradisea*) from West Africa, presented by Lieut. J. H. Hearne, R.N.; a Rufous-necked Weaver Bird (*Hyphantornis textor*) from West Africa, presented by Mr. Hincks; two Negro Tamarins (*Midas ursulus*) from Rio de Janeiro; a Common Rhea (*Rhea americana*) from Buenos Ayres; a Brazilian Teal (*Querquedula brasiliensis*), and a Bahama Duck (*Pœcilonetta bahamensis*) from South America, purchased.

THE PHYSICAL HISTORY OF THE RHINE*

THE attempt to unravel geological history, as far as the stratified rocks are concerned, and all the igneous rocks connected with them, simply resolves itself into this:—an effort to realise the physical geography of different geological epochs, to make out the relations of the sea and of the land with its plains and mountains during these periods, the history of the rivers and lakes of the time, and to know as much as may be known of all the creatures and of all the vegetation which inhabited the water and the land.

I am now going to attempt to explain the history of that great historical river the Rhine. Every river has a definite history, if we could clearly make it out. Every river has had a beginning, and it is quite possible—if we have the skill—to find out when, by special changes in physical geography, such and such a river began to flow, and why it flows in such and such a direction.

In various publications I have attempted to show what is the history of some of the rivers of England; as, for example, the history of the Severn and of the Thames, and I think I have been able to prove that the Severn is a much older river than the Thames; and, on similar principles, I now propose to attempt to reveal to you the history of the Rhine and its

* A Lecture delivered at the Royal Institution on Friday evening, March 27, by Prof. A. C. Ramsay, LL.D., V.P.R.S., Director-General of the Geological Survey of the United Kingdom, &c.

valley from early times to the present day. For many years I had an ambition to work out the history of the Rhine. I have known it now for more than twenty years; going often up and down the river, and sometimes for weeks—once for months—living on its banks. For the last thirteen years, unfortunately, I never was able to return to it, but the problem I had marked out for myself remained in my mind, and last year I went, and worked it out, with the result which is now to be explained.

First, with regard to the great main features of the Rhine valley; it has its sources, as every one knows, in the mountain regions of Switzerland, one of which is in the valley of the Vorder Rhine, and the other in that of the Hinter Rhine, both glacier regions. The ground where it rises is from 7,000 to 8,000 feet above the level of the sea. From thence it passes to the Lake of Constance, 1,305 feet above the sea; and beyond, in a westerly direction, by Schaffhaussen to Basel, where, at the bridge, the level of the water has an average height of about 803 feet above the sea. Thence it flows down the great upper plain of the Rhine northerly between the Schwartzwald and the Vosges to Mainz, where the height of the river is about 531 feet above the level of the sea, thus showing a fall between Basel and Mainz of about 272 feet, which gives an average slope for the running of the river of about 3 ft. 1½ in. per mile. Beyond that, proceeding to the north, we come to the deep gorge of the Rhine, passing between high cliffy banks, which begin at Bingen and continue down to Rheineck in the neighbourhood of the Siebengebirge, for a distance of from 60 to 70 miles, according as you take into account all the windings or omit them. Beyond the Siebengebirge there is a plain, partly formed of the delta of the river, which gradually merges into the great flats that extend all the way from Calais to the Elbe.

Now the main question I have to bring before you is, first, what is the origin of the great upper plain that lies between Basel and Mainz? and, secondly, what is the origin of the gorge between Mainz and Rheineck? Why are they there, and by what means have this plain and this gorge assumed their present forms?

When you stand above Bingen, or, better still, if you ascend the Taunus and look southerly, and consider the narrowness of the gorge and the great hilly barrier of rock that must once have extended at Bingen across the lower end of the plain, the impression is irresistibly conveyed to the mind that before that gorge was opened a vast lake must have reached all the way from that barrier to where Basel now stands, covering the great plain that lies between the mountains of the Vosges and those of the Schwartzwald. And so thoroughly has this idea taken possession of the popular mind, at least of those who have at all considered the subject, that we find this statement made in some of the Guide Books of the time, and notably by Baedeker, where it is stated that a lake must have covered the whole of that vast plain, 170 miles in length, at a comparatively recent period. It is a very obvious theory and has much to recommend it, for it seems so clear that, before the gorge was opened, all that plain must have been covered with a sheet of water, and it is hard to realise that such has not been the fact. When I first entered on the subject I was impressed with this idea, and I began to cast about and endeavour to find a reason for the scooping out of the gorge, and for the consequent drainage of the supposed lake.

Having years before written a paper on the origin of the lake basins of Switzerland, North America, and other parts of the world, and having attributed the formation of many of these, but by no means all of them, to the action of glacier-ice during the glacial period, my first impression was that ice might have had at least something to do with the scooping out of the great valley that lies between the north flanks of the Jura, the Schwartzwald, the Vosges, and the Taunus. But while slowly passing up the river, and searching for proofs which might either confirm or contradict this view, I was soon obliged to give up the idea that glacier-ice had anything to do with scooping out the great hollow. For on one side—that of the mountains of the Schwartzwald—I found that none of the glaciers of that region (and there are proofs that glaciers once existed there) even extended well down into the valley of the Rhine. And on the opposite side of the Rhine Valley, that of the old glacier region of the Vosges, I found no proof that they ever extended down so far as the plain. There is also no proof that the glaciers of the great glacial epoch of Switzerland ever extended as far north as Basel. Neither are there any signs of erratic blocks or other kinds of moraine matter on the plains or hill-slopes about Bingen, which one might expect to find there had the whole of the great plain of the Upper Rhine been once filled with glacier-ice. Therefore this theory, which I had not definitely formed, but which I surmised might possibly have had something to do with the subject, entirely melted away, and other hypothetical views along with them, and I was obliged to begin anew.

Accordingly I went to Switzerland, and with the help of friendly Swiss geologists, examined part of the Miocene or Middle Tertiary rocks between the Oberland and the Jura.

To make the rest of the subject clear, I must now say a few words about the origin of mountain chains. Most people are familiar with the outlines of the nebular hypothesis. The whole solar system was once in a nebulous state, and as this nebulous mass revolved in space, portions of it were thrown off, and one of these consisted of the matter which, by and by, resolved itself into the present earth. This nebulous fluid, in virtue of gravity, by degrees condensed more and more, and, passing through what we may call the molten state, in the course of time began to assume a solid form, and a hard outer crust was at length produced which enclosed a highly-heated fluid mass within. This crust, which continued to thicken in consequence of radiation of heat, because of the law of gravitation, was ever drawn towards the centre of the earth. By this process the circumference of the earth necessarily became less, and that consolidated rocky sphere which formed the outer shell of the earth was forced to readjust itself so as to occupy a diminishing area. Thus it happened that while some parts sank, other parts of the crust were crumpled, and relatively raised higher than other portions of the crust that still retained their original curves as part of a sphere.

This hypothesis, which, as far as I know, was first propounded by Elie de Beaumont, may be looked upon as the origin of mountain chains. What began in the earlier and prehistoric times of geological history, seems to have been going on steadily down to the present day, and thus it happens, that geologists can prove mountain chains to be of very different ages, and that, of whatever age they may chance to be, the strata that compose them are found to be bent and contorted. This contortion of strata took place simply from that shrinking of the earth's crust which was the natural result of radiation of heat into outer space. Portions of the crust more or less gave way to lateral pressure, while other parts of the great spheroidal curve more or less retained what we call horizontal or nearly horizontal position.

In this way it happened that at a certain period of geological history which preceded the formation of the Miocene rocks in the region now occupied by the Alps, a disturbance of the earth's crust took place, due to shrinkage of the general mass, of such a nature that the Alpine strata were thrown into highly-contorted forms, and a great mountain range of pre-Miocene age was the result. On the north of these mountains the Miocene strata began to accumulate in great lakes. But these lakes lay so near the level of the sea, that every now and then, by depression of the land, they sometimes sank a little below the sea, and the sea invaded the area formerly occupied by fresh water. The result was that in Switzerland, between the Oberland and the Jura, and much farther north, the Miocene strata which are hundreds and sometimes thousands of feet thick, are now found to consist of interstratifications of marine, brackish, and of fresh-water beds. At that time the Jura had no existence. It is the result of a later disturbance of the crust of the earth, and thus it happened that all the Miocene waters in which were deposited the strata that now lie between the Oberland and the Jura originally spread northwards far across the area now occupied by the Jura, and into the district of the present plain of the Rhine between Basle and Bingen.

It is hard to realise the scenery of that time; but partly by an effort of imagination, and partly by special knowledge of the fossils contained in the rocks, it is possible to form some conception of the appearance of the country.

On the east and west of the great valley were mountainous ranges now called the Schwartzwald and the Vosges, while far to the south rose the high mountains of the pre-Miocene Alps, more or less covered with a forest vegetation. On the banks of the lakes there grew in an early stage of the Miocene epoch vast numbers of forest-trees and evergreen shrubs, of genera such as are now characteristic of tropical and sub tropical countries; figs and vines, many species of Protoaceæ analogous to those that still grow in the Australian continent, together with cypress, sequoia, cinnamon, fan palms, and palmettoes, ferns, hornbeams, and buckthorns, all of genera still familiar, but mostly if not altogether of extinct species. At a later date this vegetation partly

died out, and was replaced by plane-trees, poplars, elms, willows, and maples; while cinnamons, figs, vines, laurels, and Protoaceæ still continued to flourish. In the woods, on the meadows, and in the waters respectively, the *Mastodon angustidens*, the rhinoceros, Chæropotamus, Dichobune, deer, Dinotherium, hippopotamus, crocodiles, salamanders, fish, and numerous other creatures roamed at pleasure, while the air and the land were tenanted by dragon-flies, ants, beetles, and other insects, of which more than 800 species have been distinguished.

I now come to the chief part of this lecture, which is to account for the origin of the Rhine: for at that earlier time the Rhine had no existence in this valley, and indeed there is proof that instead of the main drainage of the area, flowing from south to north as it does now through this valley, the waters drained from north to south; and the pebbles of the Schwartzwald, instead of being carried north as they are now, were carried southward by minor rivers, and found their way into Switzerland, thus helping to form some of the conglomerate rocks of which the Miocene strata of Switzerland to a great extent consist.

Not only had the Rhine no existence then, but the romantic gorge of the river, with which so many are familiar, had no existence either. It has been customary sometimes to attribute the formation of that gorge to violent disturbance and fracture of the strata, by which the waters were allowed to escape from south to north. I have no belief in such violent disturbances having any place in the modern economy of the world, nor yet in such cataclysmal action having ever affected the ancient world, as far as it is in the power of geologists to trace back events from the present day to the oldest known geological periods.

After the Miocene epoch had lasted for a long period of time, there occurred another disturbance of the European region, and of much of the rest of the world besides, though it is only the Alpine region and the countries north of the Alps that we have now to deal with. This second disturbance of the Alps produced a great upheaval of the Miocene strata. All the Miocene lakes that occupied the old lowlands of Switzerland and extended far east into what is now the Austrian dominions and into Asia itself,—all that area, as far as the Alps are concerned, was gradually heaved up high above the level of the sea, and those beds of conglomerates, sandstones, and marls that form the lowlands of Switzerland, and all across what is now the Jura, were disturbed to such an extent that the strata now forming the Righi and Rosberg and other sub-Alpine hills were partly raised to a height of at least 5,800 ft. above the level of the sea, and probably much more. The lower parts of Central Switzerland, about the Lake of Geneva, the Lake of Constance, and Neufchatel, still stand at heights of from 1,200 ft. to 1,300 ft. above that level. Then the range of the Jura first rose up to form a mountain-chain, and this is the proof of these disturbances. First we know that the Miocene rocks originally lay all the way from the Alps to the Taunus in flat-lying strata. During that period a vast quantity of Miocene pebbles were carried into the lakes, which were by and by consolidated into an exceedingly coarse conglomerate. Anyone who has ascended the Righi will remember that nearly the whole of it is formed of this coarse conglomerate, proving the prodigious amount of waste that the Alps underwent during the Miocene period. When we consider the amount of this waste, even though the waters of the Miocene period lay but little above the level of the sea, still in my opinion it is probable that the Alps themselves were then quite as high, if not higher, than they are now. For the prodigious amount of waste proved by the conglomerate, indicates the removal of an enormous amount of material from the pre-Miocene Alps.

After the disturbance which raised the Jura and the Miocene strata of the lowlands of Switzerland, this is what took place. Along with the contorted secondary strata of the Jura, the Miocene beds that previously covered them were thrown into a number of anticlinal and synclinal curves, and the greater part of the Miocene material over that area having since been removed by denudation, only a few outlying fragments of these strata remain, left in those wonderful upland basin-shaped hollows of the Jura, which still attest the original continuity of the Middle Tertiary deposits all the way from the base of the pre-Miocene Alps to the northern base of the Taunus.

When the post-Miocene disturbance of the whole of this area took place the general effect was, that much of the Swiss Miocene area was contorted and raised high into the air, while between the Jura and the Taunus, the equivalent strata were simply heaved up and tilted so as to form a long inclined plain sloping northerly and lying between the Vosges and the Schwartzwald, and the surface of which may have been about 1,200 or 1,300 ft. above the present level of the sea where Basel now stands, and about 1,000 to 1,100 ft. high where the opening of the gorge now begins near Bingen.

Before this wide-spreading disturbance took place, the Rhine had no existence, for up to that time such small rivers as occasionally ran in the more ancient Miocene valley flowed partly south. But when the inclined plain was fairly completed, the result in the long run was that for the first time the great general drainage of the area began to run from south to north, and the Rhine was established flowing at a height which we may roughly speak of as having been 500 ft. higher than now, because at that time all the great valley between Basle and Bingen was filled to that height with Miocene strata. We know this to be a fact by an examination of the valley on the right hand and the left, from Bingen towards Basle, for every here and there, we find table-shaped hills formed of flat-lying Miocene strata, which border the present alluvial plain of the Rhine and abut upon the more ancient mountains on either side. The history revealed by this fact is plain to anyone accustomed to reason on geological phenomena. The strata forming scarped slopes on opposite sides of the valley were once united, and their early continuity has been destroyed, simply by long-continued watery waste and denudation. They are indeed only the relics of an older phase of the physical geography of the district, when the surface of the plain stood about 500 ft. higher than it does at present.

Now when the Rhine first began to flow, the river then passed through a high upland valley with gently sloping sides that lay between the Taunus and the Hundsruck, and which in no manner resembled the precipitous cliffs that now bound the Rhine in the gorge below Bingen. The bottom of part of this old upland valley still forms a narrow terraced plain, immediately above and beyond the edge of the cliffy gorge of the Rhine. It is not always continuous on both sides of the gorge, but enough of it remains to attest its original continuity at heights of from 400 to 500 ft. above the present level of the river. Now what I wish to persuade you of is this, that the Rhine flowing in this valley by degrees began to cut out its own gorge, and that it was not produced by fracture. Every running river is busy eroding its channel, especially where the ground is at all steep. That is one of the main functions of running waters. They are constantly deepening their channels and carrying the sediments so formed from higher to lower levels, till in the course of time they find their way into lakes or the sea.

When we first enter the gorge of the Rhine, going southward, one feature that strikes the geological observer is the constant recurrence of this old terrace backed by the hilly country beyond. On the left bank, overlooking Bingen, the flat-topped spur of the Rochus-berg, about the same height as the tops of the neighbouring Miocene tabular hills, first strikes the eye. When fairly within the gorge below Niederheimbach, beyond its upper edge the old river plain is seen gently sloping to the north, while the sides of the gorge itself is seamed by numerous gullies worn by occasional torrents since the great ravine—a kind of canon—has been cut down to its present level.

At Welmich, below Niederheimbach, looking down the river, the edge of the terraced plain is seen receding northward in long perspective, and at Salzig, still further down, the features so well shown near Niederheimbach are again reproduced. The same outline occurs again and again all down the river between Bingen and Coblenz, and equally below Andernach, as for instance at Rheineck. Finally, above the Siebengebirge, just about the mouth of the gorge, looking up the river, the long eastern hills sloping to the river end in a terrace corresponding in general height and outline to those already mentioned. The general conclusion to be drawn from these observations is that at heights of from 450 to 500 ft. above the present river this ancient river terrace has a persistent gentle slope from south to north which approximately corresponds to that of the existing river.

The inference is plain: that formerly throughout the length of what is now the gorge the river flowed at that high terraced level, at a time when the plain above the gorge was so deeply filled with Miocene strata that the level of the river, where Mainz and Bingen now stand, was as high as the upland terrace that crowns the gorge between Bingen and Rolandseck. By degrees the river began to excavate the gorge, and slowly cutting deeper and deeper, and at the same time winding and ever changing its channel through the great plain between the Jura and the Taunus, by slow gradation it wasted away the surface of that plain more and more, and the matter won from that

surface was carried down through the gorge to be added to the old delta of the river. At last the major part of the Miocene rocks that partly occupied the plain were worn away and the plain has been reduced to its present temporary level; while the terraced hills on either bank still remain to attest the amount of watery degradation that the area has undergone.

So much for the scooping out of the valley. But there is another point which I would like to impress upon you. On each side of the Rhine there are important tributary rivers. Thus, for example, above the gorge we have the Maine, the Neckar, the Kinzig, the Elz, and other streams, flowing through deep steep-sided valleys; and these rivers have from a very early period been tributaries of the Rhine. It follows, then, that when the level of the Rhine was 400 or 500 ft. higher than at present the levels of the bottoms of these rivers must also have been 400 or 500 ft. higher than at present; and therefore, just in proportion as the great valley of the plain of the Rhine was being cut down and lowered, so in proportion must the valleys in which these rivers run have gradually been deepened. When we come to the gorge the same kind of argument applies to the Moselle and other tributaries of the Rhine.

I have elsewhere attempted to show that at one time the Moselle ran as high as the top of the table-land that now bounds it on each side. Everyone who knows that river is aware that, though it looks so hilly when we go up the stream in a steamboat, as soon as we reach the edges of the slopes on either side we are on the top of a great table-land intersected by numerous valleys, so that before the gorge of the Rhine was formed the Moselle ran at as high a level as the ancient Rhine; and just as the gorge of the Rhine was being deepened, so the Moselle was by degrees also enabled to deepen its channel. The same was the case with other rivers, right and left of the Rhine; and by applying this principle to the other great rivers of Europe we may hope in the long run to explain the physical history of all the systems of drainage of all parts of the continent.

One other point remains to be stated with regard to the physical history of the Rhine. Geologists well know that in older times the glaciers of Switzerland were on an immensely larger scale than at present. Large as they appear to us at the present day, they are of pigmy size when compared with their magnitude at a comparatively late period of the world's history. The Rhone glacier then spread across all the area now occupied by the Lake of Geneva, till it abutted on the Jura; and the old Rhine glacier extended all over the Lake of Constance, and reached at least half way from Schaff haussen to Basle. The body of water which flowed directly from such glaciers must have been very great, and enormous must the moraines have been that were shed from the ice-sheets. From an examination of the pebbles that form the superficial gravel on the present plain of the Rhine below Basle, it is certain that a large portion of them have come from the Alpine regions. Such a great moraine as was shed from the western edge of the old glacier of the Rhine was constantly being attacked by the waters that flowed from its end, and thus by degrees pebbles were carried onward into the plain. The result is that a large part of the gravels of the Rhine is simply the waste of old moraines shed from the glaciers of Switzerland, added to by material carried down by the streams of the Vosges and the Schwartzwald, also partly derived from the moraines of ancient glaciers on a smaller scale.

Last year it was my lot to deliver here a lecture on the history of old continents, and I attempted to show that one old continent in particular retained its identity through a very long period of geological time; that from the close of the Upper Silurian period, all through the Old Red Sandstone and Carboniferous periods, through the Permian and New Red Sandstone epochs, over great part of what is now Europe, that continent, with many physical changes, still retained its identity. Such a vast continent remaining through all those geological periods implies a succession of epochs of time, which, as far as years and cycles of years are concerned, the mind has as yet only hints of data which some day may help us to grapple with such a problem, and not till astronomy comes more boldly to the help of geology, may we begin to hope for the solving of the problem of the actual value of geological time. However that may turn out, it is certain that during the long continental epoch alluded to there were, over and over again, many changes in physical geography far greater than that petty change which I have been endeavouring to sketch out to-night. The floras and faunas of the world in that old time changed, not in the minor degree I have been speaking of to-night, but were more completely remodelled again and again in great part, even generically. Mountain ranges rose, glacial periods intervened and passed away. Great lakes, sometimes fresh, sometimes salt, appeared and were obliterated by great terrestrial changes. At one time vast lakes, like those of the heart of Africa and North America, covered prodigious areas of land; at another, equal or larger areas were covered by salt lakes as large as the Caspian and the Sea of Aral. And when you think of the continental episode in the modern geological history of Europe to which I have drawn attention, you will see how small it really is, though it may look large to our minds, compared to the old continental epoch of which I spoke last year. This you may depend upon, that though to the superficial eye it may seem as if the world had always been going on just as it is doing now, and that through all time to come it will go on just the same, with its mountains, valleys, rivers, lakes, and seas, yet it is none the less certain that changes, such as I have described to-night, are but the forerunners of other mutations as great, aye, and far greater, that will take place in the future. Just as there is as yet no certainly measured limit to the geological time of the past, so also we know of no measurable limit to geological time to come. But why should I keep you with words such as these, when I may convey a whole chapter in physical geology, condensed into eight lines, by the greatest of our living poets :— .

There rolls the deep where grew the tree.
O Earth, what changes hast thou seen!
There, where the long street roars, hath been
The stillness of the central sea.

The hills are shadows, and they flow
From form to form, and nothing stands:
They melt like mist, the solid lands,
Like clouds they shape themselves and go.

SCIENTIFIC SERIALS

In the *Journal of Botany* for March, the editor, Dr. Trimen, commences a series of useful articles (which is continued in the April number) on the Botanical Bibliography of the British Counties, being a list of country and district floras arranged topographically. The other paper of greatest interest in this number is one of a kind of which this very useful journal has now published a considerable number, and which may ultimately throw considerable light on some of the problems connected with the distribution of plants, On the Flora of the Leeds and Bradford District, by J. A. Lees.—The number for April commences with an article of some importance in systematic botany, A Revision of the genera *Dryobalanops* and *Dipterocarpus*, by Prof. Thiselton-Dyer, in which a number of new species are described, including two belonging to the previously monotypic genus *Dryobalanops*, and illustrated by a plate (two more being promised in the next number). The editor also gives in this number one of the most valuable specialities of the journal, his list of New Species of Phanerogamous Plants in periodicals published in Great Britain during 1873.

The *Scottish Naturalist* for April publishes a number of papers on almost every branch of Botany and Zoology, including one on Geology, of more or less interest to Scottish naturalists.—Mr. J. A. Harvie Brown proposes the establishment of a Natural History Publication Society, something on the model of the original plan of the Ray Society, for the purpose of publishing original papers on Natural History, principally on Mammalia and Aves, and for reprinting in fac-simile rare and useful tracts, pamphlets, &c., on the like subjects.—We have also further instalments of the lists of the Lepidoptera and Coleoptera of Scotland, by Dr. Buchanan White and Dr. D. Sharpe. This quarterly magazine seems to fill a most useful place in forming a channel of intercommunication between naturalists north of the Tweed.

Memorie della Soc. degli Spectroscopisti Italiani, December. This number contains a paper be G. Lorengoni, On the Observation of a partial eclipse of the sun in May last, observed by the spectroscopic and direct view methods. He discusses at length the advantages and accuracy of each method, and concludes that the former method is the best of the two.—G. de Lisa gives a table of spots on the sun, observed at Palermo in December, giving a mean of about eight spots each day.

The January number contains a note that a new Spectroscopic Station has been established at Turin, and an equatorial by Fraunhofer has been erected there.—Prof. Draper contributes a

paper on his beautiful diffraction of spectrum photographs, similar to the account of the same in NATURE some weeks ago.

Astronomische Nachrichten, No. 1,978.—M. M. Henry gives the elements of planet (126) Velléda, epoch 1874, January, 0·0 Greenwich M.T.

$$\begin{aligned} Mo &= 149^\circ\ 55'\ 51''\cdot 1 \\ \Pi &= 347^\circ\ 49'\ 11''\cdot 3 \\ \Omega &= 23^\circ\ 10'\ 12''\cdot 8 \\ i &= 2^\circ\ 56'\ 10''\cdot 6 \\ \phi &= 6^\circ\ 5'\ 31''\cdot 4 \\ \mu &= 930''\cdot 9792 \\ \log.\ a &= 0\cdot 3873777 \end{aligned}$$

Leopold Schulshof gives the following elements of the comet discovered by Winnecke in February last :—

$$\begin{aligned} T &= 1874,\ \text{March},\ 9\cdot 95342\ \text{Greenwich Time} \\ \Pi &= 300^\circ\ 36'\ 42'' \\ \Omega &= 31^\circ\ 31'\ 18''\cdot 2 \\ i &= 58^\circ\ 17'\ 14''\cdot 5 \\ \log.\ q &= 8\cdot 642852 \end{aligned}$$

The star in Perseus RA $2^h\ 13^m\ 56^s$ Dec. + 58° 1′ 53″·5 has been observed by A. Krüger to have varied from 8·5 mag. to 10 mag. in November 1872, and to have increased to 8·5 again in January last.

SOCIETIES AND ACADEMIES

LONDON

Geological Society, March 25.—John Evans, F.R.S., president, in the chair.—The following communications were read : —On the Upper Coal-Formation of Eastern Nova Scotia and Prince Edward Island, in its relation to the Permian, by Principal Dawson, F.R.S. The author described the Carboniferous district of Pictou county as showing the whole thickness of the Carboniferous system arranged in three synclinals, the easternmost consisting of the Lower series up to the Middle Coal-formation, and including all the known workable Coal-measures in the district—the second towards the west of the middle and the lower part of the Upper Coal-formation—and the third showing in its centre the newest beds of the latter. On the north the bounding anticlinal of the first depression brings up the New-Glasgow Conglomerate, which contains boulders 3 ft. in diameter, often belonging to Lower Carboniferous rocks, and represents the upper part of the Millstone-grit or the lower part of the Middle Coal-formation. The author regards this as representing an immense bar or beach, which protected the swamps in which the Pictou main coal was formed. The succession of the deposits above the Conglomerate was described in some detail as seen in natural sections. The Upper Coal-formation, as shown in the section west of Carribou Harbour, consists of—(1) Red and grey shales, and grey, red, and brown sandstones ; and (2) Shales, generally of a deep red colour, alternating with grey, red, and brown sandstones, the red beds becoming more prevalent in the upper part of the section. In Prince Edward Island beds apparently corresponding to these are found, and also gradually become more red in ascending. These are overlain, apparently conformably, by the Trias. The author gave a tabular list of 47 species of plants found in the Upper Coal-formation of Nova Scotia and Prince Edward Island, and stated that all but about ten of these occur also in the Middle Coal-formation. The number of species decreases rapidly towards the upper part of the formation ; and this is especially the case in Prince Edward Island, some of the beds in which are considered by the author to be newer than any of those in Nova Scotia. The plants contained in the upper deposits were compared with those of the European Permian, and a correlation was shown to exist between them, so that it becomes a question whether this series was not synchronous with the lower part of the Permian of Europe, although in this district there is no stratigraphical break to establish a boundary between Carboniferous and Permian. The author therefore proposes to name these beds Permo-Carboniferous, and regards them as to some extent bridging over the gap which in Eastern America separates the Carboniferous from the Trias.—Note on the Carboniferous Conglomerates of the Eastern Part of the Basin of the Eden, by J. G. Goodchild.—An Account of a Well-Section in the Chalk at the north end of Driffield, East Yorkshire, by R. Mortimer.—On Slickensides or Rock-Striations, particularly those of the Chalk, by Dr. Ogier Ward.

Royal Horticultural Society, April 1.—Scientific Committee.—Dr. Hooker, C.B., Pres. R.S., in the chair.—Prof. Thiselton Dyer exhibited seeds of the plant called in gardens *Theophrasta imperialis*, sent from Rio Janeiro by Dr. Glaziou. From the evidence now forthcoming it appears that the plant belongs to a different family, *Sapotaceæ*.—Dr. Hooker showed a photograph from Mr. Russell, of Falkirk, of a fruiting specimen of *Encephalartos villosus*, sometimes called in gardens *Zamia Mackenii*. The plant is a native of Natal, and a similar species has been discovered on the Niger by Barter, and a third in Zanzibar, by Kirk. A plant discovered by Schweinfurth in Central Africa is probably the same as that mentioned by Kirk.—Dr. Masters presented a classified list with notes of species of Passiflora and Tacsonia cultivated in European gardens.—Mr. Renny made some observations on the drawing, by Montagne, of *Artotrogus*, exhibited at the last meeting, which together with the original specimens, Mr. Berkeley had been kind enough to allow him to examine leisurely. He was able to clear up a mistake which De Bary seems to have fallen into in his description of *Peronospora infestans* (Ann. des Sc. Nat., 4e sér., t. xx. p. 105, 1863). De Bary had not met with the resting spore of that species, but suggested that Montagne's *Artotrogus hydnocarpus* might be the desired organ ; but he had doubts on the point, as Montagne had written to him that he found it also on Turnip. The facts are, that Mr. Broome found a mould on decaying Turnip, which he sent to Montagne, who pronounced it to be a species of his genus *Artotrogus*, though he does not appear at any time to have supplied a specific name. He doubtless announced to De Bary that *Artotrogus* was to be met with on Turnip, and it was De Bary's assumption that *A. hydnocarpus*, the only published species, was the one spoken of. De Bary, having a confident belief that the various species of *Peronospora* are parasitic each only on the plants of one genus, or at most of one family, seems to have been thus led to the doubt he has expressed.

General Meeting.—H. Little in the chair.—Prof. Thiselton Dyer commented on the interesting plants exhibited. Amongst these were the two forms of *Primula verticillata*, one from Sinai the other from Abyssinia ; *Boronia megastigma*, a new Australian plant with a very agreeable smell ; the stem and foliage of the splendid Bamboo *Dendrocalamus giganteus*, in cultivation at Sion House ; and cut blooms of *Sterculia nobilis* from the same collection.

Entomological Society, April 6.—Sir Sidney S. Saunders, president, in the chair.—Mr. Frederick Smith made some interesting observations relative to the habits of the bee-parasites belonging to the genus *Stylops*.—Major Parry communicated a paper entitled Further Descriptions of Lucanoid Coleoptera ; and Mr. Smith read descriptions of the *Tenthredinidæ* and *Ichneumonidæ* of Japan, from the collections of Mr. George Lewis.—Further notes were read from Mr. Gooch, of Natal, respecting the destruction of the coffee plantations there, by Longicorn Beetles.

Royal Astronomical Society, April 10.—Prof. Adams, president, in the chair.—Mr. De la Rue gave a verbal description of a piece of apparatus which he had devised for carrying out M. Janssen's method of photographing Venus near to ingress and egress upon the sun's disc. The instrument is intended to be attached to the photo-heliographs and weighs less than 11 lbs., inclusive of a small driving clock, which carries a revolving plate of about 10 in. in diameter, on which small photographs of Venus and the sun's limb are to be taken in rapid succession. Lord Lindsay also described the form of instrument which he had devised for the same purpose ; it appeared to be very similar to that described by Mr. De la Rue, except that it is mounted on a separate pillar from the telescope in order to avoid tremors.—Lord Lindsay also read a paper On a Method of Determining the Solar Parallax, from observations to be made at the next opposition of Juno, which occurs in November of this year. He proposes, while in the Mauritius, to make a series of heliometric measures of the distance of Juno from the nearest fixed stars ; and by comparisons of the measures taken soon after Juno has risen above the eastern horizon with those taken before it sets at the western to determine the terrestrial parallax. By this method he will be able to make his measures during all the clear nights of the month or six weeks before and after opposition. And although the parallax will be considerably less than in the case of Venus, he considered that he had reason to hope that the probable error of the result would, owing to the number of the

measurements and the ease of dealing with points of light instead of discs, be less than either in the case of the transit of Venus or the opposition of Mars.

Society of Biblical Archæology, April 7.—Dr. Birch, president, in the chair.—The following papers were read: On Four Songs contained in an Egyptian Papyrus in the British Museum. Translated with notes by C. W. Goodwin. Of these four songs three partook of the same nature, and were amatory compositions, written in a highly imaginative and poetical style with much voluptuousness of expression, having a very striking resemblance extending throughout whole passages, to the language of the Canticles. The fourth song or hymn is of a very different nature, and is evidently one of the solemn dirges used at festivals during the exhibition of the figures of Osiris, as related by Herodotus. This hymn is in the text ascribed to King Antuf, a monarch of the XIth dynasty.—Nimrod et les Ecritures Cuneiformes, by Joseph Grival (read in English). In this essay the author maintained that Merodach, under his Accadian name of "Amarud the eldest son of the Lord of Urhi," was identical with Nimrod the "géant chasseur" of the Septuagint.

EDINBURGH

Royal Physical Society, March 25.—On some Organisms found in the Stomach of the Herring, by F. W. Lyon.—Note on Entozoa, genus *Bothriocephalus*, found in the intestinal canal of a fish (*Cottus scorpius*), by James M'Bain.—On Recent Meteoric Chemistry, by Andrew Taylor. Mr. Taylor, in this paper, gave a *résumé* of the present state of our knowledge of the chemistry of meteorites.—On British Madreporiæ, by C. W. Peach, A.L.S. Mr. Peach read a paper on this subject, first stating that his attention had been drawn to the subject by a paper by Prof. P. Martin Duncan, on the Madreporiæ dredged by the explorers in the *Porcupine* in 1869 and 1870. He then exhibited a series of specimens he had collected in the seas of Shetland, Cornwall, &c., the most abundant being Caryophyllia, varieties *Smithii* and *Borealis*.—On the Fossil Plants of the Silurian Rocks of the Pentland Hills and of Sutherlandshire, by C. Wm. Peach, A.L.S. In this paper Mr. Peach showed that one of the large plants collected by Mr. Brown in the Upper Silurian rocks of the Pentlands was identically the same and in a similar matrix as the one collected by him in Sutherlandshire. This same plant had also been found in the Upper Silurian of the Iuaspe sandstones in Canada. He further said that the rocks in Sutherlandshire were Lower Silurian, thus showing that land plants—and of a pretty high type—came in much earlier there than from either of the other localities.

PARIS

Academy of Sciences, April 6—M. Bertrand in the chair.—The perpetual secretary announced to the Academy the loss which it had sustained in the person of M. P. A. Hansen, correspondent for the Astronomical section, who died at Gotha on March 28.—The following communications were read:—On Polygons inscribed in and circumscribing curves, by M. Chasles. —Solar Cyclones: conclusion of the reply to Dr. Reye, and observations concerning an article from the "Bibliothéque universelle" of Geneva, and a reclamation by M. Norman Lockyer, by M. Faye. The author has tabulated the dates, localities, times, velocities, &c. of thirty-one cyclones.—Earthquake shocks felt in Algeria on March 28, 1874; a letter from M. Ch. Sainte-Claire Deville to the perpetual secretary. The communication included a note from Captain Brocard, containing a seismo-graphic indication of the shocks.—Observations made at the Observatory of Toulouse during the months of February and March 1874, by M. F. Tisserand. The author communicated observations on the eclipses of Jupiter's satellites, and announced at the same time that regular observations of sun-spots had been organised with an equatorial of 0·108 m. aperture, after the method of Carrington.—Experimental researches on bi-hydrated sulphuric acid, by MM. Js. Pierre, and E. Puchot. —Scientific ascent to a great height made (in a balloon) on March 22, 1874, by MM. J. Crocé-Spinelli and Sivel. The authors had ascended 7,300 metres, the temperature at that elevation being $-22°$. The observations recorded in this communication are spectroscopic and physiological. Particular attention was given to the two obscure bands right and left of the double D line. At about 5,500 metres the right-hand band dispppeared, and the band to the left vanished at about 7,000 metres, thus confirming M. Janssen's idea of these bands being of terrestrial origin. The observers adopted M. Bert's suggestion of respiring oxygen to correct the effects of the rarefaction of the air. A carrier pigeon released at 5,000 metres tried at first to remount to its cage, but finally descended, describing curves of from 200 to 300 metres in diameter, with a velocity of translation of about 40 or 50 metres per second.—Action of electric fluid upon gases, third note, by M. Neyreneuf. The author promised from his observations a satisfactory explanation of the stratification of the electric light. —On a new process for the study and determination of the alcohol in wines, by M. Duclaux. The process depends upon the fact that mixtures of alcohol and water give for different compositions different numbers of drops when allowed to flow from a pipette of constant orifice. (The method is a practical application of Dr. Guthrie's researches upon drops to which no allusion was made.)—Note accompanying the presentation of new astronomical objectives of large dimensions, by M. Secretan. The largest was 24 centim. in diameter and had a focal distance of 3·25 metres. Its price was 6,300f.—On a new (electric) couple specially prepared for the application of continuous currents in therapeutics, by M. J. Morin.—On a system of continuous alarm signals to prevent railway collisions or collisions of ships at sea during foggy weather, by M. C. J. de Mat.—Geological considerations on the probable origin of the drift soil called *diluvium*, by M. E. Robert.—On the employment of coal-tar alkalies for the destruction of *Phylloxera*, by M. A. Rommier.—Direct construction of the centre of curvature in a point of the section made in a surface by any plane, by M. A. Mannheim.—On the diffusion between moist and dry air through a septum of porous clay, by M. L. Dufour.—Measurement of the electromotive force of batteries in absolute units, by M. A. Crova.—Density of hydrogen combined with metals, by MM. L. Troost and P. Hautefeuille. The observed density is about 0·625.—Experiments concerning combustion in the animal organisation, by M. P. Schutzenberger.—On the brominated derivatives of pyruvic acid, by M. E. Grimaux. The author described di- and tri-brompyruvic acids and touched upon the constitution of the acid itself.—Modifications employed in the preparation of iron reduced by hydrogen, for the purpose of obtaining the metal perfectly pure, by M. Crolas.—Note on the determination of lime in meteoric waters, by M. H. Marié-Davy.—On asphyxia from insufficiency of oxygen, by M. Félix le Blanc.—On the use of oxygen in ballooning, by M. W. de Fonvielle.—Injection of ammonia into the veins to oppose accidents caused by snake bites, by M. Oré.—On the functional irritability of the stamens of *Berberis*, by M. E. Heckel.

CONTENTS

PAGE

THURSDAY, APRIL 23, 1874

HERBERT SPENCER'S SOCIOLOGY

The Study of Sociology. By Herbert Spencer. (London: Henry S. King and Co.)

THERE are not a few signs, of which the book before us is an important one, that thought is moving in the direction indicated by Mr. Mill in the quasi-prophetical conclusion to his "System of Logic," where he expresses his belief in the prominence of sociological inquiries in the intellectual achievements of the next two or three generations of European thinkers. What has been called by Hegel the speculative historical method has taken a considerable step in advance since Mr. Mill wrote thus. History, written from the speculative or philosophical stand-point, may be regarded as a special Sociology—Sociology, that is, applied to the investigation of the laws of growth and development of some one society, as exhibited either throughout its whole career, or within some limited period. General Sociology stands to history in a position analogous to that occupied by general physiology with regard to the special physiology of man or of any other species of animal. This analogy will serve to throw some light upon the fact that there has been much greater progress made in the special department of speculative history than in the wider field of Sociology. Up to a certain point, the broader generalisations of the higher science must be preceded by the more restricted generalisations of the lower. But when this point has been reached, when the higher principles have been formulated with approximate completeness, then the advances along the lines of general and special thought will proceed *pari passu;* progess in one will by its reflex influence make possible a correlative progress in the other. The relations between Sociology and history appear to be nearing this stage.

Division of labour obtains in literature as well as in industry. His special turn of mind, not less, perhaps, than the character of the task to which he has devoted himself, has made Mr. Spencer a labourer in the wider field of Sociology. The volume under review, taken in connection with the two parts already issued of the "Descriptive Sociology," of which Part I. has been noticed here,* enables us, to some extent, to anticipate the character of the more elaborate and comprehensive work, the "Principles of Sociology," the promised fourth division of Mr. Spencer's "System of Philosophy." In the "Descriptive Sociology" we have an insight into the laborious thoroughness with which Mr. Spencer is preparing the foundations for his generalisations, while in the "Study of Sociology" we are introduced to his conception of the nature of the social science, of the difficulties in the way of the sociologist, and of the discipline necessary to the formation of a habit of thought adapted to sociological inquiries.

It is not necessary here to follow Mr. Spencer into the polemic contained in the first two chapters of his book, directed against the popular notions of sociological phenomena; against the dogmatic, unscientific, and off-hand way in which important and complicated sociological questions are decided not only by the vulgar, but also by men who are guided by a strict scientific method in the less intricate questions of physical science; and against the supporters of the special-providence and great-man theories of history. Mr. Spencer being the assailant, it is almost superfluous to say that the polemic is a vigorous one; indeed it may be open to question whether the assault would not have been more successful had it been conducted with less vigour and more circumspection. To use Mr. Spencer's own metaphor, a considerable correction for the "personal equation" of combativeness will be found necessary.

The possibility of a science of Sociology is shown in various ways. One cause of the denial of this possibility is to be found in the prevalent confusion between a science and an exact science. Sciences are either merely logical or mathematical also; in Mr. Spencer's phraseology, qualitative or quantitative. It is not affirmed that Sociology can be a quantitative science; but this is not to deny its scientific character altogether. Sociology presents in an extreme form that absence of quantitative definiteness which geology, biology, and psychology present in a considerable, though less, degree. Mr. Spencer puts his own case and that of the objectors to the scientific character of Sociology very forcibly in the following dilemma:—"In brief, then, the alternative positions are these. On the one hand, if there is no natural causation throughout the actions of incorporated humanity, government and legislation are absurd. Acts of Parliament may, as well as not, be made to depend on the drawing of lots or the tossing of a coin; or rather, there may as well be none at all: social sequences having no ascertainable order, no effect can be counted upon—everything is chaotic. On the other hand, if there is natural causation, then the combination of forces by which every combination of effects is produced, produces that combination of effects in conformity with the laws of the forces. And if so, it behoves us to use all diligence in ascertaining what the forces are, what are their laws, and what are the ways in which they co-operate."

Sociology is concerned with men aggregated into societies. Aggregates derive their essential properties from the natures of the individuals of which they are composed. Aggregation, though it may foster the development of some, and check that of others, of the characters of the constituent units, cannot give rise to social properties for which there is no foundation in those of the components. Setting out from this axiomatic principle, Sociology describes "the growth, development, structure, and functions of the social aggregate, as brought about by the mutual actions of individuals whose natures are partly like those of all men, partly like those of kindred races, partly distinctive. . . . Not that the social science exhibits these or those special truths, but that, given men having certain properties, an aggregate of such men must have certain derivative properties which form the subject-matter of a science."

Nowhere, perhaps, than in sociological phenomena is the truth of the doctrine of evolution, the central doctrine of Mr. Spencer's philosophy, more strikingly displayed, and nowhere, subject to proper limitations, is it likely to prove more serviceable. To borrow Comte's phraseology, Sociology is either dynamical or statical. The dynamics of Sociology is throughout an exemplification of evolution.

* See NATURE, vol. viii. p. 544.

The statics of Sociology, at any given epoch, deals with phenomena which are the results of evolution. When Sociology is regarded in its dynamical aspect, the doctrine of evolution properly understood and limited, recognising and accounting for both the relative perfection and imperfection of a given social state, occupies the true mean between the altogether optimist view of social progress which finds expression in the lines—

As round and round we run,
Ever the truth comes uppermost,
And ever the right is done;

and the altogether pessimist view embodied in the dictum of a distinguished living thinker, "The history of mankind is a huge *pis-aller*." But when Sociology is regarded in its statical aspect, an abusive use may easily be made of the doctrine of evolution. A given social state bears a relation to the past social states from which it is an outgrowth, and also to existing circumstances and conditions. Led away by the tendency of modern thought, so happily described by Mr. Bagehot as making everything "an antiquity," the sociologist is apt to dwell upon the first of these relations, to the exclusion of the second. From such one-sidedness Mr. Spencer does not appear to be altogether free.

It is always useful to know the nature, the magnitude, and the position of the difficulties that have to be encountered in the course of an inquiry. Mr. Spencer has given more explicitly and in fuller detail than any previous writer has done, an analysis of the difficulties in the way of sociological investigations. These difficulties are objective and subjective; difficulties inherent in the object of sociological science, and difficulties originating in the observer himself. The data of Sociology, the actions of men incorporated into societies, are distributed over long periods of time, and wide areas of space. The sociological inquirer must necessarily rely for his data upon past and contemporary records. But records may not exist; deep-lying circumstances of importance may be obscured by superficial circumstances; evidence will suffer vitiation through the want of perspicacity or of impartiality in the observer. A comprehensive, patient, and judicious employment of the comparative method is the only means by which order can be educed out of the chaotic mass of data which the recorded histories of societies offer. Mr. Spencer and his collaborateurs will deserve the gratitude of every sociological inquirer, for the extensive collection and collation of these materials, now in progress in the atlas-like folios of the "Descriptive Sociology."

Formidable as are the objective difficulties which beset sociological researches, not less formidable are the subjective difficulties. This class of difficulties originates either in the intellectual or in the emotional character of the observer. The want of a faculty adequate in plasticity and complexity to the many-sidedness and complexity of the object of investigation, and the tendency to automorphism, to make self the measure of things, are the principal intellectual obstacles to Sociology. Automorphism is one of the most fertile sources of error. "To understand," says Mr. Spencer, "any fact in social evolution we have to see it as resulting from the joint actions of individuals having certain natures; and this even by care and effort we are able to do but very imperfectly. Our interpretation must be automorphic; and yet automorphism perpetually misleads us."

In Sociology man is at once the observer and the observed; the inquirer is a unit of the aggregate whose laws he is investigating. We may observe a transit of Venus with the impartiality due to the absence of personal concern; we are not impartial observers of a social event with which our own interests are intimately bound up. Accuracy of observation is thus interfered with by sentiment. From the observer's emotional nature spring the various kinds of bias, educational, patriotic, class, political, and theological, described and abundantly exemplified by Mr. Spencer in a succession of chapters deserving of careful study, but to which space prevents more than a reference.

Attention to questions of scientific discipline and method is so rare among scientific men, that Mr. Spencer's book would deserve commendation for this feature, if for no other. Discipline should have reference to the work to be performed. Sociology being the most complex of the sciences, the sociological inquirer needs a discipline capable of producing an adequately powerful instrument of research. Falling back upon his classification of the sciences, into Abstract sciences, which investigate the *forms* of phenomena, Abstract-concrete sciences, which investigate the *factors* of phenomena, and Concrete sciences, which investigate the *products* themselves in their totality, Mr. Spencer shows the need in Sociology of the discipline in the necessities of relation derived from the first; in the distinctness given to the notion of simple causation derived from the second; and in the formation of the conception of continuous, complex, contingent, and fructifying causation derived from the third. Not, of course, that there can be an exhaustive or even a deep study of all or any of these sciences; a disciplinary study is all that is contended for, a study sufficient to enable the sociological inquirer to grasp the cardinal ideas proper to each science. But there is a more intimate dependence of Sociology upon the sciences of physical and psychical life, therefore the sociologist stands in need of a deeper acquaintance with biological and psychological truths. Amongst the most interesting and valuable chapters in the book are those in which Mr. Spencer enforces the need of an adequate preparation in biology and psychology. Positive arguments are supplemented by negative arguments, arguments based upon striking exemplifications of the errors that have arisen in the practical sciences of politics and education from ignoring biological and psychological teachings.

The view taken by Mr. Spencer of the method proper to sociological inquiries seems, as far as can be gathered from his own procedure, to differ little from that advocated and expounded by Mr. Mill. Placing Sociology next after psychology in his System of Philosophy, and asserting, as he does everywhere, the dependence of social phenomena upon psychological facts connected with the social units, Mr. Spencer's method appears to be to trace out deductively the connection of the empirical sociological truths, arrived at by generalisation from the data furnished by historical records, with the ultimate laws of human nature established by psychology. This is essentially Mr. Mill's inverse or historical deductive method applied to sociological inquiry.

In its style the "Study of Sociology" somewhat disagreeably reminds the reader of one of Mr. Spencer's earliest works, "Social Statics." It has two main faults—it is needlessly polemical in its tone, and it is disfigured by numerous unscientific exaggerations of language. Mr. Spencer is undoubtedly right in defending against Mr. Arnold the superiority of the guidance of psychology and logic, over mere linguistic culture, in producing a style clear, forcible, and free from tautology. But there is neither psychological nor logical defence for the two faults indicated. Amongst minor faults of style may be enumerated an occasional laxity in the use of analogies; the degeneration of the psychologically sound practice of prefacing the enunciation of an important truth by a forcible illustration of it into a disagreeable mannerism, some very marked examples of which occur in the opening paragraphs of several of the chapters; the frequent occurrence of words ineuphoniously formed, to say the least of them, such as "re-revenge," "irrelation," "wholesaler;" and the overabundant formation of compounds, especially noticeable in the compounding of the adjective and its qualifying adverb, as in "logically-conclusive," "profoundly-untrue," "equally-long."

Some of the defects pointed out are probably traceable to a desire to popularise the work as far as possible, in forgetfulness, to some extent, of the necessity to maintain the character which should appertain to it as one of a scientific series. But, while it is to be regretted that there should be such blemishes to mar the general effect of a book so full of suggestive thought and of appropriate illustrative facts, it must be allowed that the "Study of Sociology" forms a valuable addition to sociological literature, and leads the student in this department of human thought to anticipate with pleasure the appearance of the work to which it and the "Descriptive Sociology" are but forerunners.

W. H. BREWER

FRITSCH'S "SOUTH AFRICAN RACES"

Die Eingeborenen Süd-Afrika's, ethnographisch und anatomisch beschrieben. Von Gustav Fritsch. (Breslau: Hirt, 1872.)

IT is to be hoped that this work will have a good effect on the Science of Man, as a much-needed example which, once seen, will no doubt be followed. So far as the writer of the present notice is aware, the attempt at a systematic monograph of a race has never yet been made with so near an approach to success. With all our hundreds of volumes full of information as to the lower races of mankind, it is generally a difficult task for the ethnologist to piece together out of them anything like a complete picture of any tribe, with scientific fulness and accuracy of bodily, mental, social, geographical, and historical detail. Where, for instance, could he go for full information as to the two African races of whom Dr. Fritsch's work treats, the Kafirs and Hottentots?

The student's best source has been hitherto the conscientious dictionary-like summary, brief yet tedious, contained in 60 pages (Vol. II.) of Waitz's "Anthropologie der Naturvölker." The chapters in Mr. J. G. Wood's "Natural History of Man" are fuller and more life-like, but they are far too popular in topics as well as in style. Nor had either of these writers ever lived among the races about whom he compiled information. From a study of the descriptions drawn up by travellers, missionaries, and officials, who have known the Kafirs and Hottentots by

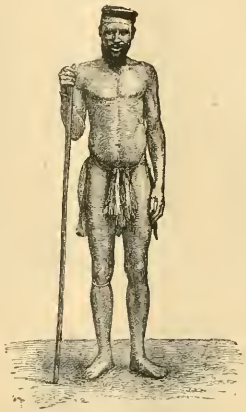


FIG. 1.—Zulu of Natal.

personal knowledge, it is possible to get much of the information wanted, but how long will it take even to glance over the volumes of Shooter, Galton, Callaway, Hahn, Casalis, Grout, Maclean, Andersson, and a dozen more? Each other savage or barbaric race of the world demands in like manner the reading through of a small

FIG. 2.—Young Kafir.

library, consisting mostly of miscellaneous literary matter, in which the ethnographic information is imbedded. The state of things is briefly this, that anthropological evidence is at present so bulky and so scattered, as to be

unmanageable except by those who can give half a lifetime to it. It is highly desirable to have the whole available knowledge as to each race condensed into a monograph like the present, by a competent ethnographer who knows that race by personal study in its home. It would be a real service to the ethnographers now at work drawing up accounts of native tribes in India and elsewhere, to put into their hands Dr. Fritsch's book as a model. As with all its excellencies of plan and execution, it is in many respects open to improvement, it would serve as a stepping-stone to yet more perfect works.

In popular language, the two indigenous races of South Africa are known as *Kafirs* and *Hottentots*, one the well-known Moslem term for "infidels" picked up by the Portuguese from the Arab traders of the sixteenth century, the other an imitative epithet, "hot-en-tot," given by the Dutch colonists to the tribes using "clicks" in their speech. Neither term is now satisfactory, and Dr. Fritsch is justified in adopting the native names by which the two races denote themselves. For the *Kafir* tribes he uses the term *Abantu*, *Bantu* (plural of *ntu*, a man), and for the *Hottentot* tribes their designation of *Koi-koin* (*i.e.* "men of men," from *koi*, a man).

Fig. 3.—Sandili's Wives.

Dr. Fritsch, as a professed anatomist, examines with almost exhaustive minuteness the bodily characters of these two races. The closer appreciation of race-types, which is now supplanting the vaguer generalities of twenty years ago, is in no small measure due to the introduction of photographic portraits, instead of the old misleading sketches by artists unable to clear their minds of the artistic types of Europe. Without photography it would be impossible to obtain a collection of portraits such, for instance, as those lately published in Colonel Dalton's "Descriptive Ethnology of Bengal." The portrait engravings from South African photographs in Dr. Fritsch's album (unfortunately arranged on somewhat different dimensions from the volume it accompanies) are at the same high level of truth and art. When race-types are so well-marked as among these South African tribes, even small figures will show their principal physical peculiarities. A selection from the small-scale woodcuts in the main volume, likewise taken from photographs, are here produced from copies of the blocks lent by the publishers.

Figs. 1 and 2, representing a middle-aged and a young Kafir, show the characteristic slimness of the figure, due to the wall-sided chest and narrow hips. The lean forearm, a peculiar conformation of the deltoid and biceps, a somewhat finely-formed hand, and an ungraceful setting back of the lower extremities and inclination of the pelvis, are other points of speciality. The narrow skull is well seen in the figures, with the broad-winged flattened nose showing the nostrils in full face, the fleshy pouting lips, and the hair naturally felted. Add to this the deep-brown colour of the skin, which is shown in No. 1 of the specimen tints given in a table at the end of the volume, with the deep-brown eyes and black frizzy hair, and the total as nearly represents the ideal Kafir of the Ama-Xosa type as ethnologists can conceive it. Fig. 3, representing a group of wives of a chief,* shows with coarse distinctness the typical Bantu features.

In strong contrast with this Kafir type is that of the Koi-koin or Hottentots, including as one of its divisions the Bushmen. Whereas the dark-brown or almost black Zulu stands little short of 5 ft. 8 in., the Hottentot, whose brownish-yellow complexion has been compared to a dry leaf, averages only 5 ft. 3 in., and the tiny dirty-yellow Bushman under 4 ft. 8 in. Bearing in mind their yellow complexion and diminutive size, some idea of the Bushman type may be gained from Fig. 4. The high cheek-bones and pointed chin give the face its peculiar triangular shape, while the characteristic snub-nose is shown in the old Bushman, Fig. 5.

Dr. Fritsch justly observes that the Bantu and Koi-koin races have hardly any essential race-character in common, unless it be the crisped hair; and even this is generally (though not through all varieties) distinct, the Bantu hair being irregularly felted into a mass, whereas the Koi-koin hair grows in little tufts, which have been compared to the bristles of a blacking-brush. The steatopygy of the Hottentot-Bushman women is shown by an extraordinary collection of portraits in Dr. Fritsch's volume; few physical race-characters are more striking than this, and it is unfortunate that illustrations of it cannot be inserted here. As in other parts of their structure, so in cranial proportions the two races in question are markedly distinct, as is fully proved by the set of lithographed skulls with tabulated measurements. The Kafir skull is narrow and high, the proportion of length to breadth being about 100 : 71·9, while the height may be taken at 73·8, being thus slightly greater than the breadth. The Hottentot skull, on the other hand, is narrow and low, the proportion of length to breadth being about 100 : 72·7, while the height of such a skull might be only 71, which is less than the breadth. The Bushman skull shows this character in still more extreme proportions in a cranium whose length is 100, the breadth

* This group illustrates in a curious way the conventional but not irrational development of the ideal of beauty from the ordinary forms of normal life. This ideal once fixed among any nation, there ensues a desire to exaggerate it. In the present instance, in grown-up Kafir women, the tendency of the breasts to become long and pendulous is considered not contrary to beauty, and is accordingly artificially increased by binding down, as shown in the figure.

being 73·8, against a height of 70·2, which gives about double the difference of the Hottentot.

The elaborate anatomical data amassed by Dr. Fritsch may afford the means of more fully working out the ethnological problems of the South African races. The evidence here brought forward of the more extreme characters of the Bushman type as compared with the Hottentot, seems to tell in favour of the view put forward by Prof. Huxley some years ago, that the Hottentots are the result of crossing between the Bushman and the Negroid tribes. Beyond this, there naturally arises another question: do the Kafir tribes, with their complexions varying from dark-brown to blue-black, owe their bodily differences from the Negro of Equatorial Africa to an intermixture of Bushman blood during a long course of ages. The evidence of language is here important. So far as it is concerned, the Kafir of South Africa is essentially a Negro, for his dialects belong to the great series of prefixing languages, the peculiar character of which is so well shown in the formation of the plural. Just as the Mpongwe language of the Gaboon makes the plural of *omamba*, snake; *imamba*, snakes; and farther east the individual inhabitant of *Unyamwezi* is a *Mnyamwezi*, and the people as a whole are *Wanyamwezi*:—so in Zululand *umuntu* is a man; *abantu*, men; and *Amazulu* is the plural name of the nation of whom an individual is *Uzulu*. The Bushman-Hottentot, or Koi-koin group of languages, are on the other hand distinguished by their tendency to monosyllabic words, their suffixes, and the "clicks" which to so extraordinary an extent are used as consonants. According to Dr. Bleek's classification, this family of languages has also relations farther north on both sides of the Continent; but this is a point which requires further examination. Now, though the fundamental types of the Kafir and Bushman languages are so absolutely distinct, it has come to pass that certain of the Kafir tribes, notably the Zulus, use to some extent in their speech clicks of the Hottentot type, whereas nothing of the kind

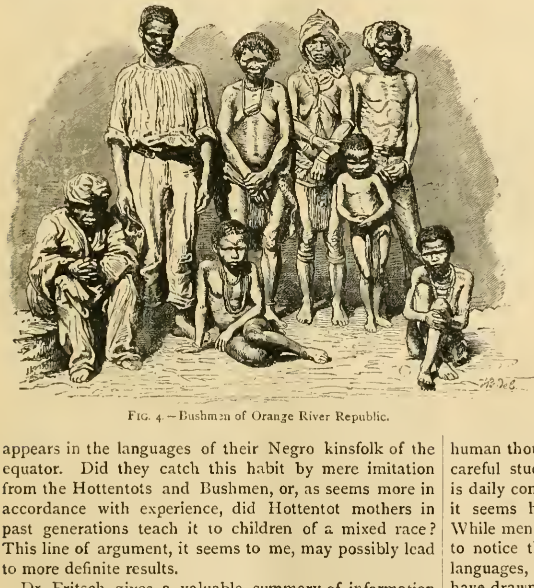


FIG. 4.—Bushmen of Orange River Republic.

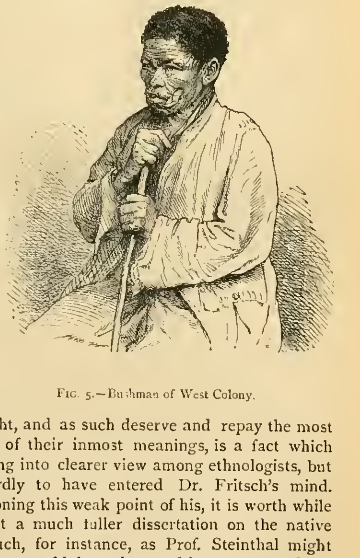


FIG. 5.—Bushman of West Colony.

appears in the languages of their Negro kinsfolk of the equator. Did they catch this habit by mere imitation from the Hottentots and Bushmen, or, as seems more in accordance with experience, did Hottentot mothers in past generations teach it to children of a mixed race? This line of argument, it seems to me, may possibly lead to more definite results.

Dr. Fritsch gives a valuable summary of information as to the industrial, social, and intellectual condition of the South African races. The latter is not, however, of such special excellence as the descriptions of physical race-characters. Indeed, Dr. Fritsch is on the whole a better judge of bodies than of minds. His account of the native religions is below his general level, as may be judged from his describing the Zulu religion without mention or apparently knowledge of the remarkable native documents collected by Dr. (now Bishop) Callaway, which throw such clear light not only on the religious ideas of these barbarians, but on the origin and development of religion among mankind at large. That savage theologies show representative stages in the evolution of human thought, and as such deserve and repay the most careful study of their inmost meanings, is a fact which is daily coming into clearer view among ethnologists, but it seems hardly to have entered Dr. Fritsch's mind. While mentioning this weak point of his, it is worth while to notice that a much fuller dissertation on the native languages, such, for instance, as Prof. Steinthal might have drawn up, would have been of interest to students whose wants are only partially supplied by the meagre though valuable classificatory sketch here given, mostly on the authority of Dr. Bleek. Our author also shows glimpses of ill-temper in dealing with authors he dislikes, such as Mr. J. G. Wood, whom he falls upon in season and out of season. An instance of the latter kind of attack is seen where Mr. Wood, speaking in perhaps too enthusiastic terms of the physical beauty of youthful savages, naturally introduced the well-known story of Benjamin West, the Quaker painter, comparing the Apollo Belvedere to a young Mohawk warrior. Dr. Fritsch, quite missing the point of the story, solemnly quotes Mr. Wood as asserting, in proof of the classical beauty of the

Kafirs, that "an American Quaker, West, took the statue of the Belvedere Apollo for the representation of a Mohawk Indian." Having made Mr. Wood talk this extraordinary nonsense, he then reviles him for being illogical. This is not the treatment Mr. Wood merits. No one denies the faults of his work, especially the unhappy straining after the picturesque which has made so many of his artist's illustrations worse than worthless. But his genial and suggestive descriptions of South African native life give a permanent value to his popular volume, while in his special line as a student of savage arts and implements, Dr. Fritsch can hardly expect to rival him.

EDWARD B. TYLOR

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Flowers of the Primrose destroyed by Birds

FOR above twenty years I have observed every spring in my shrubberies and in the neighbouring woods, that a large number of the flowers of the primrose are cut off, and lie strewn on the ground close round the plants. So it is sometimes with the flowers of the cowslip and polyanthus, when they are borne on short stalks. This year the devastation has been greater than ever; and in a little wood not far from my house many hundred flowers have been destroyed, and some clumps have been completely denuded. For reasons presently to be given, I have no doubt that this is done by birds; and as I once saw some greenfinches flying away from some primroses, I suspect that this is the enemy. The object of the birds in thus cutting off the flowers long perplexed me. As we have little water hereabouts, I at one time thought that it was done in order to squeeze the juice out of the stalks; but I have since observed that they are as frequently cut during very rainy, as during dry weather. One of my sons then suggested that the object was to get the nectar of the flowers; and I have no doubt that this is the right explanation. On a hasty glance it appears as if the foot-stalk had been cut through; but on close inspection, it will invariably be found that the extreme base of the calyx and the young ovary are left attached to the foot-stalk. And if the cut-off ends of the flowers be examined, it will be seen that they do not fit the narrow cut-off ends of the calyx, which remains attached to the stalk. A piece of the calyx between one and two-tenths of an inch in length, has generally been cut clean away; and these little bits of the calyx can often be found on the ground; but sometimes they remain hanging by a few fibres to the upper part of the calyx of the detached flowers. Now no animal that I can think of, except a bird, could make two almost parallel clean cuts, transversely across the calyx of a flower. The part which is cut off contains within the narrow tube of the corolla the nectar; and the pressure of the bird's beak would force this out at both the cut-off ends. I have never heard of any bird in Europe feeding on nectar; though there are many that do so in the tropical parts of the New and Old Worlds, and which are believed to aid in the cross-fertilisation of the species. In such cases both the bird and the plant would profit. But with the primrose it is an unmitigated evil, and might well lead to its extermination; for in the wood above alluded to many hundred flowers have been destroyed this season, and cannot produce a single seed. My object in this communication to NATURE is to ask your correspondents in England and abroad to observe whether the primroses there suffer, and to state the result, whether negative or affirmative, adding whether primroses are abundant in each district. I cannot remember having formerly seen anything of the kind in the midland counties of England. If the habit of cutting off the flowers should prove, as seems probable, to be general, we must look at it as inherited or instinctive; for it is unlikely that each bird should have discovered during its individual life-time the exact spot where the nectar lies concealed within the tube of the corolla, and should have learnt to bite off the flowers so skilfully that a minute portion of the calyx is always left attached to the foot-stalk. If, on the other hand, the evil is confined to this part of Kent, it will be a curious case of a new habit or instinct arising in this primrose-decked land.

Down, Beckenham, Kent, April 18 CH. DARWIN

Signor D'Albertis' and Dr Meyer's Discoveries in New Guinea

HAVING just returned to Europe, I read in NATURE, vol ix. p. 77, a communication which contains an assertion of Dr. A. B. Meyer, to the effect that I did not cross New Guinea at all, and that he claims the honour of having done so himself.

From what Dr. Meyer says, the public are led to believe that I have claimed the honour of crossing this unknown and little-explored island; if he had read "A Month among the Papuans of Mount Arfák," he might easily have ascertained that I never asserted this. There the reader will see that I only claimed to have penetrated the country to a distance of thirty miles, and to have ascended to a height of between 3,000 and 4,000 feet; but I *was* the first European to see alive and shoot many rare Birds of Paradise peculiar to New Guinea. One of these was entirely new to science, and has been called *Drepanornis albertisi* by Dr. Sclater (NATURE, vol. viii. p. 305); it may be the same bird subsequently described as new by Dr. Meyer.

I have no wish to deprive the last-named gentleman of the honour of having crossed a greater or lesser portion of New Guinea, but I object most decidedly, either indirectly or by insinuation, to being deprived of the credit of being the first European to penetrate into the interior of that interesting country.

April 20 LUIGI MARIA D'ALBERTIS

Spontaneous Generation

MR. RAY LANKESTER's letter in last week's NATURE affords fresh evidence of his lack of acquaintance with the several stages through which the "spontaneous generation" controversy has passed, or he would not now cite as a "most important result" only made known by recent experimentation, a fact which has been well known and repeatedly verified since the time of Spallanzani. I allude to the influence of the prolongation of the period of exposure to heat in retarding or altogether arresting the putrefactive tendencies of organic solutions. I have not thought it needful on previous occasions to point out the various misconceptions and the apparent ignorance of facts shown by Mr. Lankester in his querulous communications to your columns on the subject of "Spontaneous Generation." There are one or two points, however, to which I will now venture to solicit his attention, and that of your readers generally.

Mr. Lankester says:—"It is probably now familiar to those interested in the matter, that the experiments of Dr. Sanderson have established the fact that in an infusion of turnips and cheese prepared as directed by Dr. Bastian, heating to a temperature of 102° C. is sufficient to prevent the subsequent development of life (Bacteria) in the infusion, even when the exposure to that temperature is only maintained for a few minutes." To this statement I have to add that since the publication of the experiments above alluded to by Dr. Sanderson, I have heated flasks, sealed in the ordinary way and containing the fluid above mentioned, to a temperature of 105° C. for ten minutes in a chloride of calcium bath, and have found these fluids swarming with Bacteria after six days. I have also heated in the same manner simple neutralised turnip-infusion (filtered through cotton-wool instead of filtering paper) to a temperature of 105° C. for ten minutes, and by subsequently keeping these less putrescible fluids at a higher temperature (about 35° C.) they became turbid and swarmed with Bacteria in three days. Neither Dr. Sanderson's experiments nor those of Mr. Lankester and Dr. Pode have, therefore, the cogency which Mr. Lankester imagines them to possess. But, as I have endeavoured to point out on a previous occasion (NATURE, vol. viii. p. 548), experiments of this kind at the present stage

of the controversy can teach us nothing definitely as to the death-point of Bacteria and their germs, though they are of interest with regard to the question of the degree of heat which suffices to check the productivity of the fluids in question.

We are now told that Mr. Lankester himself, and those with whom he sides, are agreed as to the fact that Bacteria are killed at "a temperature a little below 70° C." Of course I cannot tell to what extent Mr. Lankester is in possession of the views of Prof. Huxley and others, but if what he states is really true, the statement is of a reassuring nature; it looks like progress, and leads me to hope that the only remaining doubt may soon be solved. How long does it take for the "through-heating" of certain "possible" Bacteria germs? This is now the knotty problem which, according to Mr. Ray Lankester, seems alone to require solution before we can positively decide as to the heterogenetic origin of Bacteria. Perhaps I may help him on his way to the solution of this difficulty by calling his attention to certain experiments made in Calcutta by Dr. Timothy Lewis, in reference to the existence of living tape-worm germs in cooked meat ("Report of Sanitary Commissioners with the Government of India, 1871"). Dr. Lewis says:—"The temperature of legs of mutton which had been put into the boiler almost as soon as the water was put into it averaged 140° F. (60° C.) in the interior at the moment the water had reached the boiling point (212° F.), and after boiling for five minutes the temperature had reached 170° F. (76° C.)." Now with these facts in his possession, and with some suggestions from physicists of his acquaintance as to the mode of conduction of heat generally, Mr. Lankester may perhaps soon solve his problem, so far as this is practicable. The problem itself may be stated thus:—If the through-heating of several pounds of protoplasm in the shape of a leg of mutton, when immersed in water, takes place at such a rate as to raise the central portions of the joint to a temperature of 60° C. by the time the water has reached 100° C., and if the exposure of the leg of mutton to this heat for the space of five minutes suffices to raise its central portions from 60° to 76° C., how many seconds, minutes, or hours will it take to heat an infinitesimal part of a grain of protoplasm (all through) to the temperature of 76° C.—that is, to a degree of heat decidedly above the death-point of bacterial protoplasm as given by Mr. Ray Lankester? The Bacterium-germ in question, it must be recollected, cannot be supposed to have undergone any extreme amount of desiccation previous to its immersion in the experimental fluid, since such desiccation would have already destroyed its life, according to Dr. Sanderson.

Whilst Mr. Lankester is seeking the solution of the problem above stated, perhaps he might with advantage also reflect a little more closely upon the possible value or otherwise of some of the negative results to which he is so fond of alluding. It is perhaps scarcely necessary for me to remind Mr. Lankester that the obtaining of such negative results is always easy, and may show nothing more than the relative incapacity of the experimenter for performing careful work according to instructions. Not long ago Mr. Lankester, upon the strength of his own negative results, triumphantly announced that he was about to prove to the world the falsity of my views, and so help to justify the opinion which he at the same time expressed as to my being "the mesmerised victim of delusion," "an abnormal psychological phenomenon," and many other fine things. But unfortunately for Mr. Lankester, just about the same time Dr. Sanderson (whose opinions he so much respects) had an opportunity of satisfying himself that I could demonstrate the experimental results which Mr. Lankester failed to obtain. Dr. Sanderson helped to show, in fact, that my positive results were worth more than the many negative results obtained by other workers.

Finally, I think it necessary to add a few words concerning the views of my colleague, Dr. Sanderson, on the subject of heterogenesis, simply because I find his experiments and supposed views frequently quoted by Mr. Lankester, and others, as evidence of the erroneous nature of my conclusions.

I have been led by my experiments to believe in Heterogenesis and also in Archebiosis, but I regard the recognition of the present occurrence of Heterogenesis as of far more importance than the recognition of Archebiosis. Now the controversy between Needham and Spallanzani, and also that between Pasteur and Pouchet was as to the present occurrence or non-occurrence of heterogenesis. This was what they understood, and what the majority of people at the present day still understand, as "Spontaneous Generation." And as to the reality of this process, Dr. Sanderson has been convinced. He admits that Bacteria may appear in flasks, and other situations, where we are warranted in believing that no bacterial matter pre-existed—which is exactly equivalen to a belief in "Spontaneous Generation," in the sense implied by Pasteur and others. In support of this statement I have only to make the following quotations from his papers and reported speeches of the last two years. Referring to experiments made in 1871, Dr. Sanderson says: "Bacteria could not be shown to be present either actually or in germ in the healthy liquids or tissues, or in the products of healthy inflammation" (*British Medical Journal*, May 11, 1872, p. 508). This statement was made with reference to man, and also to the lower animals with which he had experimented. In another part of the same communication as it stands revised in the "Transactions of the Pathological Society," for 1872, Dr. Sanderson says: "If a few drops of previously boiled and cooled dilute solution of ammonia are injected underneath the skin of a guinea-pig, a diffuse inflammation is produced, the exudation liquid of which is found, after twenty-four hours, to be charged with Bacteria." Other chemical agents will act in the same way even when every precaution against external contamination has been adopted; and as a drop of this fluid introduced with equal care into the peritoneum of another animal is always capable of exciting the phenomena of pyæmia, Dr. Sanderson has made known the very important fact that this process "can be proved to be capable of originating from inflammations produced by chemical agents *under conditions which preclude the possibility of the introduction of any infecting matter from without.*" Again, in a speech delivered last month before the Clinical Society, and reported verbatim in the *British Medical Journal* for March 24, Dr. Sanderson insists upon the complete establishment of the truth of this latter proposition both for man and the lower animals. He says: "We must admit that the whole process of pyæmia can originate in the organism independently of external influences." But, as he also says: "In every pyæmic inflammation—whether it be a primary or a secondary one—in every form of pyæmic action, you have always the presence of septic products," that is of Bacteria. Now if Bacteria by their germs do not normally exist in the tissues of animals, and if you can determine their presence there at will under conditions which, as Dr. Sanderson says, "preclude the possibility of the introduction of any infecting matter from without," what must be the mode of origin of the Bacteria in such cases, and how can Dr. Sanderson do other than yield his assent to the doctrine of "Spontaneous Generation," or Heterogenesis, so far as the origin of Bacteria is concerned?

University College, April 6 H. CHARLTON BASTIAN

Earthquake in St. Thomas

ON the morning of the 11th instant at 4.30 A.M., a smart shock, accompanied by a rumbling noise, like that of a waggon rolling over rough pavement, travelling, as is usual here, from east to west, woke up the inhabitants of St. Thomas. It was followed within a few seconds by another shock, to the full as abrupt in its character as the first; the movement appeared to be not so much undulatory as vertical.

The concussion produced was felt still more distinctly within the harbour itself, where the jar communicated to the ships resembled, as one of the captains described it, that which might be produced by a heavy bale falling through the hatchways into the hold. Simultaneously the water of the bay, then perfectly still, assumed a turbid appearance, as though clouded by mud and sand; and a little later the surface was agitated by a strong ripple from the south, lasting some time.

On the same morning early the royal mail steamer *Corsica*, commanded by Capt. Herbert, was at anchor discharging cargo off the harbour of Dominique, about 170 miles distant from St. Thomas, S.E. The harbour is on the side of the island, and sheltered from the swell produced by the trade winds; the weather calm. Just about 5 A.M. a succession of heavy rollers broke in; they lasted for half an hour, and rendered all communication with the shore during that space impossible. No shock was felt on board the *Corsica*, but Captain Herbert caused note to be taken of the marine phenomenon, not doubting that it must have been due to an earthquake, as indeed was evidently the case.

The centre of disturbance would appear to have been in this case under the sea at some distance S.E. from St. Thomas, a direction often indicated in such occurrences. On one occasion only, that of the severe shock of November 1867, did the movement seem to have been propagated from due south, its centre

being in the deep soundings between the islands of St. Thomas and Ste. Croix.

During the same day two other slight shocks, one at about 10 A.M. the other at noon, were felt at St. Thomas; they were unaccompanied by noise. W. G. PALGRAVE

St. Thomas, W. I., March 21

Physical Axioms

CONVINCED that the fulfilment of astronomic predictions can never *demonstrate* the laws of motion, and yet feeling myself quite destitute of intuitive belief in those laws, I have been led to think that in the present controversy truth may lie somewhere between the positions respectively enunciated by Mr. Spencer and his critic.

By reasoning which seems to me equally lucid, ingenious, and unanswerable, Mr. Spencer has shown that certain ultimate mechanical laws are tacitly assumed in every process of experimental verification. But I do not see that this vitiates *completely* the inference drawn from such verifications. The pure empiricists argue that because certain observed results coincide with the results of calculation, therefore the assumptions on which the calculation was based must be true. Now without doubt the *demonstrative* character of this inference vanishes entirely under Mr. Spencer's searching criticism. But it seems to me that a *high probability* remains behind. For were there any but an excessively minute error in the laws of motion, our astronomical observations could agree with the results of calculation only by a conflict of errors—a conflict which Mr. Spencer himself hints at. But there are overwhelming chances that these errors would not be so accurately adjusted throughout an immense variety of cases as exactly to compensate one another in every single instance. Hence I cannot but regard the laws of motion as hypotheses, the truth of which is shown by experiment to be overwhelmingly probable. The doctrine here assumed may be illustrated by an appeal to those old friends of probability students—the dice. If I throw double sixes ten times running I naturally conclude that the dice are loaded. This supposition almost necessarily involves the sameness of the ten throws, whereas the supposition that they were not loaded is consistent with an immense number of other results. Our minds choose the former alternative in obedience to an instinct which might with much show of propriety be formulated into an axiom. We may, however, deduce a justification for it from two ultimate intuitions of our nature—belief in uniformity of sequence and the general doctrine of chances—intuitions by which the mind apprehends respectively the ultimate law of knowledge and the ultimate law of ignorance. Belief in any special fact beyond individual experience can be rationally arrived at only by applying the former law to that knowledge which our individual experience furnishes, and the latter law to that ignorance which our individual experience has failed to enlighten.

It is the *approximate* truth of the laws of motion to which I have throughout referred. That there may be an *excessively minute* error in all physical and even all geometrical principles, Prof. Clifford has long ago shown how unphilosophical it is to deny.

F. W. FRANKLAND

Royal College of Chemistry, April 18

The Fertilisation of Fumariaceæ

Apropos of the interesting discussion on this subject which has appeared in your columns, I should much like to know whether any of your readers have observed the mode of fertilisation in *Corydalis claviculata*. Last summer I spent a considerable time in attempting to find this out, but without success. In every flower which I gathered in the mature state, I found the style broken off at the articulation immediately above the ovary, as if to prevent the possibility of fertilisation after a certain period. As the interior parts are completely concealed by the corolla, it was difficult to determine whether the separation had actually taken place on the flower, or was the result of the dissection, but I believe the former to be the case. In a large number of observations, extending over a considerable time, I never saw an insect visit the plant (this was in Westmoreland), though seeds were freely produced. Müller does not mention this species in his classical work on the subject, "Die Befruchtung der Blumen durch Insekten." ALFRED W. BENNETT

ALLOW me to bring before the notice of readers of NATURE a small point bearing on the fact of the bright hue presented, after fertilisation, by the flowers of *Fumaria capreolata*.

Is it not possible that the pale colour may be more attractive to the fertilising insects than a brighter one would be? May not the drawing-principle be the result of correlation between the art-manifestations of the attracting and the æsthetic susceptibilities of the attracted organism, and not depend solely on gaudiness of the flower? If this be so, we know that these susceptibilities have, at any rate sometimes, a very limited range, as is seen in the bee-orchis, where the similarity of the labellum to the body of a bee is very close, both in colour and in form, and cannot be useless, seeing that a great amount of developmental force is expended in its production. On this view also the rejection of highly-coloured poisonous caterpillars may in part be referred to the non-agreement of their hues with the orthodox colour-notions of birds. On the other hand, if mere gaudiness is aimed at, why should there be such diversity exhibited? why would not one colour answer the purpose in every instance?

The present case is capable of ready explanation on the supposition that it comes under the influence of natural selection; for, as Mr. Spencer has shown, the hue of the flower results from a diminished amount of nutritive material supplied to the coloured parts, so that the least vigorous individuals would have these most highly coloured at the time of fertilisation. But since the pale flowers are preferred by the insects, they would stand a better chance of being fertilised than would the bright ones, so that a process of selection would be set up resulting ultimately in the disappearance of the latter.

If it be established that cross fertilisation is not the rule with the flowers of this fumitory, of course it is a fact which has nothing whatever to do with the present argument, and the explanation given by Messrs. Darwin and Müller is entirely satisfactory. I cannot but think, however, that special attention will bring to light many cases of cross-fertilised flowers becoming more highly coloured after fertilisation, the phenomenon being explained simply as a decomposition-phase in the life-history of the contents of the cells composing the coloured organs.

S. MOORE

I VENTURE to suggest the following as possibly an explanation of the fact observed by Mr. Traherne Moggridge, that the flowers of *Fumaria pallidiflora* attain their brightest colouring when the time for their fertilisation has past.

In plants with a racemose inflorescence the individual flowers do not open simultaneously, but more or less in succession. The flowers lowest in the raceme open first: by the time they have in *Fumaria pallidiflora* attained their brighter colour, those a little higher up on the rachis are just at the stage for fertilisation, and the former may serve to attract insects to the latter, just as in some plants (*e.g.* Poinsettia) we may presume that the highly-coloured bracts attract insects to the comparatively inconspicuous flowers which they surround. The flowers a little way up the raceme would serve in their turn to attract insects to those above them; and these again to those still higher; the process going on for a considerable time in Fumaria, as it is quite common for the pedicels in the lower part of a raceme to be bearing fruit that has attained its full size, while at the top there are flower-buds still unopen.

Quisqualis indica affords another instance of flowers assuming a more intense colour after fertilisation. Its flowers grow in short spikes; on first opening and during fertilisation, are white, very faintly tinged with pink; but subsequently turn a light reddish-orange, and finally a purplish-red. T. COMBER

Newton-le-Willows, April 7

Power of Memory in Bees

ILLUSTRATIONS drawn from experiments or observations made upon animals lower than ourselves in the scale of life must always possess great interest. That impressions received by us in early life are more permanent than those made in after years, and that the memory of the old is less retentive in the reception of new impressions than is that of children, are circumstances universally acknowledged. On October 29, 1873, I removed a hive of bees in my garden, after it was quite dark, for a distance of 12 yards from the place in which it had stood for several months; and between its original situation and the new one there was a bushy evergreen tree, so that all sight of its former place was obstructed to a person looking from the new situation of the hive.

Notwithstanding this change, the bees, every day, flew to the locality where they formerly lived, and continued flying around the site of what had been their home, until, as night came on, they many of them sank upon the grass exhausted and chilled by the cold. Numbers, however, returned alive to their new position,

after having looked in vain for their hive in its old place. At night I picked the exhausted bees up, and, having restored warmth to them (by leaving them for a time upon my coat-sleeve), I returned them to their companions.

Here was an illustration that the faculty of *memory* was superior to that of *observation*; but that was not all. Nearly every bee which I picked up during the twenty-three days through which this effort of memory lasted was an *old one;* as was easily deduced from observing the worn edges of the wings: showing that, whilst the young insects were quick in receiving new impressions, and in correcting errors, the nervous system of the old bees continued *acting in the direction which early habit had affected.* So true is it that "One touch of *Nature* makes the whole world kin."

Marlborough House, Torquay JOHN TOPHAM

Pollen-grains in the Air

WILL you allow me to ask Mr. Hubert Airy, in reference to his interesting paper on the "Microscopic Examination of Air," in NATURE, vol. ix. p. 439, on what ground he refers the "triangular pollen" captured on his slide to the birch and hazel? Observations of my own have led me to the conclusion that the pollen of plants which depend exclusively on the wind for their fertilisation is perfectly spherical, at all events before the form of the grain is disturbed by the emission of the pollen-tubes, and this indeed one might expect from *à priori* considerations. Among the pollen-grains I have especially observed, are those of *Corylus avellana*, *Betula alba*, and *Populus balsamifera*. I shall be much obliged if any of your readers could refer me to any accurate published description of the form of pollen-grains beyond those contained in Fritzsche's "Beiträge zur Kenntniss des Pollen." ALFRED W. BENNETT

6, Park Village East, N.W.

Lakes with two Outfalls

I AM a little surprised to find, by the recent letters in your paper, that Science makes so wide a mouth over this phenomenon, though its exceptional character, and the general correctness of Colonel Greenwood's theory, must readily be recognised. My surprise is occasioned by the fact that Norway, which is now visited by thousands of educated English tourists every year, can supply, not one, but several, I had almost written many, apparent examples of this double outflow. I have not myself passed the watershed at the Lesjeskaagen Lake, though I was close to it in August last, and would have examined it if I had known its importance; but I know enough of the locality to think that Colonel Greenwood is probably right in his explanation of it. But there is another, which I have passed, and which is situated on perhaps the most frequented route in Norway, viz. that from Lærdalsören over the Fille Fjeld, to which I hardly think the same explanation would apply. Between Nystuen and Skogstad is a chain of lakes crossing the watershed, the highest of which (not the one marked on the Vei-cart over Norge, I think) sends its waters to the west, past Nystuen to the Sogne Fjord, at Lærdalsören, and on the east by the Lille Mjösen, and Aadalen to the Tyrifjord, and so past Drammen to the Christiania Fjord. This lake is a small one, and the double outflow is close to the high road. I cannot imagine any commercial object for an artificial cut, and it must be well known to hundreds who annually pass it. The Vei-cart shows several other instances, I know not how authentic, though I have always found it fairly accurate, erring rather by omission than commission. But in lat. 62° N., long. 24° 40′ E. or thereabouts, is a very remarkable watershed, having a complication of outfalls; the Bredals-Vand sending one to the N.W. to the Geiranger Fjord, and a second to the Vaage-Vand and Gudbrandsdalen; which is also joined by a draft from a lake to the S.W., which likewise sends a feeder to the Opstryen Vand, and so W.S.W. to the Nord Fjord. This I have not myself seen, but I was at Merok on the Geiranger for some days last August, and was assured by my landlord that the map was correct in this particular. As the Norwegian peasantry are well-educated, intelligent, and truthful, and this route forms their regular short cut to Christiania, I cannot doubt but that it is the fact. However, I have engaged to go over the track this summer with Captain Dahl, the well-known jolly commander of the *Erknö*, and I will take care to ascertain the truth and report the result. If, moreover, there are any geological or geographical points to be attended to, and Colonel Greenwood will kindly furnish me with instructions, I shall be happy to attend to them.

I have a strong recollection of having passed two or three cases of double outfall on a small scale in my wanderings; but not having been aware of the importance of the point, I did not take notice sufficiently precise to enable me now to put my finger on them with certainty, but my general conviction is strong, that Norway can furnish several, if not many examples, which are the more significant from the fact that it is one of the oldest countries in the world. W. B. THELWALL

Burghley Road

WILL you permit me to correct a mistake as to a matter of fact in NATURE, vol. ix. p. 441. Loch-na-Davie, Arran, has two outlets, as is correctly represented in the Ordnance Map, and also in that in Bryce's "Geology of Arran." In August 1872 I walked up the north stream from Loch Ranza to its outfall from Loch-na-Davie. I think Colonel Greenwood ought at least to have made himself acquainted with the Ordnance Map.

Edinburgh A. CRAIG CHRISTIE

*THE "CHALLENGER" EXPEDITION**

IV.

TRISTAN D'ACUNHA

AMONGST the places in the Atlantic marked out by the Circumnavigation Committee as being of especial interest, the small island of Trinidad is noted with those whose vegetation is absolutely unknown, or all but so. From this fact Trinidad became a point of attraction which Mr. Moseley was most anxious to reach. Owing, however, to unfavourable winds and other causes, as well as to a desire of those in command of the ship to proceed south, the visit to this little island was abandoned, with the hope of calling there on the return voyage. After a narrow escape, also, of missing Tristan d'Acunha, the vessel anchored on the north side of the island, and the morning was spent in searching the low lands under the cliffs, 500 feet being the greatest height that was attained during the stay. On this side the island rises in a range of perpendicular cliffs of black volcanic rock, in appearance somewhat similar in structure to that exposed in section in the Grande Cural in Madeira. At the base of the cliffs here are *débris* slopes, and a narrow strip of low shore land of an irregular rocky and sandy nature. The settlement lies on a stretch of low land, broader and more even, and extends westward. The ascent to the plateau above the cliffs is comparatively easy, owing to the deep gullies by which the cliffs are broken.

Though the extent of the island is small, its actual area being not more than 16 square miles, the botanising was confined to the irregular strip of shore land just alluded to, and to the gully immediately above the settlement. Further exploration would have been made, but a sudden squall coming on, the recall was hoisted from the ship, and the party had to leave the island, after a visit of only six hours. Grasses, sedges, mosses, and ferns grow on the cliffs, and occasional patches of *Phylica arborea* Th., a rhamnaceous tree peculiar to the islands, as well as a species of *Empetrum*; these plants, however, are more prominent towards the summit. At the foot of the water-courses under the cliffs are bright green patches of *Rumex frutescens* Th. Mosses and liverworts cover the lower part of the cliffs, and the latter also abound beneath the grass in some situations to such an extent, indeed, as to cover the earth as with a green sheet. *Spartina arundinacea* Carm., grows in rounded tufts amongst the other herbage, and in the clefts of the rocks was seen in abundance *Asplenium obtusatum* Forst., and *Lomaria alpina* Spreng. It is remarkable that the plants of *Lomaria* when found in stony places, and in a comparatively starved condition, were mostly furnished with fertile fronds, whilst those growing in rich vegetable mould were barren. Amongst flowering plants the most common were *Apium australe* Th., *Pelargonium australe* Jacq., *Sonchus oleraceus* L. our common annual sow-thistle, *Hypochæris glabra* L. a closely allied plant to the sow-thistle, and also found in many parts of England. A cinchonaceous plant, *Nertera depressa* Banks, was very abundant, and

* These Notes are founded on letters sent home by Mr. H. N. Moseley. Continued from p. 451.

Oxalis corniculata L., with its yellow flowers, was likewise seen, but not in any quantity.

An interesting plant—*Chenopodium tomentosum* Th.—grows abundantly on Tristan as well as on Inaccessible Island; it is known as the tea plant, and the leaves, which are strongly scented, are used for making a decoction which is drunk with milk and sugar.

In the gully above the settlement, shrubs of *Phylica arborea* commence at an elevation of about 400 ft. No trees are found in this locality, having all been cut down at different times for fire-wood, but on other parts of the island there is abundance of wood. The diameter of the trunks of the trees on the upper plateau, it is said, reach to 18 in. On some fresh-water ponds close to the sea was a quantity of confervæ, but no chara was seen, a species of *Isolepis* also grew on the edges of these ponds which was not seen on the other two islands. A few willow bushes grew in a sheltered situation in a ditch near the cottages, and seemed to be thriving. Growing round the island is a belt of *Macrocystis pyrifera* Ag., a gigantic sea-weed, abounding in the southern temperate zone, and stretching up from thence along the Pacific to the Arctic regions. It occurs in immense lengths, single plants of from 100 to 200 ft. being common, and it is said that they are sometimes seen from 700 to 1,000 ft. in length, forming cable-like masses nearly as thick as a man's body, and having the appearance of huge buoys.

The surf on the rocky coast of Tristan is so heavy that the more delicate sea-weeds stand no chance, but are dashed and torn into numerous pieces.

The temperature of the fresh-water ponds at the sea-level gave a result of 54° F. while the water of the streams running down the cliffs stood at 50°, the difference being due evidently to the influence of the snow-water from above.

FUNERAL OF THE LATE DR. LIVINGSTONE

ON Saturday last the remains of David Livingstone, which left Central Africa now nearly a year ago, were interred in Westminster Abbey, in presence of a multitude such as was probably never collected therein on any similar occasion. The funeral procession, which started from the Geographical Society's Rooms, Savile Row, was of great length, though of the plainest description possible under the circumstances; we have not learned whether this was in accordance with the wishes of the late traveller's relatives, or whether it arose from scarcity of funds. Every mark of respect was shown to the procession along its route, and at several advantageous points considerable crowds had collected to witness the last journey of the great explorer.

Men of all ranks and of all pursuits in life formed part of the procession, and stood around the grave during the service in the Abbey. The patriarchal Dr. Moffat, Livingstone's father-in-law, and the traveller's two sons, Thomas and Oswell Livingstone, Mr. James Vavasseur, Sir F. Steele, Dr. Kirk, Mr. W. F. Webb, the Rev. Horace Waller, Mr. H. M. Stanley, Mr. E. Young, Sir W. Fergusson, the Duke of Sutherland, Sir Bartle Frere (President of the Royal Geographical Society), Sir H. C. Rawlinson, Vice-Admiral Baron de la Roncière le Noury (President of the French Geographical Society), Dr. Hooker (President of the Royal Society), Mr. C. R. Markham, Mr. R. H. Major, Mr. H. W. Bates, Dr. Houghton, Mr. J. Young of Kelly, are the names of some of those who followed the body to the grave; there were besides, deputations from Edinburgh, Glasgow, and other places, and the carriages of Her Majesty the Queen, the Prince of Wales, and of many other noble and distinguished persons formed part of the procession. Among those who were waiting inside the Abbey were men of every shade of thought, political and religious, men distinguished in every walk of life, deputations from many religious bodies, from the establishment outwards, and representatives of various scientific Societies. The bearing of the crowds both outside and inside the Abbey showed that they were brought together from genuine admiration and sincere respect for the memory of the simple-minded hero.

We think the character of the assemblage which gathered to do honour to Livingstone's remains is one proof that he has done a work calculated to call forth the admiration and gratitude of those whose suffrages constitute fame of the highest and most enduring kind. If to conceive a great and noble purpose and to carry it out even unto death, with indomitable energy, determination, and the greatest skill, in the face of every possible discouragement, discomfort, and obstacle, be a mark of greatness, his contemporaries have certainly made no mistake in raising David Livingstone to the lofty pedestal which he at present occupies. He has probably added more largely to the sum of exact geographical knowledge than any other explorer has hitherto done. As Dean Stanley eloquently said in his funeral sermon on Sunday afternoon:—"By his indomitable resolution we have now revealed to us, for the first time, that vast tract of Central Africa which, to the contemplation of the geographer, has been literally transformed from a howling wilderness into the glory of Lebanon. The blank of unexplored regions which in every earlier map formed the heart of Africa is now disclosed to us adorned with those magnificent forests, that chain of lakes 'glittering'—to use the native expression—'like stars in the desert;' those falls more splendid, we are told, even than Niagara, which no eye of civilised man had ever before beheld. And to his untiring exertions, continued down to the very last efforts of exhausted nature, we owe the gradual limitation of the basin within which must at last be found those hidden fountains that have lured on traveller after traveller, and have hitherto baffled them all."

A deputation of gentlemen interested in the family of the late Dr. Livingstone waited on Monday upon the Chancellor of the Exchequer and the Secretary of State for Foreign Affairs, for the purpose of representing to Her Majesty's Government the very general anxiety that was felt throughout the United Kingdom that some substantial recognition, in the shape of an adequate provision for his family, should be made of the services of the great traveller. A requisition to the Prime Minister, asking him to confer a pension on the family of Dr. Livingstone, was on Monday night circulated among members of Parliament at the House of Commons. A large number of signatures has already been attached by gentlemen on both sides.

About three years ago, Her Majesty, at the recommendation of Mr. Gladstone, conferred a pension of 300*l.* a year upon Dr. Livingstone, who, however, it is sad to think, never knew that his services had been so recognised by the Government. Upon the death of Livingstone the pension ceased, but it was deemed by Mr. Gladstone a matter of sheer merit, due to the great explorer, to confer some pecuniary benefit upon his children, and the figures on the civil list were thereupon reduced from 300*l.* to 200*l.*, which is actually the amount that will henceforth be paid by the Government to those he has left behind him. Though Dr. Livingstone made a large sum of money out of the first book he published, still he disbursed more than half that amount in his promotion of the exploration of the Zambesi.

Livingstone's devotion to the cause of science and of philanthropy has thus been the means of leaving his family very inadequately provided for; but as he has added so greatly to the glory of his native land, and as he spent his life in the service of civilisation, we feel confident that those for whom he was therefore unable to provide will be well cared for.

From a letter in yesterday's *Times* we see that the Diary kept by Jacob Wainwright for nine months after Livingstone's death will shortly be published.

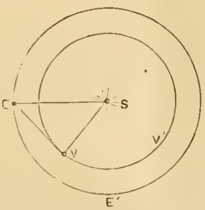
THE COMING TRANSIT OF VENUS *

II.

THERE is perhaps no problem which has been so constant a source of interest to the learned in all ages as the solving of the mystery of the solar system. The labours of Copernicus, Tycho Brahé, Kepler, and Newton have given us a general knowledge of the nature of the planetary motions; and the investigations of later mathematicians have enabled us to predict, with wonderful accuracy, the future positions of the planets. But the dimensions of the solar system are not known with the same precision.

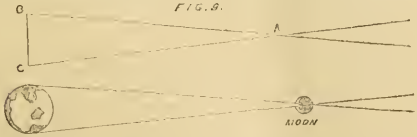
It is true that we know the *relative* distances of all the planets from the sun with tolerable exactness. This problem has been attacked in two totally different methods. The first is by measuring directly the changes that are

FIG. 8



produced in the motions of the planets when the earth has moved through a certain portion of its orbit. In the case of the planets Mercury and Venus, which move in smaller orbits than that of the earth, the direct observation can easily be made. For let us suppose VV′ and EE′ (Fig. 8) to be the orbits of Venus and the earth, and S to be the sun. Let us watch the position of Venus night after night until she is as far away from the sun as possible. If we measure her apparent distance from the sun by astronomical means, we shall know that the sun, Venus, and the earth occupy positions such as S, V, and E; the directions ES and EV being known from our observations. By measuring off the distances SV and SE on the diagram, we actually find the relation between the earth's distance from the sun and that of Venus. The same can be done with Mercury; but for the superior planets the direct mode of observation is more difficult.

FIG. 9.

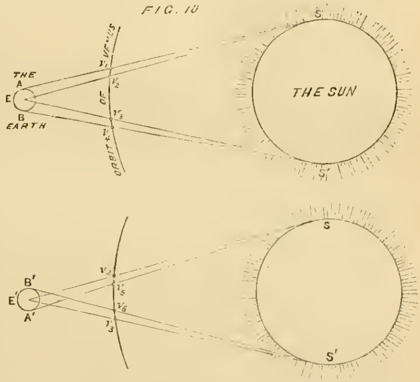


But there is an indirect method which is much more easy to apply. Kepler's three laws have been shown to be necessary consequences of Newton's theory of gravitation. Now Kepler's third law tells us how to find the relative distances of two planets from the sun when we know the relation between their periods of revolution. The exact law is this:—Multiply the number of years taken by a planet to go round the sun, by the same number. This gives us a first number. Then find a second number which, multiplied by itself twice, gives us the first number; this second number is the distance of the planet from the sun (the earth's distance being called 1). To take an example: Jupiter takes about 11 years to go round the sun; 11 multiplied by 11 gives us a first number, 121. Now if 5 be multiplied by 5 we get 25, and if this be again multiplied by 5 we get 125, which is almost the same as the first number, 121. Hence we are right in saying that Jupiter is about five times as far from the sun as the earth. If we had used the exact number of years we should have got the exact distance. Now it is very easy to find the period of revolution of a planet. For we can easily measure the interval between two dates when Jupiter and the earth, for example, are in the same line with the sun; in other words, we can measure the "synodical revolution" of Jupiter; and from this it is easy to calculate the time of Jupiter's revolution round the sun.

By applying these methods to all the planets we can lay down their orbits upon a plan; *all we wish now is to find the scale upon which our plan is drawn.* If we knew the distance of the earth from the sun, or if we knew the distance between any two of the planetary orbits, we should know the scale upon which our plan is laid down. Various methods have been adopted for this, but the one which makes use of a transit of Venus has generally been considered to be the most accurate.

One method which has successfully been applied to measuring the moon's distance is that used by surveyors. The surveyor chooses two spots, B, C, whose distance he measures. Suppose it to be one mile. He draws this distance, say, to one inch on a sheet of paper. He then

FIG. 10



takes a telescope, mounted so as to enable him to measure any angle through which it is turned. He places the telescope at B, pointing towards C. He then turns it till it points at the distant object, and finds what the angle of B is. He then draws the line BA upon the paper, and he knows that the distant object lies somewhere on the line BA. He then does the same with C, and thus he knows that the remote object lies on CA. But A is the only point lying both on BA and CA; hence A corresponds to the distant object. If on measuring CA he finds it to be 30 inches, then since CB, which is 1 inch, means one mile; CA, which is 30 inches, means 30 miles, and this is what he wanted to find out.

If, instead of taking a base-line (as it is called) of one mile, the diameter of the earth, or 8,000 miles, be taken; then, if the moon be the distant object, we can determine its distance in almost the same way. It is in this manner that the moon's distance has been measured. It is easy to see that if the angle at A (Fig. 9) were very small, a slight error in measuring either of the angles B or C would make a great difference in the distance deduced for the remote object. Hence, if the moon's parallax were very small, this method would be unsuitable. But the parallax of the sun is very small, and

* Continued from p. 419.

hence we cannot find the sun's distance with any exactness by this method.

But if any one of the planets ever came so close to the earth as to make its parallax tolerably large, then we could determine the scale upon which the solar system is built up. Now Venus and Mars are two planets which at certain times come closer to the earth than any other planet. But, unfortunately, when Venus is most near to the earth she is generally invisible, because the whole of her illuminated side is turned away from us. Mars, however, is a planet that gives us a very favourable opportunity for determining its distance. The advantage is increased by this peculiarity, that every fifteen years Mars is at its shortest distance from the sun, at the same time that the earth is at its greatest distance, the two planets being also in the same line with the sun, so that they are closer than we might have thought possible. In fact, on these occasions Mars is nearer to the earth by $\frac{1}{25}$th part than she is if the conjunction take place when both the earth and Mars are at about their mean distances from the sun. Suppose then that under such circumstances two observers, one at Greenwich and the other at the Cape of Good Hope (where there is a fine observatory), observe the position of Mars as compared with that of a star at the same time. The position of Mars will be displaced by parallax; and by comparing the apparent distance of the planet from the fixed star at these two places we can find the sum of the parallaxes in these cases. Hence we can find the distance of Mars, as already explained.

This was the first method to give a value of the solar parallax with anything like accuracy. At the suggestion of Cassini, the French sent out an expedition to the Cape, under the astronomer Picard. The value obtained for the sun's parallax was 9″·5. Prof. Henderson in 1836, and Mr. Stone, in 1862, utilised this method. Another opportunity will occur in 1878.

Before proceeding to the method of the Transits of Venus, it will be well briefly to allude to some other methods by means of which the solar parallax, or the sun's distance, has been estimated.

It has been found that light takes a sensible time to propagate itself through space. Hence, when one of Jupiter's satellites passes into the shadow of the planet, this fact is not communicated to our vision for something like 38 minutes, the time taken by light to pass from Jupiter to the earth. Now, when we are on the same side of the sun as Jupiter, this distance is shorter by the whole diameter of the earth's orbit than when we are at the opposite side of the sun. Hence, in the former case, the eclipses will seem to take place sooner than the predicted time, and in the latter case later. The difference in either case is about 8 minutes, and as we know that light travels over 298,500 kilometres per second,* this tells us that our distance from the sun is about 91,000,000 miles.

But our knowledge of the velocity of light has been utilised in another manner to solve the same problem. You see that if we know the earth's velocity in miles, we can find its distance from the sun. For if it goes $1\frac{1}{2}$ million miles in one day, it must go over 365 times that in a year, and *that measures in miles the circumference of our earth's orbit*, and hence we can get our distance from the sun. How then are we to find the velocity of the earth in miles. This depends on a curious property of light. In a steady down-pour of rain you hold your umbrella upright if you are standing still, but incline it forward if you are walking fast. This is to make the umbrella catch the rain-drops. The amount of inclination you give it depends upon the rate at which you are walking compared with the velocity with which the drops fall. The same thing happens with light. We have to incline our telescopes forward a little in the direction in which the earth is moving to catch the rays of light; and at opposite seasons of the year the earth is moving in contrary directions, and the telescope has to be pointed in sensibly different directions. The inclination that a telescope receives is known, and the velocity of light being known, we can find the velocity of the earth, and hence, as I have shown, the distance of the earth from the sun.

There is another method of peculiar interest depending upon the motions of the moon. The law of gravitation says that the attraction of each body for each other one depends upon the distance between them. The moon is attracted to the earth by a force, depending upon the distance of the moon, which is known in miles. But the moon is caused to deviate from its natural course on account of the sun's attraction. This depends upon the distance of the sun from the earth, and if this be not known exactly in miles we shall see that it is impossible to apply calculation to foretell the motions of the moon; for, if upon any scale we attempt to lay down upon paper the relative positions of the sun, earth, and moon, we shall place the moon at its proper distance, and the sun, though in its proper direction, will not be placed at the proper distance, and we shall not know the direction in which it attracts the moon, nor the magnitude of this attraction, and we shall make our calculation wrongly, and the moon's observed place will differ considerably from its calculated place.

Such a difference was actually detected by the illustrious Hansen, whose tables of the moon are the best we possess. Hansen saw that this must be due to a wrong assumption as to the distance of the sun, and communicated his doubts to the Astronomer Royal * in the year 1854. This led to a re-discussion of our knowledge of the subject which has confirmed Hansen's views, and which leads us to see the importance of knowing accurately the sun's distance, if we wish ever to have our tables of the moon so accurate that we may determine the longitude by their aid. This method for investigating the solar parallax was first used by Laplace.†

More recently, M. le Verrier has suggested a new method that promises in time to be the best.‡ In the lunar theory, an equation appears connecting the relative masses of the earth and sun with the solar parallax, so that if we know the one we can find the other; and from a peculiarity in the equations, a small error in determining the relative masses will affect only very slightly the deduced parallax. Le Verrier finds the ratio of the masses of the earth and sun by determining the effect of the earth's attraction upon Venus and Mars. This being applied to the lunar theory, a value of the solar parallax is obtained.

The method, however, which has found most favour up to the present time, is the employing of transits of Venus to measure the sun's distance. When a transit of Venus occurs, the first evidence of the phenomenon is given by a slight notch being made in the contour of the sun's edge at a certain spot. This notch increases until the full form of the planet is seen. The first appearance of a notch is called the time of first external contact. But when the planet appears to be wholly on the sun, her black figure is still connected with the sun's limb by a sort of black ligament, of which we shall say more hereafter. When the whole of the planet is just inside the sun's edge, the time of first internal contact has arrived. The breaking of the ligament is a very definite occurrence, and was, until lately, taken to indicate the true moment of internal contact. The second internal and external contacts take place as the planet leaves the sun.

In 1663, the celebrated James Gregory, in his famous work the "Optica Promota," *prop.* 87, *Scholium*, alludes

* As determined by Foucault, *Comptes Rendus de l'Acad. des Sciences*, vol. lv. p. 502; also by Cornu, *Comptes Rendus*, Feb. 10, 1873.

* *Monthly Notices, R.A.S.*, vol. xv., Nov. 1854.
† *Système du Monde*, t. ii. p. 91.
‡ *Comptes Rendus*, July 22, 1872.

to the possibility of determining the sun's parallax by means of the transit of an inferior planet. He has been showing methods of finding the parallax of a planet by comparison of observations made at different parts of the earth upon the position of the planet compared with that of a star. He then takes, in place of a fixed star, another planet, the two being in one line, as seen from the earth. The application of this to the case of Mercury or Venus and the sun, was obvious.

But Halley was the first to see clearly what a powerful means of determining the sun's parallax an observation of contact really is. So far as I can discover, he first mentions the method in a letter to Sir Jonas Moore, written at St. Helena in 1677,* just after having seen a transit of Mercury. The exactness with which he believed the time of contact to be determinable, led him frequently afterwards to urge his countrymen to make every effort to utilise the method on the occasion of the transits of 1761 and 1769, when he should be dead.† And thus, in addition to his celebrated prediction of a comet, he left a second legacy to his successors, who, as Englishmen, might be entitled to be proud of his foresight though he could not live to reap the glory of it.

It is a matter of some difficulty to show, in an elementary manner, the way in which the value of the sun's parallax can be found from observations of contact. We will try, however, to put it in a light which anyone, with a little attention, will understand.

1. It must be thoroughly understood, from what has already been said, that if we know the amount of the sun's parallax we know its distance. In other words, if we know the angle subtended by any known distance on the earth's surface at the distance of the sun.

2. We know that the relative positions of the earth, Venus, and the sun, are given by supposing the earth to go round the sun in 365 days, and Venus in 224 days. Or, if we please, we may take no account of the earth's revolution, but suppose it fixed, in which case the revolution of Venus *relatively* to the earth (*i.e.* the synodical revolution) is 584 days.

3. If, then, Venus moves round the sun through 360° relatively to the earth in 584 days, she moves through $\frac{1}{584}$ of that in one day, and through $\frac{360}{584 \times 24}$ of a degree in one hour; which is at the rate of about $1\frac{1}{5}$ seconds of arc in a minute of time.

Now we are ready to understand Halley's reasoning.

Let A (Fig. 10) be the position of an observer on the earth at the time of 1st internal contact. S is the sun, and V_1 is now the position of Venus. This observer sees the contact earlier than a hypothetical observer at the earth's centre would see it, by the time Venus takes to move over V_1V_2. If we knew by calculation the instant when an observer at E would see it, and the observer at A saw it 8 minutes sooner, then, since Venus moves over $1\frac{1}{5}''$ in a minute, she has moved over $8 \times 1\frac{1}{5}$ or $9\frac{3}{5}''$ of arc in this time, and hence we learn that the angle A S E = $9\frac{3}{5}''$.

Suppose that by the time of the last contact the point A on the earth's surface has been carried by her rotation to B: the time of the last contact will now be too late by $8'$; since the whole duration of the transit as seen by this observer is $16'$ too long, and the angle moved over by Venus in $16'$ is the sum of the sun's parallax as seen from A and from B.

But we cannot calculate with absolute accuracy the duration a transit would have when seen from E, because we should require to know more accurately than we do the values of Venus' and the sun's diameters.

Halley got rid of this by taking another station which should be in the position A at the beginning of the transit. In the case we have been considering the time of the first contact would here be too late by 8 minutes; and if this place had reached B′ by the end of the transit, the time of contact would be too soon by 8 minutes. Hence in this case the whole duration would be shortened by 16 minutes; but in the former case it was lengthened by 16 minutes. Hence 32 minutes is the time taken by Venus to pass over an angle equal to the sum of the parallaxes in the four cases considered. This difference of duration, whether it be 32 minutes or anything else, is a quantity which can be observed. Now Venus moves over about $1\frac{1}{5}''$ of arc in a minute, or $38\frac{2}{5}''$ in these 32 minutes. Hence one-fourth of $38\frac{2}{5}''$ or $9\frac{3}{5}''$ would appear, from the above hypothetical observation, to be the value of Venus's parallax.

It must be noticed that we have here supposed that the transit takes exactly twelve hours, whereas the longest transit cannot exceed 8 hours. We have also supposed that two stations had been selected which were exactly situated so as to bring out the full effect of parallax at the time of each observation. These suppositions have been introduced only to simplify the understanding of the method. Anyone who has followed the above explanation will see how the method may be applied to actual cases that may occur.

Halley saw (what many people fail to see even now) that the great accuracy of the method consists in this, that in one second of time Venus moves over about $0''\cdot02$; and if we can determine the time of contact, with an error of no more than a second, we are measuring the sun's parallax with an error of no more than ·02 of a second of arc.

Halley even pointed out the best stations for observation. We may consider the earth to be at rest if we suppose Venus to move with the velocity she has relative to the earth. He supposed that the planet would cross near the sun's centre, and that the transit would occupy about eight hours. An observer in India would see the commencement of the transit four hours before mid-day, and the end of the transit four hours after mid-day. But, in the meantime, the part of the earth where he is has been moving from west to east, and Venus has moved from east to west, hence the duration of transit will have been shortened. But at Hudson's Bay the transit begins just before sunset and ends just after sunrise, that part of the earth having moved in mean time from east to west so as to lengthen the transit; and thus at one place the duration of transit is lengthened, and at the other shortened, and the difference of time depends upon the parallaxes of Venus and the sun * at the two stations, and after finding these parallaxes we can calculate the equatorial horizontal parallax.

GEORGE FORBES

(*To be continued.*)

* Hooke's "Lectures and Collections," 1678.

† "Catalogus Stellarum Australium;" also "Phil. Trans.," 1694 and 5.

* This lengthening or shortening of the time of transit will be rendered more evident by an analogy. A person standing still sees a carriage pass between him and a distant house The carriage will take a certain time to pass the house. But if he be also moving, and in the same direction with the carriage, the transit of the carriage will take longer; but if he move in the opposite direction to the carriage, the transit will take a shorter time. If, then, two persons be seated at opposite sides of a merry-go-round, so that at the time the carriage seems to be passing the distant house, one observer is moving with the carriage and the other in the opposite direction; then one observer will see the time lengthened, and the other shortened Now, the world is such a merry-go-round, and the positions of these two people correspond to the positions of India and Hudson's Bay, as pointed out by Halley.

THE LECTURES AT THE ZOOLOGICAL SOCIETY'S GARDENS

I.

ON Tuesday, April 14, Mr. P. L. Sclater, F.R.S., gave the Introductory of the twelve lectures which are to be continued during the spring. His remarks on that occasion were chiefly confined to the subject of Zoological Gardens in general. After an interesting account of the most important continental gardens, including those of Paris, Amsterdam, Antwerp, Berlin, and Hamburg, he

went on to speak of the different animals which thrive best in captivity, taking each order of each of the great classes of the vertebrata separately, and pointing out that whilst some, as the Carnivora, thrive well in confinement, others, as the Insectivora, can hardly be kept in a menagerie at all.

On the following Friday Mr. Sclater commenced the first of four lectures On the Geographical Distribution of Mammalia. A fauna constituting the animals inhabiting a country, and a flora its plants, the lecturer went on to illustrate the fundamental law that the animals and plants found in far distant countries are usually different, and that those of near countries closely resemble one another. We find the animals in France much like those in England, those in Ceylon much less so, and those in Australia as different as possible. It might at first sight be thought that difference of climate caused the differences that are observed in geographical distribution, but that such is not the case is proved without difficulty by taking different countries in the same latitude and with a similar climate and comparing them. For instance, on and near the equator we have Borneo, part of Africa, and the country bordering the Amazons; nothing can be more different than their faunas, and yet they are similarly circumstanced, so far as temperature and climate are concerned. So the polar seas of the northern and southern hemispheres are very different as regards their animals, although nearly identical in climate. The auks and seals of the one are replaced by the sea lions and penguins of the other. The faunas of the Himalayas and of the Andes, mountains both in hot countries, are very different also.

The meaning of the terms "specific area" and "generic area" was then explained. A species, the aggregate of similar individuals, has an habitat or area of distribution which is definitely circumscribed. In some animals this area is large, as in the case of the lion; in others, as in the case of the aye-aye of Madagascar, it is extremely limited. Among birds this limitation, strange as it may appear, is sometimes extreme; on each of the two nearly adjoining mountains of Pichincha and Chimborazo there are species of humming-birds found, which occur nowhere else. The area which includes all the areas of the species of a genus forms a generic area. These areas are continuous, or were so at one time; physical changes having sometimes intervened to produce an apparent interval.

From these observations it is evident that the locality in which an animal is found is as important a fact in estimating its individuality as are its internal structure and general configuration. This point is frequently but too little taken into account.

The lecturer, having said thus much on the general subject, proceeded to show how the class of Mammals was to be distinguished from the other classes of Vertebrates, and stated that for geographical purposes the mammalia, or those animals which suckle their young, might be most conveniently divided into terrestrial and aquatic. Our knowledge respecting the former of these sections is, as might be imagined, much greater than of the latter; nevertheless, within the last few years the aquatic mammalia have received considerable attention, and have become much better known.

(*To be continued.*)

NOTES

THE magnificent bequest of 10,000*l*. has been made by the late Mr. E. R. Langworthy to the Owens College, Manchester, for the purpose of developing the chair of Experimental Physics. A splendid opportunity is thus afforded to the Professor of Physics in Owens College not only to advance original research in connection with that subject, but also of teaching the students of his class in the only effectual way by which physics can be taught. Physics, in short, can now be placed on the same footing in that University as chemistry. The terms in which the bequest is made are so forcible and clear that they deserve to be quoted here:—"I bequeath to the trustees of the Owens College ten thousand pounds, and I desire that the same may be applied by them as they may think best in order to establish in connection with that institution a professorship of Experimental Physics. It being my wish that students may be instructed in the method of experiment and research, and that Science may be advanced by original investigation. And I also desire that the professor from time to time appointed may be selected on account of his knowledge having been especially obtained by original investigation, and that his appointment shall be contingent upon the continuance of such investigation. And I declare that the above desire shall not be construed as a trust and bind the trustees to establish a professorship; but in case it shall be deemed advisable such money may be applied in such other way as the trustees for the time being may think fit, provided such money is only used for the purpose of promoting Science." The late Mr. Langworthy deserves credit not only for his liberality, but for the sound and advanced views he held as to how Science should be taught, and as to the necessity of encouraging original research in connection with the chairs of Science in our Universities. Mr. Langworthy has also bequeathed 10,000*l*. each to the Salford Library and Museum, and to the Manchester Grammar School, in the latter case for the purpose of founding twenty scholarships.

THE Chair of Chemistry in the University of Glasgow is vacant. We hope the Home Secretary in filling up the vacancy will, in the spirit which urged the late Mr. Langworthy to make the magnificent bequest above referred to, show by the appointment he makes the appreciation in which he holds original research. It is now high time that it should be distinctly understood that no man deserves to be appointed to a Chair of Science in any of our Universities unless he has shown that he has that knowledge of his subject which can only come from original investigation.

THE Professorial Chair of Physiology in University College, London, has become vacant by the resignation of Dr. Sharpey, who has held it since the year 1836.

SIGNOR L. M. D'ALBERTIS, the distinguished Italian traveller, who has lately penetrated into the mountains of New Guinea, and discovered the remarkable Bird of Paradise which bears his name (*Drepanornis albertisi*), has just returned to this country from Sydney, *viâ* San Francisco, bringing with him his large collection in every department of natural history which he formed during his expedition.

WE would call attention to the Swiney Course of Lectures on Geology which are at present being delivered by Dr. W. B. Carpenter, F.R.S., in the Middle Class School, Cowper Street, Finsbury. The course was commenced last Thursday, and will be continued on Mondays and Thursdays at 8 P.M.; there will be twelve lectures in all. We are sure that many of our London readers, on being made aware that such a course of lectures is being delivered by such an authority, will be glad to take advantage of the opportunity, especially as the lectures are free to the public.

THE first of the course of lectures at the Zoological Gardens given in pursuance of the provisions of the Davis Trust, was delivered on Tuesday the 14th, by Mr. P. L. Sclater, being an Introductory Lecture on the animals in the Gardens, of which he gave many particulars that seemed greatly to interest the audience. Last Friday Mr. Sclater gave the first of his course of four lectures On the Geographical Distribution of Mammals, in which he dealt with the general laws of the distribution of animals on the globe. Both lectures were well attended, the picture gallery being nearly full.

At the annual election to Mathematical and Physical Science Postmasterships in Merton College, Oxford, early in October an election will be made to two Physical Science Postmasterships, each of the value of 80*l.* a year, and tenable for five years from election, provided that the person elected do not accept any appointment interfering with the full course of academical studies. There is no limit of age, but candidates, if already members of the University, must not have exceeded six Terms from Matriculation. The persons elected, if not members of the University, will be required to pass the University Examination for Responsions within a year of election. The subjects of examination will be Chemistry and Physics. There will be a practical examination in Chemistry. Candidates will have opportunities of giving evidence of a knowledge of Biology; but it must be borne in mind that in such cases the examiners will look for evidence of an acquaintance with the principles of Chemistry and Physics equal in extent to that which is required in the Preliminary Honour Examination in the Physical Science School. A paper will be set in algebra and elementary geometry, which, *cæteris paribus*, will be of weight in the election to Postmasterships. Further information may be obtained from the Tutor in Physical Science.

Mr. R. Hind, writing to the *Times*, sends the positions of two telescopic comets, discovered within the last ten days. He says:—"The first was detected by Prof. Winnecke, at Strasburg, on the morning of April 12. It is a diffused nebulosity, about four minutes in diameter, somewhat extended on the side opposite the sun. Our observations during the past night give the following place:—April 21, at 3h. 22m. 9s. A.M., mean time at Twickenham—right ascension, 20h. 50m. 41·6s.; polar distance, 88° 10′ 50″; present diurnal motion about 5′ in R.A., and 1° 5′ in P.D., both decreasing. The second comet was found by M. Coggia at Marseilles, on April 17. It is much smaller than the above, but has a strong nuclear condensation. Last evening its observed position was:—April 20, at 9h. 47m. 15s. mean time—right ascension, 6h. 25m. 15·6s.; polar distance, 20° 15′ 23″. Its motion is slow, towards the south-west.

The instruments used by Dr. Livingstone in his last journey, a sextant, thermometer, and chronometer, are still exhibited in the map room of the Royal Geographical Society, together with some of his maps made in 1856-7. Those who have not before seen any of the maps will be interested in noticing the great care and neatness with which the work is done, and the amount of information crowded into them. There are also several portraits of the traveller taken at different periods.

At the last meeting of the Linnean Society, Dr. Masters and Messrs. Hiern and Maw were appointed to represent the Society at the forthcoming congress of botanists in Florence.

The removal of the Library of the Geological Society from Somerset House to Burlington House, has been completed.

Mr. Leonard Lyell, B.Sc., has been appointed Professor of Natural Science in the University College of Wales.

The Brothers Henry, astronomers at the Paris Observatory, have invented a modification of Leon Foucault's process for testing his telescopic glass mirrors. They are using that process at Secretan's in the construction of lenses used for dioptric astronomical instruments. One instrument constructed by them has been tried at the observatory and proved highly satisfactory; an object of an inch is equal to one of two inches when the surface has been worked under their optical supervision. They reject every part of glass which is not perfect. The first *lunette astronomique* so constructed has been sold.

In the last sitting of the Academy, M. Becquerel, senior, one of the greatest electricians of the age, was presented with a medal in commemoration of the Fiftieth Anniversary of the Academy, of which he became a member four years afterwards. In 1824 the sittings were private, and only open to a very few learned persons. The admission was considered to confer a great honour, and was a step preliminary to membership. It was only in 1834 that the secrecy was removed on the proposition of Arago; Biot raised an opposition to it, but was outvoted. The publicity of sittings was coupled with the publication of *Comptes Rendus*, a weekly journal, exclusively devoted to the papers read before the Academy, and which has rendered immense services for a period of thirty-nine years.

We very much regret that Sir John Lubbock's bill for the Preservation of Ancient Monuments was thrown out of Parliament last week by a very considerable majority. Patriotism seems to be at a discount in the House of Commons.

Prof. Bastian, of Berlin, has received favourable news from the German expedition on the west coast of Africa. Dr. Gussfeldt, who is at the head of the expedition, has advanced into the Interior, and reached the Fangela country, which, it is believed, is the right point for further advance into Central Africa. The travellers at the latest dates were at the station of Chinchato, and were busy with the preparations for the more important expedition.

The German exploring expedition into the Libyan Desert, under the leadership of Gerhard Rohlfs, returned to Cairo on April 17.

MM. Andre and Rayet are at present publishing, at Gauthier Villars', a work on "The History of Astronomical Observatories." The first part which is on sale is devoted to British observatories. The learned astronomers remind their countrymen that at the end of the last century France had a greater number of astronomical establishments than all other countries. The same thing can now be said of Great Britain.

Mr. Harrison, as President of the Institution of Civil Engineers, will give a *conversazione* on Tuesday, May 19, in the west galleries of the International Exhibition at Kensington, which have been kindly placed at his disposal by H.M.'s Commissioners. As in the two preceding years, models of engineering works and of recent scientific inventions will be transferred to the west picture galleries from other portions of the Exhibition, and these will be supplemented by similar objects specially lent for the occasion.

Dr. Carpenter has replied to Mr. Carter's letter to Prof. King on the structure of the so-called *Eozoon canadense*. He complains that Mr. Carter makes his charges without having, according to his own admission, read what has been written in favour of the view of the organic origin. In support of this view the examination of specimens by Prof. Schultze at the end of last year is referred to, by which he was completely satisfied as to the Forameniferal character of Eozoon. Dr. Carpenter says he does not pretend to affirm that the doctrine of the Forameniferal nature of Eozoon can be *proved* in the demonstrative sense; but he does affirm that the convergence of a number of separate and independent probabilities all accordant with that hypothesis, while a separate explanation must be invented for them on any other hypothesis, gives it that *high probability* on which we rest in the ordinary affairs of life, in the verdicts of juries, and in the interpretation of geological phenomena generally.

The Society for Promoting Christian Knowledge has begun to issue a series of "Manuals of Elementary Science." Is it to be regarded as a sign of the times that this Society as a publishing body is devoting to the spread of a knowledge of Science funds which have been avowedly collected for the purpose of "promoting Christian knowledge"?

The re-mapping of England by the Geological Survey, giving the drift in its various divisions is steadily progressing, and in a short time a large part of Lancashire will be published. The quarter sheets, numbered by the survey 81 N.W., 88 S.W., 89 S.E., 90 S.E., 91 S.W. are engraved and in the hands of the colourist, and the work for 91 S.E., 90 N.E., 89 N.W. has been completed and the maps are in the engravers' hands. The sheet N.E. Somerset, and the London district have been ready some time. The old maps giving the rock mapping will continue on sale, for information that cannot be so readily gained in any other way arises from a comparison of the mapping of the rock with that of the surface drift.

According to the Abbé David, the Chinese river Hangkiang, until lately almost unknown, is an important river of commerce, traversed by vessels of every size. A considerable portion, however, is difficult of navigation, owing to the existence of numerous rapids and many rocks.

The death of Rev. John Bachman is announced as having taken place at Charleston on February 24. In the decease of this gentleman, Science loses one of the oldest of American naturalists, and one who has been quite prominent in the history of American zoology. He is well known from his association with Mr. Audubon in the preparation of the great work on the North American mammals, of which one edition was published, in folio, at 400 dols., and another, in quarto, at 40 dols. This, as far as its illustrations and biographies are concerned, still forms the standard treatise on the subject, although the systematic portion has been in a measure superseded by later and more critical investigations. It was, however, preceded by several monographic papers upon squirrels, hares, shrews, and other species, and also by papers upon the seasonal and other changes in colour in birds and mammals. Dr. Bachman's friends claimed for him the distinction of having been the first person in the United States to practise the art of artificial impregnation of fish, although this is stoutly contested by Dr. Garlick and other writers.

Mr. R. B. Walker writes from Corisco Bay, in Western Africa, in regard to a young gorilla which he had alive for some time, and hoped to forward to the Zoological Society of London. Contrary to the usual assumption in regard to this species, the specimen in question proved to be extremely docile and perfectly tame. When first purchased it was shy and suspicious, but not spiteful. At the expiration of about a week it was led around without resistance, and it ate whatever eatable thing it could lay its hands on, including a basin of condensed milk with a raw egg beaten up in it. It was quite tame, eating, sleeping, and playing with a large bull-terrier, the two animals being constantly together. It unfortunately disappeared one night, and was supposed to have fallen overboard.

The forthcoming number of Petermann's *Mittheilungen* will contain the conclusion of the account of the return journey of Count Wiltschek's Arctic expedition through North-east Russia, and some remarks on the geognostic survey map of the coast of the Waigatt Strait in North Greenland, between Disco Island and the mainland, by M. Steenstrup. The number will also contain an account of Gosse and Warburton's travels through West Australia (recently referred to in Nature), accompanied, of course, by an excellent map.

A Roman Company, we learn from *La Nature*, proposes to lay a railway between Naples and Mount Vesuvius.

We would direct the attention of our physiological readers to a short paper which has just appeared in the "Proceedings of the Royal Society," by Mr. E. A. Schäfer, on the Intracellular Development of Blood-Corpuscles in Mammalia, in which he shows, in the subcutaneous tissue of the new-born rat, how the red corpuscles, statically developed together with the primitive capillaries, become the dynamically circulating blood-discs of the older animal, as in the *area vasculosa* of the embryo chick.

We are glad to see that the Leeds Naturalists' Field Club and Scientific Association has just concluded the most successful year of its existence, its operations during the past twelve months having been attended by most gratifying and steady progress. We have received the syllabus of a number of lectures (by Mr. L. C. Miall) and excursions to take place during the present and next months, illustrative of the geology of the West Riding. There will be four lectures, illustrated by seven excursions.

We have received a short and carefully compiled sketch of the Geology of the County of Suffolk, written by Mr. J. E. Taylor, of the Ipswich Museum, a gentleman who, by the popularity of his lectures and the large audiences which he draws, is doing more than anyone to develop a genuine and lasting love for natural history in that part of the country.

Messrs. Longmans & Co. have in the press a "Manual of Industrial Chemistry." It is a translation of Profs. Stohmann and Engler's German edition of Payen's "Précis de Chimie Industrielle," by Dr. J. D. Barry. It will be edited and supplemented with chapters on the chemistry of the metals, by Dr. B. H. Paul, and will be copiously illustrated. The same publishers also have nearly ready an "Introduction to Experimental Physics, Theoretical and Practical," by Adolf F. Weinhold, Professor in the Royal Technical School at Chemnitz, translated and edited by Benjamin Loewy, F.R.A.S.; it will also have a preface by Prof. G. C. Foster, F.R.S., and be illustrated with numerous woodcuts.

The additions to the Zoological Society's Gardens during the past week include a Mourning Kangaroo (*Halmaturus luctuosus*) from the south of New Guinea, deposited by Signor L. M. D'Albertis; two Gold Pheasants (*Thaumalea picta*) from China, presented by the Rev. A. B. Frazer; a White-cheeked Flying Squirrel (*Pteromys leucogenys*) from Japan, presented by Mr. A. Gower, H.B.M. Consul at Kobe; a Common Fox (*Canis vulpes*) from Russia, presented by Mr. J. W. Ouchterlony; a Long-nosed Crocodile (*Crocodilus cataphractus*) from West Africa, presented by Mr. H. T. Cooper; and a Red Kangaroo (*Macropus rufus*), born in the Gardens.

SCIENTIFIC SERIALS

The *Geographical Magazine*, No. 1, April.—Such is the title of the successor to *Ocean Highways*, which a "Notice" informs us, "has been discontinued," Mr. C. R. Markham, C.B., F.R.S., "having taken the editorship of the *Geographical Magazine*, issued under new proprietorship." We certainly prefer the outside appearance of the new magazine to that of its predecessor, the cover being much more tasteful and business-like; it has made an excellent start also as to contents. The first article, accompanied by a map, is on "The Basin of the Helmund," which includes all the streams that flow down into the great lake or swamp of Sistan, and lies athwart the line of advance from the north towards India. A large part of this area is still entirely unknown, and the article gives an account of the existing materials whence a knowledge of the region can be obtained. The next article gives an interesting account of the Russian Staff-Captain N. M. Prshevalski's Travels in Mongolia in 1870–73. Captain Prshevalski "has acquired most valuable scientific information which, combined with the map he intends shortly to publish, will shed a flood of light on the geography, zoology, and botany of Mongolia and Northern Thibet." This is succeeded by an article on "The Hydrographical Department of the Admiralty," giving a brief history of this most important department of the naval service, and a sketch of its labours. The article contains some valuable hints as to how the department might be made more efficient than it is if Government would only be a little more wisely liberal. An article on the Island of Hormuz, by Lieut. A. W. Stiffe, gives an account of the present state of the island and of the remains of its ancient grandeur. We can only name the other original

articles :—"A Highway to Bolivia," by Mr. Alfred A. Geary ; "The Kashgar Mission," of Mr. Forsyth and party ; "Dr. Beccari's Travels," in which Prof. H. H. Giglioli gives the latest news of the Italian traveller and naturalist, who has left Makassar for Kandari, an unexplored region of S.E. Celebes, where he hopes to secure specimens of the great Anoan antelope (*Anoa depressicornis*) ; "Geographical Progress in India in 1873 ;" and "the Products of West Africa," by M. W. Robinson. There are, besides the usual Reviews, Correspondence, Proceedings of Societies, &c.

Bulletin de l'Académie Royale de Belgique, No. 2, 1874.—The principal paper in this number is one by M. Montigny, in which it is sought to show that "the frequency of variations of the colours of stars in scintillation is generally in relation with the constitution of their light, according to spectral analysis." The author's observations embrace two distinct periods—one from Oct. 1870 to end of March 1871 (47 nights of observation), and the other from June to Dec. 1873 (19 nights). After referring to Secchi's three types of star-spectra, he gives a table of the stars observed, indicating the type of spectrum, the scintillations observed in a second at 60° zenith distance, the size, &c. It is found (1) that the stars scintillating most belong to the first type, or those with four spectral lines, while the stars showing weak scintillation are generally in the third group or type of nebulous bands and dark lines ; (2) that the average, 86 (scintillations per second), of the first type exceeds considerably that of the third, which is 56. The average of the second group (the spectra resembling that of the sun) is 69, and thus intermediate, though a little nearer that of the third ; (3) while some stars little differing in size resemble each other also in numerical intensities of scintillation (especially in the first type), no marked connection appears between the frequency of scintillation and the order of size of the stars ; the last two types even present equal mean sizes, though their scintillations differ considerably. The average scintillations of the three types are in proportion of the numbers 14, 11, and 9. The author points out how his researches not only confirm M. Dufour's law that the red stars scintillate less than the white ones, but affords an explanation of it. The more frequent scintillation of the white stars is due to the fact, that, with equal distance of the observer, the total separation of the coloured bundles of rays, dispersed by the atmosphere, and which have emanated from a white star, is greater than in the case of a red star; the original rays of the white star being more numerous and more exposed to undergo frequent interception by the passage of aerial waves.—M. d'Omalius d'Halloy contributes a note on the Devonian system, and MM. Quetelet and Terby give accounts of auroræ boreales observed in January and February.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, March 1.—This number opens with the concluding part of a paper by M. Mühry in orographic meteorology. The author adduces evidence from hygrometric phenomena, that the permanent equatorial ascending-current forms the transition of the polar, into the returning anti-polar, current ; he also proposes a new classification of clouds, according to ascent or descent. Some particulars are furnished, in a note, as to the climate in southern parts of Europe—Gibraltar, Tarifa, and San Francisco : and M. Jelinek translates a paper by Mr. Kingston of Canada, treating of the most suitable arrangement of thermometers in determining the temperature of the air.

March 15.—The beneficial effect of Alpine health-resorts has been attributed to the greater abundance of ozone in the mountain air. Dr. Haller here communicated the result of observations on the subject in July 1872 and 1873, made at Fusch Bad, in the Alps, at a height of 1,179 metres. Comparing data obtained at the meteorological central observatory of Vienna (194 metres), it appears, that in the bright and warm July of 1873, the ozone-contents of the air at Fusch Bad were considerably greater ; by night about 2°·3, and by day 2°·6. In July of 1872, which was cold and rainy, the average of ozone was by night somewhat less (0·6) at Fusch Bad than at Vienna ; by day, however, it was 2° greater. It seemed likely that, on further ascent, an increase of ozone would be met with, but after climbing to 23,000 metres, there was no marked difference.—This paper is followed by an account of M Poey's recent observations (French Academy), on the relation between sun-spots and cyclones in the Antilles.—From a study of meteorological phenomena at St. Louis, Dr. Wislizenus finds that the electricity of the atmosphere shows a three-fold periodicity, daily, yearly, and secular (or cyclical). As to the second, the quantity of positive electricity increases in the colder months, reaches its maximum in January, and diminishes with increase of temperature to a minimum in July. The cyclical periodicity is probably one of ten years.—Among other subjects treated in this number are the formation of rain-stations in Bohemia, the inadequacy of the ozonometer at present in use, the decrease of water in springs, rivers, and streams.

Gazetta Chimica Italiana. Fasc. I. e II. 1874. These numbers contain the following papers :—Studies in Toxological Chemistry. I. Search for solanine in cases of poisoning. II. Extraction of the alkaloids from the viscera, and search for nicotine, brucine, and strychnine. III. Detection of hydrocyanic acid in cases of poisoning, by Prof. F. Selmi.—Old and new Reactions of ordinary Phenol, by E. Pollaci.—A product of condensation of Oxalic Aldehyde, by H. Schiff. The substance obtained is formed according to the equation $6C_2H_2O_2 + H_2O = C_{12}H_{14}O_{13}$.—Action of Amides upon the Phenols, by Dr. J. Guareschi. The author has tried the following reactions :—paracresol and benzamide, methyl salicylate and benzamide, and ethyl salicylate and benzamide.—Concerning the action of Sulphur upon Calcium Carbonate, by Prof. A. Cossa.—Reduction of Silver Chloride by means of Sodium Hydrosulphite, by G. Scurati Manzoni. The chloride is reduced according to the equation $Na_2SO_2 + 2AgCl = 2Ag + 2NaCl + SO_2$.—On the Expansion of Fused Sulphur, by G. Pisati.—Upon the Reactions of Phenol, by G. Tasca-Lanza. The remainder of these numbers is principally devoted to abstracts from foreign journals. There is also a complete translation of Prof. Clerk-Maxwell's lecture on molecules, which has already appeared in our columns.

Journal de Physique, March.—This number commences with a paper by M. Bertrand, in which several known theorems relating to static electricity are demonstrated in a new and simple manner, which reduces them to a common principle.—M. Chautard describes an improvement on Mayer's acoustic pyrometer.—M. Lespiault calls attention to a new method proposed by M. Galle for estimating the height of the corona of aurora borealis. As applied to the aurora of February 1872, it gave 56 geographical miles (or 415 kilometres) for the absolute height. The agreement between results obtained from four different stations appears to confirm the principle on which M. Galle's method is based.—An ingenious mode of sending signals in opposite directions simultaneously, in a telegraphic apparatus of compressed air, is described by M. Deprez.—M. Gripon gives an account of some experiments made with a tuning-fork ; referring to movement of cords or wires connected with it, vibration of wires in liquids, movement of liquid in a tube vibrated by fork, &c.—We further note a useful summary, by M. Violle, of MM. Favre and Valson's recent researches in crystalline dissociation, and an account of Prof. Tyndall's investigation as to acoustic transparency and opacity of the atmosphere.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti : t. vii. Fasc. iv.—In this number we find the continuation of Prof. Lombroso's researches on anthropometry and physiognomy of criminals. The results arrived at, from an extensive range of observation, are worthy of study. Among other things, the author concludes that criminals have, in general, a greater stature and weight, more ample chest, and darker hair than the normal ; that they present a series of sub-microcephali (53 to 51) double the normal ; that the index of the cranium tends to the brachicephalic, especially in assassins ; that there is frequent cranial asymmetry ; that, tested by the dynamometer, criminals show less force than the normal, but greater than lunatics ; that, more often than in sane people, the eyes are chestnut or dark, and the hair is thick and black (especially in murderers) ; that incendiaries, and, still more, thieves, have very often the iris grey, and always a stature, weight, muscular force, and cranial capacity less than assassins or homicides. In concluding his paper, Prof. Lombroso remarks that prognathism, abundance and curliness of hair, scarcity of beard, frequent dark colour of skin, oxycephalus, obliquity of the eyes, smallness of cranium, development of jaws, retiring forehead, large size of ear, similarity of the two sexes, and scant muscular force, are points of resemblance between the European criminal and the Austral or Mongolian man.—Dr. Polli traces the recent progress of the doctrine of zymotic disease, and of the treatment of it with sulphurised preparations. Figures are given which show the largely increased production of sulphite of magnesia and sulphite of soda by certain chemical works in Italy, for medicinal purposes alone, within the last ten years.—MM. Bizzozero and Manfredi contribute a note in patho-

logical anatomy, On the Development of Contagious Molluscum.—The Architecture of Ants forms the subject of a communication from Prof. Maggi, who has been studying the habits of *Formica fuliginosa* Lat.—M. Tessori furnishes a geometrical demonstration of the error of representations given in many treatises on physics, as to deviation of the plane of oscillation of the pendulum.—In the department of moral and political science, Prof. Bucellati has a paper on central military prisons.

Archives des Sciences Physiques et Naturelles, March 15.—This number commences with a *resumé* of spectroscopic observations of the sun, made at Geneva, by M. Emile Gautier during the last three years. The results of this work (carried on under much less favourable climatic conditions than in Italy), are mainly a confirmation of those got by other observers. The protuberantial phenomena are classed under three heads; eruptions, exhalations, and detached formations; all of which the author illustrates with drawings. Like P. Secchi he was often struck by the fact (which has been doubted), that when a protuberance is observed near a pole, there is generally one symmetrical with it, at the other end of the corresponding solar diameter, and near the opposite pole. The decrease in the number and dimensions of protuberances appeared during these years (from 1869) to precede and exceed that of the spots. M. Gautier adheres to the hypothesis of spots being formed by scorial matters resulting from cooling of the surface by radiation.—In the next paper M. Humbert gives a useful summary of what has hitherto been done by the *Challenger* expedition.—The *Bulletin Scientifique*, which follows, is larger than usual. Among other notes in it, we find an account of some instructive researches by Dr. Macaluso, on polarisation of electrodes, by chlorine and hydrogen. There is also a notice of an important geological map of the Austro-Hungarian Empire, recently completed by M. de Hauer, whose name it bears. The publication, directed by Heidenhain from 1850 till 1863, represents at least twenty years' labour (under considerable difficulties), of a large number of eminent geologists. Each plate is accompanied with detailed explanations. We further note a *résumé* of some recent researches on the minute structure of the eye; and another paper on physiological antagonism of poisons, in which are described some observations by MM. Martin-Damourette, Rossbach and Fröblich, and others, with regard to the effects of physostigmine, the active principle of Calabar bean, and atropine.

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, April 9.—Prof. Cayley, vice-president, in the chair.—Mr. G. H. Darwin read a paper On Probable Error in Statistics. He stated that he had been at work at a statistical inquiry, and was desirous of forming some idea of what degree of accuracy he had a right to expect from the collection of a given number of cases. He put the problem into the following form:—A bag is known to contain a very large number of black balls and white balls, mixed at hazard; on drawing a large handfull of n balls, I find p are white and the rest black. What is the probable error in asserting that $\frac{p}{n}$ of all the balls in the bag, are white? n and p, though large numbers, are supposed to be small compared to the number of balls in the bag. Mr. Darwin then made some further remarks On the Combination of Statistics. The question he considered was the following:—If X and Y are measurements or estimations of quantities such that the errors are distributed according to the exponential law, what is the "probable error" of XY and $\frac{X}{Y}$ in terms of the moduli c and c' of X and Y respectively? M. J. W. L. Glaisher made some remarks on the papers, drawing the author's attention to the fact that the two questions had been treated of by Laplace and De Morgan.—Mr. Merrifield then gave a sketch of his paper entitled Determination of the Form of the Dome of Uniform Stress. He remarked that the general question of the equilibrium-figure of a thin dome is indeterminate, even when the law of thickness or density is given, and it thus differs from the question of the arch, by requiring the assumption of a further condition in order to render its form determinable. If the two following conditions are introduced simultaneously into the general equations, he stated that a very remarkable simplification occurs in the analysis:—(1) that the thrust along a meridian hall equal the thrust along the parallel per unit of area at every point; (2) that the normal thickness shall vary in such a manner that the area under compression shall be proportional to the thrust. These seem to be the conditions necessary to the economical use of building materials of homogeneous character, for the maximum stretch is evidently least when the stress is equally distributed through the whole of the material. The form obtained bears a general resemblance to the upper half of a claret bottle, and the dome evidently required a heavy lantern.—Mr. A. J. Ellis gave an explanation of his theory that ordinary (commutative) algebra is the calculus of similar triangles upon one plane. Taking two fixed points O and I, any third point A determines a triangle, so that if B be a fourth point, it is immediately possible to find a fifth point C, such that the triangle BOC shall be similar to the triangle IOA, and have the angles thus named turned in the same direction. Marking this operation by a, as being determined by the position of the point A, and terming it a *clinant*, he showed that clinants obey every law of commutative algebra, so that it was possible to consider any and every existing algebraical expression as a clinant, and hence as determining a point in a plane. Clinants thus embraced not only the integers and fractions of ordinary arithmetical algebra, but incommensurables, negatives, and imaginaries. Hence also if x and y be any clinants, and $f(xy) = o$, if x be determined by taking X anywhere, a corresponding point Y would be determined. Hence arose a complete calculus of the correspondence of points in a plane, which Mr. Ellis calls *stigmatic geometry*, and which he showed comprehended under one set of equations and greatly generalised, not only the algebraical geometries of Descartes and Plücker, but the homographic geometry of Chasles, and from a single general principle gave a perfect geometrical representation of all the imaginary cases as part of one conception with the real cases. The actual algebraical work, though having the old form and obeying the old laws of operation, is greatly simplified by the clinant signification attached to the symbols, and in especial the expression and determination of direction is rendered easy and certain. (A more detailed explanation will be given, the speaker said, in his "Algebra Identified with Geometry," at the present time in the printer's hands.)—Prof. H. J. S. Smith made a short further communication in reference to his former paper On the Higher Singularities of Plane Curves.—A paper by Mr. H. M. Taylor, On Inversion, with special Reference to the Inversion of an Anchor-ring, was taken as read. Some of the properties given in the paper have been already given by Maxwell (Quart. Journ. Math., vol. ix.) where excellent stereoscopic views of four species of cyclides are given, and by Cayley in the same journal, vol. xii., and in a paper in the Phil. Trans. by Casey. The novelty of the paper consisted in the point of view from which the properties of the cyclides are investigated, viz. as the inverse figures of the anchor-ring, many of whose geometrical properties are as easily seen as those of the circle.

Linnean Society, April 16.—H. Trimen, M.B., in the chair.—A number of papers were read, being Nos. 3-14 of the series of contributions to the botany of H.M.S. *Challenger* Expedition, as follows:—Notes on Freshwater Algæ collected in the boiling springs at Furnas, St. Michael's, Azores, and their neighbourhood, by H. N. Moseley.—Note on the foregoing communication, by Prof. Thiselton Dyer.—Notes on some collections made at Furnas, by M. Archer. The diatoms belong to species of most frequent occurrence in fresh water, and appear to be in no way affected by the high temperature. The other Algæ are mostly common species, several of them British, belonging to the genera *Spirogyra*, *Mesocarpus*, *Bulbochæte*, *Œdogonium*, &c.—Notes on plants collected at St. Vincent, Cape de Verdes, by H. N. Moseley—Enumeration of Algæ collected by Mr. Moseley at the Cape de Verdes, by Dr. G. Dickie.—Enumeration of the fungi collected during the expedition of H.M.S. *Challenger*, Feb.-May 1873, by the Rev. M. J. Berkeley.—Note on plants collected at St. Paul's Rock, by H. N. Moseley. The only aërial plant found on the island was a *Chlorococcus*.—Enumeration of the Algæ collected by Mr. Moseley at St. Paul's Rock, by Dr. G. Dickie.—Notes on plants collected at Fernando Noronha, Cape de Verdes, by H. N. Moseley.—Enumeration of Algæ collected by Mr. Moseley at Fernando Noronha, by Dr. G. Dickie.—Enumeration of Algæ collected by Mr. Moseley in 30 fathoms of water at Barra Granda, Pernambuco, by Dr. G. Dickie.—Enumeration of Algæ collected by Mr. Moseley at Bahia, by Dr. G. Dickie.

Chemical Society, April 16.—Prof. Odling, F.R.S., presi-

dent, in the chair.—Dr. A. W. Tilden read a paper On Aqua Regla and the Nitrosyl Chlorides. He finds that when the gases evolved on gently heating aqua regia are passed into concentrated sulphuric acid, a product is obtained which, at a low temperature, deposits crystals of nitrosyl sulphate, $NOHSO_4$. Both these crystals, and the liquid producing them, when mixed with sodium chloride and gently heated, evolve nitrosyl chloride NOCl, an orange-yellow gas which may be condensed to a deep orange-red liquid boiling at -8° C. The author could not obtain the dichloride $NOCl_2$, which Guy Lussac supposed to exist, but which he believes to be merely a solution of chlorine in the monochloride.—Dr. C. R. A. Wright then read a paper On Isomeric Terpenes and their Derivatives, Part IV. § 1. On Cajeput Oil, by C. R. A. Wright and C. Lambert. It was found that the cajeputol, $C_{10}H_{18}O$, boiling at 176°—179° C., obtained from oil of cajeput, combines with bromine forming the compound $C_{10}H_{18}Br_2O$. On heating this it splits up into cymene, $C_{10}H_{14}$, hydrobromic acid, and water. § 2. Action of Pentasulphide of Phosphorus on Terpenes and their Derivatives, by C. R. A. Wright. When cajeputol is treated with the pentasulphide, it yields a mixture of terpene and cymene, the latter being formed by a secondary action of the pentasulphide on the terpene. This was shown really to be the case by treating the terpene from oil of turpentine and hesperedene with the pentasulphide, when cymene was formed in both cases.

Anthropological Institute, April 14.—Prof. Busk, F.R.S., president, in the chair.—Mr. John Brent exhibited and described a series of flint implements from Canterbury and Reculver.—A description, by Mr. Howorth, was read of an Ashanti fetish letter, or curse. The document, which was lent by Capt. Gordon for exhibition, was written in the Arabic character and in the language of the Barbu tribe, on a sheet of rough paper of large foolscap size, folded about two inches square and tied with green thread. The letter contained a prayer that the English might fight among themselves and return to the coast, and that pestilence might overtake them. The Ashanti grievances were enumerated, and it stated that the white man came with covetous eyes and seized the land, and that covetousness brought down the curses of Suleiman the high priest. It was thought by the English scouts that it was Suleiman himself who endeavoured to stay the British troops on their approach by throwing down the fetish, and that his failure would probably cost him his life.—Capt. S. P. Oliver, R.A., contributed a series of papers On the Non-historic Stone Relics of the Mediterranean. The series comprised full accounts, with ample illustrations, of the Torre dei Giganti, Malta; Tumuli near Smyrna; Dolmen-mounds of the Albegna; Sardinian Nuraggls; and the Sepolture de is Gigantes of Sardinia.

Meteorological Society, April 15.—Dr. R. J. Mann, president, in the chair.—On the Climate of Patras, Greece, by Rev. H. A. Boys. The author shows that the climate of Patras is naturally mild and relaxing, seldom disagreeably dry, and not often very damp, being indeed drier by a good deal than any part of England.—Remarks on the Atlantic Hurricane of August 20 to 24, 1873, by W. R. Birt.—On the Meteorology of December in the southernmost part of the Southern Indian Ocean, by Robert H. Scott, F.R.S. This paper has been prepared for the purpose of giving information on the climate of Kerguelen Island to those gentlemen who are going out to observe the Transit of Venus in December next.—On the Diurnal Variations of the Barometer, by J. K. Laughton. Whilst it has long been well known that barometric maxima and minima occur daily with unfailing regularity, especially within the tropics, the cause of this recurrence is yet unknown; and though it has been attributed to the different temperature and humidity at different times of the day, such explanation is far from satisfactory, for the maxima occur at the times of mean temperature and humidity without regard to the direction of the change, and the minima occur indifferently at the times of both greatest and least temperature and humidity. It seems that an explanation is rather to be found in the inertia of the atmosphere, which in the first instance permits its elastic force to be increased by a rapidly increasing temperature before the inertia of rest can be overcome sufficiently to allow it to enlarge its volume in due proportion, but when that inertia of rest is overcome, then the inertia of motion permits it to move away from the place of observation in excess of what is due to the increased elasticity; the nocturnal maximum and minimum being caused by the resilient power of the air, which gives it alternately an inward and outward motion, and each way in excess of what is due to the decrease or increase of elasticity by reason of the inertia of motion. If this explanation is correct, we ought to find a certain tendency of the wind towards east in the morning and towards west in the evening; and this tendency does seem to be shown in the very few published observations which permit a comparison to be made. Further observations, as confirming or disproving the proposed theory, are much to be desired.

Victoria Philosophical Institute, April 13.—Mr. Edmund W. Gosse, of the British Museum, read a paper On the Ethical Condition of the Early Scandinavian Peoples, in which he illustrated the peculiar features of the civilisation of Scandinavia in pagan times, and showed in what salient points that civilisation differed from the spontaneous developments of morality in other cultivated heathen races—the Elder or Poetic Edda of Sœmund Sigfussen being taken as the text.

MANCHESTER

Literary and Philosophical Society, March 24.—Rev. William Gaskell, vice-president, in the chair.—On some of the Perplexities which the Art and Architecture of the Present are preparing for the Historians and Antiquarians of the Future, by the Rev. Brooke Herford.—A Few Observations on Coal, by E. W. Binney, V.P., F.R.S. From his observations the author was led to conclude that soft or cherry coal was chiefly composed of the bark, cellular tissue, and vascular cylinders of coal plants with some macrospores and microspores. That caking coal had much the same composition, except that it contained a greater proportion of bark in it. That splint coal had a nearly similar composition, but with a great excess of macrospores. That cannel coal, especially that yielding a brown streak, was formed of the remains of different portions of plants with a great excess of microspores, which had long been macerated in water. These conclusions were arrived at merely as to the composition of the different kinds of coal. No doubt each seam would be materially affected by the nature of the roof, whether the latter was an open sandstone or a close and air-tight black shale or blue bind, for the former would allow the free escape of gaseous matter, and the latter would prevent its escape. It is well known that the character of the roof has a deal to do with the quality of the coal under it.

April 7.—E. W. Binney, F.R.S., vice-president, in the chair.—The chairman exhibited to the meeting some portion of the cast-iron roof from the Salford Station of the Lancashire and Yorkshire Railway, which after having been up for a period of four years was so much corroded and damaged that it had to be taken down. He attributed the effects to sulphuric acid and soot arising from the combustion of the coal used in the locomotives passing under it, aided by the action of steam and vibration.—On the Action of Nascent Hydrogen or Iron, by William H. Johnson, B.Sc. In a paper read before the Society last year, the author showed that a piece of iron immersed in hydrochloric, sulphuric, or other acid which evolves hydrogen by its action on the metal, on breaking gives off bubbles of gas from the surface of the fracture. It subsequently occurred to the author that these bubbles might be produced by subjecting the metal to the action of nascent hydrogen for some time, and without the aid of acid at all. To test this he connected two pieces of iron wire ·07″ diam. respectively with the copper and zinc plates of a battery of 50 Daniell's cells and immersed them in a vessel of Manchester town's water at a distance of one inch apart. On closing the current, bubbles of hydrogen were given off from the wire connected with the zinc, but none from the wire connected with the copper, the oxygen liberated at the pole apparently forming oxide of iron which in 12 hours formed a thick smudge at the bottom of the vessel. After 24 hours the surface of the wire connected with the zinc was unchanged, but on moistening the fracture bubbles were given off abundantly just as if it had been immersed in acid. The other wire, on the contrary, though much oxidised and eaten away, did not give off bubbles when broken. A variety of experiments were made in the same way with similar results. The author concludes that if the oxidation of the surface of iron be as a rule accompanied by the absorption of nascent hydrogen into the interior of the iron, then the diminution of strength and toughness consequent on this will affect iron ships, telegraph cables, and other structures in which iron is largely used and which are constantly immersed in water.

EDINBURGH

Geological Society, March 13.—Mr. Andrew Taylor exhibited a specimen of coal converted by a recent explosion in

a Lancashire pit into anthracite, and even in some parts into graphite.—A paper by Mr. Payne was read, On the Oolitic coalfield of Brora, Sutherlandshire. One of the coal-seams, about 3 feet 6 inches thick, is being worked at a depth of from 720 to 300 feet.—Mr. Taylor then read three short papers on (1) An analysis of various coals and peats. (2) Specular iron recently discovered in New South Wales. (3) Shale recently discovered at Waitata, New Zealand.—Mr. Peach stated that, in the course of preparing these sections, he had made a discovery which may yet prove to be of some service in the Fine Arts, viz., that the pounded dust of such shale as this, an enormous bed of which occurs in New Zealand, yields a colouring material closely resembling sepia, a costly substance.

April 16.—Mr. David Milne Home, F.G.S., president, in the chair.—The first paper was read by Dr. Ramsay H. Traquair, Keeper of the Natural History collection in the Edinburgh Museum of Science and Art, On the Structure and Affinities of the genus Cheirolepis. Dr. Traquair submitted the following conclusions at which he had arrived on the matter:—(1) That Agassiz was correct in ascribing branchiostegal rays and irregular dentition to the cheirolepis, but the larger teeth are placed in a distinct row internal to the smaller ones, not in the same line as Agassiz described them. (2) That the plates described by Powrie as principal jugulars belong to the shoulder girdle, being in fact the interclavicular plates of Parker; and that cheirolepis has no jugular plates. (3) That the osteology of cheirolepis shows it to be so closely allied to Palæoniscus that it ought to be included in the same family, notwithstanding the minuteness and non-overlapping character of the scales.—Mr. George Lyon read a paper On a Species of Griffithides (Trilobite) from a limestone quarry south of Dalkeith, near Edinburgh, and which belongs to a genus extremely rare.—Mr. David J. Brown read a paper On a new Theory of the Formation of Till, or Boulder-clay. The author submitted that till is in reality formed by glaciers, after they enter the sea, tearing up the rocks that form its bed, and grinding them to boulders and mud, and that this mud deposited along with the boulders forms boulder-clay.

VIENNA

Geological Institute, Jan. 7 (anniversary meeting). The Director, Fr. v. Hauer, read the annual report, which states, that during the last year the palace of Prince Liechtenstein has been purchased for the collections, the library, laboratory, and the working rooms of the institute. The staff has been reorganised, and now consists of the Director, Fr. v. Hauer; Vice-Director, Fr. Foetterle; Chief Geologists, D. Stur, G. Stache, and E. v. Mojsisovics; Chief of the Chemical Laboratory, K. v. Hauer; Geologists, H. Wolf and K. Paul; two adjuncts, O. Lenz, the second at present being vacant; two assistants, A. Redtenbacher and K. John; two practitioners, C. Doelter and R. Hörnes.—After mentioning the share which the institute took in the general exhibition of last year, the report announces that geological explorations have been carried on during the last summer in the Bukovina as well as in the Tyrol, whence the examination of the northern chain of the Austrian Alps was finished with the Bregenzer-Wald (Vorarlberg), whilst that of the central chain was continued in the environs of the Oetz valley and the Ortler mountains, and that of the southern chain was begun in the environs of Lienz, in the valley of the Drau. Grateful allusion is also made to the liberal foundation of a capital of 12,000 florins in bonds of the Southern Railway Company, the gift of Albert Schloenbach, of Salzgitter, Hanover, in memory of his late son, the eminent geologist, Urban Schloenbach. The annual interest of this sum will be given to officers or friends of the Geological Institute, to enable them to travel in foreign countries to compare geological observations made in the Austrian dominions with those abroad. The first to whom it has been granted is D. Stur, whose studies on the exact geological position of the Bohemian coal-beds are likely to lead to very interesting results; results, however, which require a comparative study of other coal basins, and chiefly of the rich collections of fossil plants in the Museum of Dresden, for their secure confirmation.—The following specimens have been newly arranged in the museum of the Institute:—The silurian fauna of Galizia; the Devonian fauna of Moravia; the carboniferous flora of Ostrau-Orlau-Karwin, of Schazlar-Schwadowitz, of Kladno-Schlan, of Swina, of Stradonitz, of Radnitz and its environs, of the Pilsen basin, of the Rossitz basin, the flora and the fauna of the old red in Austria, Moravia, and Bohemia; the cretaceous flora of Moravia and Bohemia; the flora of many tertiary deposits in Bohemia, and of Wieliczka and Swaszawicœ, in Galizia. In the chemical laboratory, more than 300 analyses and assays have been performed, the library has been augmented by 661 volumes, and the collection of maps by 194 sheets. The progress of the publications appears very satisfactory: besides the periodicals, the *Jahrbuch*, the *Mineralogische Mittheilungen* and the *Verhandlungen*, four sheets of the "Memoirs," were edited, viz., Vol. V., No. 4, On a Fossil Saurian from Lesina, with 2 plates, by Prof. A. Kornhuber; No. 5, On the Cephalopods of the Gosau beds of the north-eastern Alps, with 9 plates, by Dr. A. Redlenbacher; No. 6, Fauna of the beds of Aspidoceras acanthicum, with 13 plates, by Prof. M. Neumayr; and Vol. VI., No. 1, The Fauna of the Flambach and Halstatt beds, with 32 plates, by Dr. E. v. Mojsisovich. Also, a Geological Map of the Environs of Vienna, on the scale of 1 : 28800, with explanations by Th. Fuchs, and a Catalogue of the Objects exhibited by the Institute at the General Exhibition, have been published. Finally, the most important work has been the completion of M. v. Hauer's large geological map of the Austro-Hungarian empire, printed in colours on the scale of 1 : 576000, the last four sheets of which were published last year. Further communications were made by T. Hirschwald, On the Transformation of Wood into Brown Coal, in the Mine Dorothee, on the Ober-Starz; by S. Nedeljkovic, On the Sanidin-Trachytes of Syrmia; Dr. A. Redlenbacher, Remains of *Ursus spelæus* from a cavern near Wildalpe, Upper Styria; Dr. G. Stache, On the Fauna of the lower eocene beds of Cosina, in Istria; Dr. C. Doelter, On some Eruptive Rocks in the Transylvanian Erzgebirge.

GÖTTINGEN

Royal Society of Sciences, Jan. 3.—M. Wielen communicated the results of an examination of Greek names of makers inscribed on ancient earthenware lamps in several archæological collections in Athens, Corinth, and Smyrna.—M. Lolling presented a paper on the Theseion and the Hephaisteion in Athens.

RIGA

Society of Naturalists, Nov. 5, 1873.—M. Russwurm furnished some interesting particulars as to the seal-fishing on the Russian coasts. The Baltic supplies annually about 12,000 animals, with a value of 125,000 roubles (the rouble = 3*s.* 1½*d.*); the White Sea and neighbouring parts, 18,000 animals, worth 212,000 R.; the Caspian Sea, 100,000 animals, worth 900,000 R. The Russians (unlike the Finns, &c.) do not eat the flesh of seals, but throw it away. The various species met with, as also the mode of capture, were described.

Nov. 19.—Dr. Gutzeit gave an account of a new official map of Russia, just completed at St. Petersburg.—M. Teich communicated some observations on the power of scent in butterflies; he thinks they are greatly guided by the sense of smell, which has its seat in the feelers.

Dec. 3.—Prof. Petzholdt read a paper on structural relations of ice and axes of crystals.—Prof. v. Sivers made some observations on driftwood collected in the Arctic regions by the recent German expedition.

CONTENTS

THURSDAY, APRIL 30, 1874

THE FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Association Française pour l'Avancement des Sciences. Comptes Rendus de la 1[re] Session, 1872. Bordeaux. (Paris, 1873.)

THIS, the first volume of the yet young French Society's Proceedings, does it infinite credit. It is a handsome, beautifully printed volume of 1,330 pages, containing upwards of 200 papers, addresses, and lectures on a wide variety of subjects connected with Science, pure or applied. The volume is also well illustrated, some of the plates appended being coloured, a feature which we think the British Association would do well to imitate in its "Proceedings."

The French Association, as our readers no doubt know, made a very auspicious start, the number of members amounting to somewhere about 800. There are two classes of members—1st, *membres fondateurs*, who subscribe one or more shares of the capital of the Association, a share amounting to 500 francs; there are about 250 members of this class, some of whom have subscribed several shares, among the latter being a considerable number of railway and other public companies: 2nd, ordinary members, paying an annual subscription of 20 francs, or a life-subscription of 200 francs; the names of about 50 life-members are in this volume. After an existence of scarcely three months, the Association possessed a capital of nearly 140,000 francs, and an annual revenue of more than 16,000 francs.

The French Association is modelled pretty closely after the older British one, its aim being, according to the rules, "to promote by every means in its power the progress and diffusion of the sciences from the double point of view of the perfection of pure theory and of the development of their practical applications." These ends it proposes to accomplish by means of meetings, lectures, publications, and donations of instruments or money to persons engaged in scientific researches. It appeals for help to all those "who believe that the cultivation of Science is necessary to the greatness and the prosperity of the country."

The Association is divided into four Groups, and each group into several sections; the Groups are—1. The Mathematical Sciences; 2. Physical and Chemical Sciences; 3. Natural Sciences; 4. Economic Sciences. The French Association devotes more attention to the practical application of scientific principles than does the British one; the 1st Group, for example, including Sections of Navigation and of Civil and Military Engineering; the 3rd Group including the Medical Sciences, and the 4th Group Agriculture. This arrangement may at present have some advantages in France, where there are probably fewer special Associations than there are in this country, and because, until the Association gets itself firmly established, it may be advisable to appeal to as many classes of supporters as possible: but we are inclined to believe that it will by and by find that it will serve the cause of Science more effectually by confining its attention to the pure sciences.

In points of administrative detail, the French follows very closely the British Association. One of its rules ordains that each year the capital fund be increased by 20 per cent. of its revenue. If it prospers in the future as it has done hitherto, we have no doubt that it will soon have a very large sum at its disposal.

As we noticed pretty fully the proceedings of the Association at the time of its meeting at Bordeaux in September 1872, it is unnecessary to notice in detail the papers contained in the volume before us. There will be found in its pages the names of many of the most prominent men of Science in France, and a few belonging to foreign countries, among the latter being Sir Benjamin Brodie and Dr. Gladstone. Two of the published lectures have been published in NATURE *in extenso*—that of M. Janssen on the Eclipse of December 12, 1871, and that of M. P. Broca on the Troglodytes of the Vézère.

M. de Quatrefages, the first President, in his eloquent and powerful opening address, speaks very highly, and we would fain hope with justice, of the work which has been done by the British Association. "Thanks to it," he says, "a part of the population has been reformed. The sons of those fox-hunters, who, as a relief from their rude pastimes, only knew of joys equally violent and material, are now botanists, geologists, physicists, and archæologists."

The President's impressive words as to the sphere of Science at the present day are well worth quoting:—"Science is at present everywhere; she is becoming more and more the sovereign of the world. What industry can dispense with the aid of mechanics, and is there any industry which would wish to be bound to the progress already realised by that Science? Is there one which would despise the help of Chemistry? What physician, worthy of the name, would consent to dispense with physiology, that complex science, daughter of chemistry? with physics and with mechanics, any more than with anatomy? What enlightened agriculturist does not understand that the problems of culture and of production are essentially questions of zoology, botany, geology, and chemistry? And in this great city (Bordeaux), one of the queens of universal commerce, what merchant will deny the importance of geography? Science is as indispensable to the military man as to the manufacturer, the physician, the agriculturist. Certainly I am far from denying the part which in war will always fall to courage, to inspiration. But inspiration must be enlightened by study; bravery must be furnished with arms equal to those of the enemy. Revive in imagination Renaud de Montauban or the Roland of legend; place them upon Bayard or Frontin; cover them with their enchanted armour, and dart them against a simple mechanic mounted upon his locomotive. You all know what will be the result of the shock: coursers and paladins will be brayed."

It will be remembered that the first meeting of the French Association took place while the country was yet sore with the humiliation inflicted upon it by Germany; and very naturally the address of the President, as well as the addresses of many others who spoke, took their tone, to some extent, from this condition of affairs. Still the character of these addresses, though intensely patriotic, is perfectly healthy, the various speakers showing

that they possessed a clear perception of the most effectual means of raising and advancing their fallen country; they read aright the lessons of the recent war, and declared that Science alone, in its widest acceptance, could be the saviour and elevator of France. And, indeed, there is the greatest hope of a country that has produced men, and that in so great numbers, capable of doing the work the results of which are chronicled in the handsome volume before us; for we are persuaded that this first volume of the French Association's Proceedings will compare favourably with any single volume of the Proceedings of the British Association. The meeting last year at Lyons fully bore out the promise of the first meeting, and we have no doubt that this year's meeting at Lille will be at least equally successful. Let the members of the Association only do all in their power to keep up its high character and carry out faithfully its declared objects, and the beneficial results of its establishment both to Science and to France will, ere long, be evident. As it is, partly no doubt owing to the work of the Association, Science since the conclusion of the Franco-Prussian war has taken immense strides in France; everything taken into consideration, the amount of scientific activity which has recently been developed in that country is very wonderful, and calculated to call forth the gratitude of the friends of science and humanity.

NORTH AMERICAN BIRDS

A History of North American Birds. By S. F. Baird, T. M. Brewer, and R. Ridgway. Vols. i. ii. and iii. Land Birds. (Little, Brown and Co., 1874.)

THE ornithologists of the United States appear to be not less active than those of this country at the present moment. Whilst here we have Gould's "Birds of Great Britain," Dresser's "Birds of Europe," and Newton's new edition of "Yarrell," all appearing at the same time, so in America Coues's "Key" and Cooper's "Birds of California" are quickly followed by the present important work on the whole of the North American Ornis. For this undertaking Prof. Baird, the well-known Assistant-Secretary of the Smithsonian Institution, has obtained the assistance of two very efficient coadjutors, Dr. T. M. Brewer, of Boston, and Mr. Ridgway, already well known for his accurate work in ornithology.

The object of the present work, which aims at a wider grasp than any of its predecessors, is to give an account of what is known of the birds, not of the United States only, but of the whole of the Continent of North America north of the Mexican boundary. Greenland is included on the one side, and the newly acquired United States territory of Alaska on the other, so that many European and Asiatic forms, which have been lately discovered in these two countries, are now for the first time added to the American list.

The materials upon which this undertaking is principally based consist of the very extensive collections of birds from every part of the New World, in the Smithsonian Museum at Washington. The numerous expeditions for exploration and survey sent out of recent years by the Government of the United States into nearly every portion of their enormous western domain have been invariably accompanied by one or more collectors whose contributions have all been deposited in the stores of the Smithsonian Institution. But besides their collections these investigating naturalists have reaped a rich harvest of facts concerning the life-history of the creatures they have collected, and have deposited their records and journals also in the Smithsonian Archives. From these manuscripts, particularly from the notes of the late Mr. Robert Kennicott, who made most extensive explorations in Western America and in the most northern portion of the Hudsons Bay Territory, many of the most novel facts recorded in the present work have been drawn.

The special value of the researches of Mr. Kennicott and his fellow-workers in the north-west lies in the fact that a large number of the rapacious birds and water-fowl of North America resort in summer to these thinly-populated districts for the purpose of breeding. Their haunts, not having been previously invaded, much novel information on the nesting habits of the members of these two groups is for the first time published in this work.

Besides Messrs. Baird, Ridgway, and Brewer, whose names appear on the title-page, we are informed in the preface that two other well-known American naturalists have contributed to the present work—Prof. Gill having furnished a portion of the introduction, and Dr. Coues the tables of the orders and families.

The work is profusely illustrated by woodcuts, besides containing a series of illustrations of the heads of all the species, drawn upon separate plates. The woodcuts contain the outlines of the principal characters of every genus, embracing the shape of the bill as seen from above and from the side, the comparative lengths of the wing and tail feathers, and the outline of the tarsus and toes; besides reduced but well-executed and highly-characteristic whole figures of many of the species.

The tendency of the American ornithologists of late years has been rather to unduly augment the number of species by raising slight local variations in form and structure to specific rank. In the present work rather the opposite tendency is manifested, and we are not sure that it is not in some instances carried too far. For instance, the whole of the Purple Martins, of the genus *Progne*, recently divided by Prof. Baird into seven or eight species, are now treated of as one; and the different species of Redpole Linnets of Dr. Coues are again reduced to their primitive number. As, however, the distinctive characters, such as they are, are invariably stated with accuracy and precision, it does not really make much difference whether the forms are actually classed as species or varieties.

The three volumes of this elaborate work now before us contain the whole of the Land Birds. A fourth volume, shortly to be issued and to be devoted to the Water Birds, will complete the undertaking. There can be no doubt, as will be at once apparent to anyone who consults the work, that it is of a most complete and exhaustive character, and that it will fully sustain the well-known reputation of Prof. Baird and his fellow-labourers.

OUR BOOK SHELF

Our Common Insects. By A. S. Packard, jun. (Naturalist's Agency, Salem, Mass.)

IN this fully illustrated little work Mr. Packard, the author of the excellent and much larger "Guide to the

Study of Insects," gives a short and popular account of entomology generally, by taking a series of types from amongst the best-known North American insects, and describing them in detail. We should have liked to find some of the descriptions rather more explicit, as they might have been, without any alteration in the size of the volume, if some of the illustrations had not been so frequently repeated. In a work like Euclid there is no doubt considerable advantage in having the figures so placed that it is not necessary to turn over the pages in referring to them, especially when it has to be read by boys; but when space is short and the subject of such general interest, we cannot help feeling that their repetition, three times in more than a single instance, is quite uncalled for. The author's own work at the development of Insecta, which he has published in the "Memoirs of the Peabody Academy of Science," enables him to take a larger view of his subject than that held by most. This is particularly indicated in the very suggestive chapter entitled "Hints on the Ancestry of Insects," in which the researches of Ganin, Lubbock, Brauer, Haeckel, and Müller are all brought to bear on such questions as the relation of the *Zoea* form of the embryonic Crustacean to the similarly undeveloped and generalised, here termed *Leptus*, form of Insecta, in which the configuration is ovate, the head is large, bearing from two to four pairs of mouth-organs resembling legs, and the thorax is merged with the abdomen; this general embryonic form characterising the larvæ of the Arachnida, the Myriapods, and the true Insects. The elaborate observations of the first-named of these authors on the development of *Platygaster error*, an ichneumon parasite, in the author's mind tend to confirm the theory held by him that the ancestry of all the Insects, including the Arachnids and Myriapods, should be traced directly to the worms. We recommend this small book to all interested in the progress of this branch of invertebrate zoology.

The Transactions of the Academy of Science of St. Louis, vol. iii. No. 1. (St. Louis, U.S., 1873.)

THIS volume contains a journal of the proceedings of the Society from March 1868 to January 1873, and a few papers *in extenso*. The latter are:—Notes on the Genus *Yucca*, by G. Englemann; On the new Genus in the Lepidopterous Family Tineidæ, with Remarks on the Fertilisation of the *Yucca*; and Supplementary Notes on *Pronuba yuccasella*, by C. V. Riley; Descriptions of North American *Hymenoptera*, by B. D. Walsh; Atmospheric Electricity, by Dr. A. Wislizenus, being the yearly report of atmospheric electricity, temperature, and humidity, from observations made at St. Louis; Catalogues of Earthquakes for 1871, by R. Hayes; and On the Occurrence of Iron Ores in Missouri, by J. R. Gage. Mr. Hayes, on the basis of the recorded earthquakes from 1739 to 1842 has found that the "largest maxima occurred in the years of the heliocentric conjunction and opposition of Jupiter and Saturn, with but three exceptions, and in these cases the increase began in those years, but the maximum was not reached till the following year." He suggests that "these planets induce electric currents which *call into action* those forces to which the causes of seismic phenomena are usually ascribed."

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Herbert Spencer and *à priori* Axioms

MR. HERBERT SPENCER (vol. ix. p. 461) has "ended what he has to say on the vexed question of the origin of physical axioms" by laying down—

(1) That "the perceptions and inferences of the physicist cannot stand without *preconceptions which are the products of simpler experiences than those yielded by consciously-made experiments.*"

(2) That "the preconception which immediately concerns us is the exact quantitative relation between cause and effect."

(3) That "if definite quantitative relations between causes and effects be assumed *à priori*, the Second Law of Motion is an immediate corollary."

By speaking of it as an "*immediate corollary*," I presume that Mr. Spencer means that Newton's Second Law of Motion is the proposition obtained by substituting for the general term, *cause*, the particular term, *force*, and for the general term, *effect*, the particular term, *motion generated*; so that, according to Mr. Spencer, this law simply asserts "a definite quantitative relation between a force and the motion generated by that force." But surely the quantitative relation asserted by Newton is not only *definite*, but is further the *special* relation of *proportionality*; so that, if the law is an immediate corollary of an *à priori* assumption, the assumption must be that "the exact quantitative relation between cause and effect is that of direct proportionality," or in more familiar words, that "effects are proportional to their causes." Perhaps this is what Mr. Spencer meant to assert. At any rate let us admit it as a definite basis for reasoning, and endeavour to deduce some consequences from it.

"The cause of a stone falling when left to itself is its weight; but 'the greater the cause, the greater the effect,' therefore the greater the weight of the stone the more quickly will it fall, and thus of two stones let fall from the same height, the heavier will reach the ground sooner than the other." Something of this kind, it may be presumed, was the argument of Aristotle and his followers before the age of Galileo: and how on *à priori* principles is it to be refuted? Of course it is disposed of at once by the simple observation that the same force does not produce the same motion in different masses: but independently of some such observation or experiment, it seems to me impossible to deny that it *may be* true, though even an *à priori* philosopher might show that, as other alternatives are conceivable, it is not *necessarily* true. As a matter of historical fact, Galileo refuted it once for all by the "consciously-made experiment" of letting two different weights fall simultaneously from the leaning tower of Pisa.

But it may be said that the above argument is hardly "*definitely* quantitative." Let us then examine Newton's Second Law of Motion as an "immediate corollary" of our *à priori* assumption. Here the cause is "the motive force impressed," and the effect "the alteration of motion." But then the question arises—how are the quantities of this cause and effect to be measured? Newton carefully defines quantity of motion as proportional to *mass* and *velocity* jointly; that is, he measures it by *momentum*. From another point of view it would have been correct to measure quantity of motion by *kinetic energy* or *vis viva*, that is, as proportional to mass and the *square* of the velocity jointly. Further the "alteration of motion" might be measured either with respect to a given time or to a given space. Newton implies the former, and consequently the explicit statement of his second law is that "the *momentum* generated *in a given time* by an impressed force is proportional to that force." Substitute for this "the momentum generated in moving through a *given space*," or "the *kinetic energy* generated in a given time," and the law becomes untrue. Substitute "the *kinetic energy* generated in moving through a *given space*," and we have a law which is true, but not that which Newton asserted as his second law. Now among these four alternatives how is our *à priori* philosopher to decide? He might perhaps analyse them further and show that some of them are inconsistent with the others, and I believe he might reduce the questions to be decided to still simpler ones; but I fail to see (in common, I believe, with everyone who has thoroughly grasped the fundamental principles of rational mechanics) how, without recourse to consciously-made observations or experiments, he could arrive at a certain conclusion.

May we not say then that these great *à priori* principles, whatever value they may have in a "System of Philosophy," are of little avail in any special science, and that the "axioms" of such science, however much they may involve these principles, are not mere "immediate corollaries" therefrom?

If not intruding too much on your space, I am tempted to apply to Mr. Spencer's great principle of the "Persistence of Force" the same mode of treatment as I have applied above to the principle that "effects are proportional to their causes."

Mr. Spencer distinctly refuses to identify this principle with the great physical principle of the Conservation or the Persistence of Energy, the firm establishment of which undoubtedly marks one of the most important epochs in the history of Science. Force, in Mr. Spencer's use of the term, includes numerous species of which energy is but one. I feel sure that every mathematician and physicist would protest against the inclusion under one term of magnitudes of such different kinds as statical force and energy, or the work done by such a force; but not to dwell on this, I believe that Mr. Spencer would certainly acknowledge as one of his species, that which (in my view) is alone properly termed Force, namely, such as can be measured in terms of the weight of a pound or a gramme. What then does Persistence of Force of this kind mean? Does it mean that the numerical sum of the intensities of all the Actions and Reactions throughout the universe is constant? If so, it is untrue: for, to take a simple illustration, if a weight be supported, first by a single string, and then by two strings not vertical, the tensions are quite different in the two cases, and there is no equivalence between those which disappear, and those which are introduced in passing from one to the other. If not, we must take account of the *directions* of our forces, and then, if it mean anything, it appears to be but the expression of Newton's Third Law that "action and reaction are equal and contrary" in this form:—"The algebraical sum of all the forces throughout the universe is persistently zero." To every mathematician, at any rate, this assertion and the assertion that "the sum of the energies of all kinds throughout the universe remains persistently of the same definite numerical amount" are assertions of facts of such different orders, that to class them together is rather to introduce confusion of thought than to establish a grand general principle.

I have offered the above remarks because it appears to me only fair to the author of the article on Herbert Spencer in the *British Quarterly Review* to show that it is felt by others, who have made a study of the fundamental principles of rational mechanics, that his strictures on Mr. Spencer's treatment of those principles are in all essential points fully justified, however much they may wish that the expression of those strictures had been in some instances modified in its tone.

The Park, Harrow, April 20 ROBERT B. HAYWARD

I THINK it is positively due, not only to the writer of the now famous article in the *British Quarterly Review*, but to Newton's memory and to Science itself, that the correspondence which has been going on should not seem to terminate as a drawn game, at any rate in the opinion of some bystanders, who may from their antecedents be presumed competent to judge.

That Mr. Spencer will ever be convinced is, I suppose, hopeless; I at any rate am not going to try to convince him. But I can assure the *British Quarterly Reviewer* that he has my very deepest sympathy in his argument with an antagonist who is at once so able a master of fence as Mr. Spencer, and yet is so intensely unmathematical, it would seem, as to pass from "exact quantitative relation" to "proportionality;" or as to talk of the effect of a force, without defining how the effect is to be measured, without feeling the slightest difficulty.

Nor does it seem that Mr. Frankland, in NATURE, vol. ix., p. 484, is quite justified in his conclusion that the truth lies *between* the two opposite views. And his own view is in fact entirely coincident with the Reviewer's, except, perhaps, on a point which is not relevant to the controversy, viz. how far the experimental proof of the so-called physical axioms is *complete*.

Will it comfort the Reviewer if I tell him some of my own experience? I, too, read Spencer after my degree; and on the first reading of the "First Principles" came to the sad conclusion that I had not understood any mathematics properly; so much fresh light seemed to be thrown on them. I read it again, and more critically, and doubted whether Spencer was quite correct. I read it again, and concluded that he was wrong in his physics and mathematics. I ought to add that I too was, like the Reviewer, A SENIOR WRANGLER

I AGREE so fully with the chief contents of Mr. Frankland's letter (vol. ix. p. 484), that I wish to call his attention to one point in which his letter seems to me calculated to mislead.

He says, "the pure empiricists argue that because certain observed results coincide with the results of calculation, therefore the assumptions on which the calculation was based must be true. Now without doubt the *demonstrative* character of this inference vanishes entirely under Mr. Spencer's searching criticism. But it seems to me that a *high probability* remains."

Now, in the name of pure empiricists, I must protest against our being supposed to think that anything "must be true" in any other sense than that there is a "high probability" of its truth. I cannot refer to a better exponent of our views on this point than Prof. Clifford, to whom Mr. Frankland himself refers. And the idea of our having to thank Mr. Spencer for showing that the inductive proofs of the laws of motion (or of any other physical truths) are not *demonstrative* in any other sense than the above is quite new to us. What Mr. Spencer has done is to bring up instances of this so-called imperfectness in the demonstration as evidences that no *à posteriori* proof of the proposition can exist, when in point of fact they are specially characteristic of such a proof.

Those of your readers who have examined Mr. Spencer's ingenious proof of the second law of motion, contained in his last letter to NATURE (vol. ix. p. 461), will not ascribe my not immediately answering his letter to any difficulty in so doing.

THE AUTHOR OF THE ARTICLE IN THE BRITISH QUARTERLY REVIEW

Lakes with two Outfalls

IN NATURE, vol. ix., p. 485, Mr. Craig Christie begins a letter "to correct a mistake as to a matter of fact:" "Loch-na-Davie, Arran, has *two* outlets, as is correctly represented in the Ordnance map;" and he ends his letter: "I think Colonel Greenwood ought at least to have made himself acquainted with the Ordnance map."

I take the liberty to enclose to you the new Inch Ordnance map of Arran, to which my letter in vol. ix. p. 441 referred. You will see that as "a matter of fact" the map does *not* give two outlets, but only one.

I need not ask for your valuable space in reference to Mr. Christie's own "matters of fact," since my views with reference to them are printed in the *Athenæum* of July 22, 1865. He will see there that I have not only "walked up the north stream from Loch Ranza," but also by Glen Catacol and Glen Dzeven, and a third time from Corrie by Glen Sannox over the water-parting. Also that I have sounded the whole of this little pool of bog-water by walking it, bare-legged, without being over my knees in the deepest part, which was at the south end, where the only outlet is to Glen Iorsa.

I shall have the pleasure to communicate with Mr. Thelwall in reference to his obliging letter.

GEORGE GREENWOOD

[The Ordnance map forwarded to us by Colonel Greenwood gives only one outlet to Loch-na-Davie.—ED.]

As this subject appears to me to possess an interest apart from the issues hitherto in question, I trust you will allow me a little of your space.

From the fact that lakes do not ordinarily occupy the crest of a watershed, it would *à priori* appear more likely that a double outfall, if it exist, should lie in or towards adjacent districts than connected with opposed valley systems. The following instance, which I observed in Norway last summer, is, in view of Colonel Greenwood's letter (NATURE, vol. ix. p. 441), worth mentioning. The lake exhibiting it lies about two miles inland (N.W.) from the elevated coast which faces Trondhjem, and is named Stor Lake; its length—nearly parallel to the Trondhjem fjord—is about seven miles, its greatest breadth about two. Like many Norwegian lakes, it presents a *facies* different to what we are most familiar with in Britain. Instead of occupying a single valley-basin, it consists of a chain of minor basins strung along an axis of depression (probably a pre-existing valley), and each separated from its neighbours by the subsided walls of the valley of which it is the cup-like enlargement. The form of Stor Lake is irregular, with long arms or creeks extended (obliquely to its longer axis) into the mouths of the valleys. In such lakes it might be expected now and then that the effluent waters should pass out at more than one of these channels, and in Stor Lake such is the case. One stream is discharged from one of the component basins, nearly at right angles to the lake's greatest length, the other issues along the depression on which I have said the basins are "strung"—bead-like. The former opening is of post-glacial date, and is superseding the original one for several reasons:—(1) it flows along the strike of a homogeneous bed of schist, whereas the other cuts across beds of various textures, and (2) its volume is greater. Its rival bears evident traces of

progressive attenuation, and is not marked on any published map.

In this case the streams are nearly at right angles to each other when discharged; another instance, however, seems to be furnished in a neighbouring loch, Grön Lake, in which they are collateral. Krefting's map (1868) represents the loch as bifurcating at its north-east end, each of the inlets giving rise to a stream; they seem about two miles apart, are marked by lines of about equal thickness, and flow nearly parallel to the Trondjhem fjord near Mosvigen.

I believe that instances of a like nature with these are by no means rare in Norway. I know at least one lake near Trondjhem, which at a former period seems to have had a double outfall, and many others in which, were the existing outlet dammed by a moraine twenty to fifty feet high, the water would find one or several openings elsewhere.

I have indeed noted several instances of lakes with two outfalls upon Prof. Munch's large map of Norway (1845), but failing to discover any confirmation in other maps, and finding it in other respects unreliable upon matters of such detail, I can assign no value to them.

It would be a fact of curious significance, as bearing upon Prof. Ramsay's theory of the glacial origin of lakes, if most authenticated instances of lakes with several outfalls could be referred to districts which have been traversed by a continuous sheet of glacier ice. When glaciers were confined within valley boundaries, as in Britain, their force was of necessity concentrated along lines, but upon level tracts or plateaux they were free to scoop wherever circumstances favoured erosion. Should it prove that Norway, North America, and Lapland give us the majority of lakes with several outfalls, no other theory can explain the fact.

St. James's Park, S.W. HUGH MILLER

Trees "Pierced" by other Trees

COLONEL GREENWOOD'S answer (NATURE, vol. ix. p. 463) to Mr. J. J. Murphy encourages me to mention a botanical phenomenon which I witnessed in 1865, but have scarcely ever mentioned before for fear of being disbelieved. I was standing on the bank of the little river Evenlode, in Oxfordshire, looking at an old pollard willow trunk about six feet high, when I observed in the decayed wood of the tree an upright sort of staff resembling a dark-coloured old school ruler, and of about that size. I knocked away some of the touchwood above and below, and found my ruler lengthened each way. At the point where it would naturally issue at the top, I found a small twig of undoubted ash, of which the leaves were fully expanded, sprouting up among the branches of willow. Upon clearing away a little more rotten wood I laid bare another ruler, which, like the first, appeared to lengthen upward to the top of the trunk and downward to the ground, but there was no second twig of ash above. The "rulers" were rough where they were totally enclosed by the willow, and had put forth little threadlike rootlets. But the part which I found exposed to the air was smoother and looked like a true branch, but was darker than the usual colour of ash. I afterwards drew the proprietor's attention to the tree, but he could not suggest any explanation. I daresay it is there and in the same condition to this day; if anyone wished it, I could easily describe where it might be found. One explanation I have had offered is, that an ash-seed had fallen down a deep crack in the willow. But there was no sign of such a crack—no crack-like cavity—one of the "rulers" being totally and closely enveloped with the rotten wood, and the other very nearly so. Whether it would have been possible for an ash-seed to germinate in a crack which must have been at least four feet deep and probably much deeper, and was open at the top only and was certainly no larger than the shoot which it formed, is a question I must leave to botanists. Another explanation was, that as ash-roots travel for a considerable distance underground, it was possible that two such roots, finding suitable pabulum in the rotten trunk of the willow, had turned upwards. But this also I must leave to men of science, and notably to Col. Greenwood. T. S.

PROF. TAIT ON "CRAM"

ON Wednesday, the 22nd inst., at the ceremony of capping the Graduates in Arts of Edinburgh University, Prof. Tait gave an address in which he touched on various subjects of Academical interest. On the subject of "Cram" he spoke as follows:—

"It is a mere common-place to say that examination, or, as I have elsewhere called it, artificial selection is, as too often conducted, about the most imperfect of human institutions; and that in too many cases it is not only misleading, but directly destructive, especially when proper precautions are not taken to annihilate absolutely the chances of a candidate who is merely crammed, not in any sense educated. Not long ago I saw an advertisement to the effect:—'History in an hour, by a Cambridge *Coach*.' How much must this author have thought of the ability of the examiners before whom his readers were to appear? There is one, but so far as I can see, only one, way of entirely extirpating cram as a system, it may be costly—well, let the candidates bear the expense, if the country (which will be ultimately the gainer) should refuse. Take your candidates, when fully primed for examination, and send them off to sea—without books, without even pen and ink; attend assiduously to their physical health, but let their minds lie fallow. Continue this treatment for a few months, and then turn them suddenly into the Examination Hall. Even six months would not be wasted in such a process if it really enabled us to cure the grand inherent defect of all modern examinations. It is amusing to think what an outcry would be everywhere raised if there were a possibility of such a scheme being actually tried—say in Civil Service Examinations. But the certainty of such an outcry, under the conditions supposed, is of itself a complete proof of the utter abomination of the cramming system. I shall probably be told, by upholders of the present methods, that I know nothing about them, that I am prejudiced, bigoted, and what not. That, of course, is the natural cry of those whose 'craft is in danger'—and it is preserved for all time in the historic words, 'Thou wert altogether born in sin, and dost thou teach us?' I venture now to state, without the least fear of contradiction, a proposition which (whether new or not) I consider to be of inestimable value to the country at large:—Wherever the examiners are not in great part the teachers also, there will cram to a great extent supersede education. I need make no comment on this, beyond calling your particular attention to the definite article which twice occurs in the sentence, and which gives it its peculiar value.

"I said, in my former address [eight years ago], that 'coaching' seems quite natural to all who are engaged in it, and, in particular, that it did so to myself more than twenty years ago. This shows that it is possible that something akin to the results of the profound speculations of Riemann, Helmholtz, and others, may hold in the moral if not in the physical universe. It is probably new to most of my audience to hear that very great authorities are as yet in doubt whether the properties of space itself are the same in different localities; whether, in short, in our rapid flight through space, we may not be insensibly getting into a region, our existence in which will involve a gradual change of form, in order that our physical substance may continue to fit the varying circumstances of our position. Assume that something like this holds in the world of mind, and you see at once how the same man may, while residing in Edinburgh, honestly denounce certain methods as wholly pernicious which a few years' residence in Cambridge may invest in his eyes with a perfection more than human. I do not say that this is an explanation; but the analogy is at least worthy of remark; and I leave further discussion of it to my old friend Mr. Todhunter, who, living in the middle of that singular region, tells me he thoroughly agrees with me in my main arguments against examinations, and then soundly rates me for my mode of propounding them."

After advocating the restoration of the B.A. degree to Edinburgh University, Prof. Tait spoke in forcible terms

against the centralisation of our various Universities, Licensing Boards, &c, "with its inevitable acolyte cram." He illustrated in an original and striking way what he thinks would be the inevitable result of centralisation, by referring to the dead and motionless uniformity which must be the result of the degradation of energy. Prof. Tait drew a ludicrous yet melancholy picture of what would be the results of universal uniformity in the social world.

"The application of these ideas," he said, "to political and social questions, among which of course comes University centralisation, is not far to seek. What would the world of men be without what we may call 'social entropy'? Everyone would then be his own farmer, baker, butcher, brewer, banker, boot-black, &c.—all would be at the same dead level—no possible help from one to his neighbour, even if it could be required; no distribution of tasks, and therefore (in every department) that endless waste which is inevitable in operations conducted on a petty scale. No possibility of that mutual reliance and assistance which forms the friendships we delight in, none of that variety which is the real charm of life—no idea which would not simultaneously strike every unit of the race—no news, no books—nothing but sameness! None of the pleasure of being able to assist struggling worth, none of gratitude for generous aid. Nay, we might pursue it further. No difference of temper, character, tendencies, age, sex—a state lower than the lowest known in vegetation; but here the end must come. Or, to take a somewhat different point of view (though the basis is absolutely the same, for oscillation implies entropy), what if everything were always at its average value? Never absolutely either fair or rainy weather, clear or cloudy, calm or stormy, hot or cold; but a dead average. Never either absolutely day or night; no tides, no seasons; men never either absolutely awake nor absolutely asleep—continually in a semi-lethargic state—half happy, half discontented; half playful, half serious—neither running, walking, standing, sitting, nor lying, but a perpetual average. No catastrophes such as a birth, a marriage, or a death—no distinction between man and man—nothing of that variety which is the law of nature. Eternal, hideous, intolerable sameness, by necessity devoid of all capacity for action: the human race turned into a set of Nürnberg toy-solders, all cast in the same mould, of the same base material, and all similarly bedaubed from the same glaring paint-pots, and moving on the same lazy-tongs with the same relative velocities. No one to advise you in a difficulty, no one in whose superior strength of mind or body you could confide; nothing around you except what you feel must be but the image of yourself (as you will early have learned introspectively to look at it)—mean, sordid, and grovelling! No one whom you can respect, none to trust—all, like yourself, vile and despicable! Here I would gladly say—'Enough of such horrors,' and quit the disgusting theme. But, unfortunately, the application has still to come. It will be found very pertinent to many things which have been of late evolved from the innermost consciousness of statecraft, and hailed, with altogether inexplicable delight, by what seemed (till lately) to be at least a numerical majority of the representatives of our countrymen."

Prof. Tait then referred to the late Prof. Forbes and the recent discussion concerning his character and work. For what Prof. Tait has to say on this subject we must refer our readers to his address, which is printed in full in the *Scotsman* of the 23rd inst. He then spoke of the scheme for extending Edinburgh University, and the facilities which would thereby be acquired for teaching Science practically, as it ought to be taught, and thus tend to extinguish "paper-science," a term which "conveys to all who are really scientific men an impression of the most unutterable contempt." In conclusion, Prof. Tait referred to the difficulties attending the work of his own class, that of "Natural Philosophy," arising from the want of adequate means. He hopes to be able, at least, to put the Natural Philosophy Department in Edinburgh University on a proper footing for his successor.

THE SOIRÉE OF THE ROYAL SOCIETY

On Wednesday, April 22, the first soirée of the Royal Society since their removal into their new apartments was given by the President, Dr. Hooker, and came off with the greatest *éclat*. There was a remarkably good display of scientific apparatus, and we think that the interdependence of the man of Science and of the manufacturer of instruments is at no time better exemplified than on occasions like the present. The apartments devoted to the purposes of exhibition were thronged by the most eminent in the various branches of Science—it might have been said with reason that a considerable fraction of the nation's mind had centred for the time being in the rooms at Burlington House. Not as an unhealthy sign either did we regard the presence of Archbishop Manning and the attention shown towards that divine by scientific men of the very opposite poles of thought.

Of the objects of interest displayed in the six rooms devoted to this purpose we can here only give details of the more prominent. In the first room several maps and photographs were exhibited by the Royal Geographical Society; also some splendid pieces of glass-work by Messrs. Chance, consisting of a dioptric fixed light (4th order) with nine prisms and six rings of lenses in four panels, a segment of a dioptric totally reflecting mirror first proposed by Mr. Thomas Stevenson, C.E., a dioptric holophote designed by the same engineer, and a lamp-burner designed by Mr. J. N. Douglass, C.E., with six concentric wicks. This burner can be used either for colza oil or for petroleum. The President exhibited also in this room some interesting objects from the Kew Museum. Amongst these we noticed some fossil copal gums from Zanzibar, carved cocoa-nut shells from the Fiji Islands, a vase made from the ash of *Moguilea utilis*, mixed with clay, from Parà, and different chemical and medical products from species of *Eucalyptus*.

In the second room Mr. Crookes exhibited his experiments showing the attraction and repulsion accompanying radiation. The pendulum described by Mr. Crookes in his communication to the Society was exhibited under various forms, and the experiments excited the liveliest interest. Here also Dr. C. J. B. Williams exhibited some new ear-trumpets, and Messrs. Whitehouse and Latimer Clark an electrical recorder for registering time, speed, distance, and number of passengers inside and out in tram-cars and omnibuses. This information is registered in four parallel columns in red ink on long strips of paper, by automatic pens.—Mr. Vernon Heath exhibited some autotype landscapes, and the president some Tappa dresses from Fiji, which reminded us strongly of the ornaments placed in our fire-stoves during the summer. Here also we were shown a microscope by Messrs. Powell and Lealand, with a $\frac{1}{80}$ immersion objective and the eternal Podura scale.

In the third room, the Entrance Saloon, were some exquisitely coloured drawings of the flora of Brazil, and landscapes by Miss North; likewise some coloured drawings of New Zealand birds, exhibited by Dr. W. Lawry Buller. The pair of new Paradise Birds collected by Signor D'Abertis* in New Guinea, promised by Dr. Sclater, was not exhibited.

In the fourth room, the Reading Room, Dr. Tyndall exhibited the apparatus (already described in our columns) for showing the stoppage of sound by a non-homogeneous mixture of air and vapours, and also experiments illus-

* See NATURE, vol. viii. p. 305.

trating Savart's observations on the action of sound on a jet of water. Dr. J. H. Gladstone exhibited some photographs of fluorescent substances. Bottles containing fluorescent liquids, such as æsculin or quinine di-sulphate, appear in the photographs nearly as black as a bottle filled with ink; similarly, labels written with such liquids, although the characters are ordinarily invisible to the eye, show up their designs when photographed. In this room were to be seen also photographs of the Naples Aquarium, exhibited by Mr. W. A. Lloyd, and one of Dr. Dohrn's Zoological Station at Naples, lent by Mr. Darwin; likewise some lithographed plates of recent Foraminifera from the Abrolhos Bank, exhibited by Profs. W. K. Parker and Rupert Jones. Mr. J. Norman Lockyer exhibited a series of photographs of metallic and solar spectra enlarged by Messrs. Negretti and Zambra from photographs taken by his new method of comparing spectra by means of a perforated shutter sliding in front of the slit of the spectroscope. In this room the new sextant devised by Capt. J. E. Davis was exhibited. This instrument, which will be found particularly useful in night observations, permits the taking of a series of observations without reading off each observation; this being accomplished by the adaptation of a micrometer movement to the tangent-screw, and the application of indicators to the arc of the instrument. Mr. Alfred Tribe here exhibited some specimens of metals (palladium, copper, &c.) which had become agglomerated in a most remarkable manner by hydrogenisation; under ordinary circumstances the metals shown existed in the form of fine powders, but, as soon as charged with hydrogen, become agglomerated.

The fifth room, or Principal Library, is by far the largest apartment of the suite. Mr. C. V. Walker's electrical apparatus for carrying out the "block system," or "space intervals," between trains on the South-Eastern Railway, was here displayed. Messrs. Tisley and Spiller exhibited their compound pendulum apparatus in action, and distributed cards with the exquisite curves described upon them. This firm exhibited also the beautiful triple combination double-image prism belonging to Mr. Spottiswoode. Mr. E. B. Tylor's ingenious apparatus for illustrating refraction (already described in these columns) was exhibited in this room.* We observed also some splendid gold crystals exhibited by Mr. W. C. Roberts, Chemist to the Mint; Mr. W. H. Barlow's "Logograph," a recording instrument for showing the pneumatic action accompanying the exercise of the human voice; and a pair of gyrostals exhibited by Prof. Sir William Thomson. Messrs. Negretti and Zambra exhibited their ingenious thermometer for recording deep-sea and atmospheric temperatures, already described in NATURE. Mr. John Browning exhibited a good collection of apparatus. Mr. G. P. Bidder's micrometer, a most ingenious device for observing the transit of very faint stars, in which the spider lines, capable of the usual micrometer movements, are illuminated by a side light, and are reflected into the eye-piece by a mirror, thus appearing bright upon a dark ground, and by interposing coloured glasses between the lamp and the spider lines can be coloured at pleasure. Sir Charles Wheatstone's new photometer is well worthy of notice: the screen slides along the divided scale and its motion causes the increased overlapping of two sliding wedges of neutral-tint glass. The light is looked at directly through a hole in the screen, and the latter moved along the scale till the light just ceases to be visible. We noticed also a micro-spectroscope of very good definition, showing the absorption spectrum of cantharides. Mr. Apps exhibited a model and diagram of a fireproof building, and a model of an improved apparatus for indicating the speed of revolving shafts, both being the inventions of Sir David Salomons. The plan for rendering buildings fireproof consists in laying on water-pipes between the walls and floors of the building, these pipes being self-acting by means of fusible-metal plugs or electrical communications. The last-named model is an application of the ordinary governor balls, which are connected with the shaft, and by a system of levers, with an index, which moves up a graduated scale. A double-action spectroscope with a divided object-glass, made by Grubb, of Dublin, was shown and explained by Lord Lindsay; this instrument is intended by its owner to be attached to a large equatorial for the observation of stellar spectra. Among other noticeable things in this room we may mention the Megohm, one million British Association units, by Messrs. Elliott Brothers; Mr. George Barnard's highly artistic water-colour drawings and the copies of sacred Icons of the Greek Church in Russia, and photographs by Mr. John Leighton. Col. Stuart Wortley's photographs from life are high examples of art, and the group of living corals (*Astroides calicula*) from the Bay of Naples, exhibited by the Crystal Palace Aquarium Company, attracted large numbers of admirers by their beauty. At 10 o'clock Dr. R. Norris, of Birmingham, exhibited in the meeting-room experiments to illustrate a form of contractive energy which displays itself in various substances. Among other things the Doctor showed that the statement that india-rubber *contracts* by heat is incorrect; this substance, it is true, contracts in the direction of its length, but it expands in breadth at the same time, thus resembling the so-called contraction of muscular fibre.

In soirées of this kind experiments illustrative of new chemical discoveries are generally "conspicuous by their absence." This surely cannot be due to the fact that the science does not permit of public demonstration; it arises rather from the "messy" nature of the materials employed by chemists, thus precluding the introduction of chemicals into such rooms as are devoted by the Society to their gatherings. We are of opinion that in not fitting up and adding to their now noble apartments a laboratory, an omission has been made which may be regretted in the future.

* We should recommend lecturers using this apparatus to see that the wood is well seasoned; the one exhibited soon ceased to act satisfactorily, owing to the warping of the board.

THE LECTURES AT THE ZOOLOGICAL SOCIETY'S GARDENS

II.

IN the second and third of his lectures On the Geographical Distribution of the Mammalia, delivered on the Tuesday and Friday of last week, Mr. Sclater described in detail the ranges of the different orders of terrestrial mammals; and to avoid unnecessary repetition, employed the well-known system of division of the earth's surface, proposed before the Linnean Society in 1857, from a study of the bird class, according to which there are six regions—(1) The *Palæarctic*, including Europe, Africa north of the Atlas Mountains, and Northern Asia. (2) The *Ethiopian*, including all Africa south of the Atlas Mountains, and the southern part of Arabia. (3) The *Indian*, including Asia south of the Himalayas, Southern China, and the Indian Archipelago. (4) The *Australian*, including Australasia. (5) The *Nearctic*, including North America down to the centre of Mexico; and (6) The *Neotropical*, including South and Central America. The following is a summary of his remarks.

Among the monkeys the anthropoid apes inhabit equatorial Africa, where the gorilla and chimpanzee are found; Sumatra and Borneo are the home of the orang outang; while the eastern portion of India, Burmah, and the Indian Archipelago constitute the habitat of the various species of gibbon. The catarrhine monkeys, including the green monkeys (*Cercopitheci*), and the macaques inhabit Africa and India respectively; the latter, however, extending into Africa north of the Sahara, as far as Apes Hill and the Rock of Gibraltar. The platyrrhine monkeys, among

which are the spider monkeys, the howlers, and the marmosets, are found in the Neotropical region, except in its southern and western parts. The lemurs are mostly confined to the island of Madagascar, some few inhabiting Eastern India, and two forms occurring in Western Africa.

Among the large order of the Carnivora the lion is a denizen of the forests of the Ethiopian region, and spreads slightly beyond it into India. The tiger is found in the Indian region, and spreads up into China and Central Asia, where its coat becomes coarser in texture. The leopard is distributed over the districts of the lion and tiger; it is also found in Borneo and Ceylon, whilst the lynx occurs in the Neartic and Palæarctic regions. The dogs are cosmopolitan, though it is doubtful whether the single form of Australia has not been introduced by man in early times. The bears inhabit the Palæarctic, the Nearctic, and the Indian regions, being also found in the Andes of Peru.

Among the odd-toed, or Perissodactylate Ungulates, the horses and asses are strictly Old-World forms, the exact place of origin of the former being uncertain. The asses are spread over the Indian and Ethiopian regions. The tapir is very aberrant in its distribution, one species appearing only in Sumatra and the Malay Peninsula, while in the northern portion of South America and Central America three others occur. The rhinoceroses are from the Indian and Ethiopian regions only, the Asiatic species all being now or having lately been exhibited in the Zoological Gardens. Those from Africa are less perfectly known, only two species having been accurately determined.

Among the even-toed, or Artiodactylate Ungulates, the camels are very peculiar in their habitats, the Llamas of the Andes and the camels of Africa, Arabia, and part ef Russian Asia being the only known forms; those from the last-named locality being the only known wild true camels of the present day. The giraffe is purely Ethiopian. The bison in North America represents the oxen of the Indian region, which in Africa and Arabia are in great measure replaced by the antelopes, so varied in form and size. The Cervidæ are not found in the Ethiopian nor Australian regions. The hippopotamus inhabits all the large rivers of Africa, the smaller species being found in and about Liberia. Of the Swine-family the peccaries are the representatives in the Neotropical region, whilst the quaint Wart-Hog and Red River Hog are exclusively African.

The hyrax, or coney of Scripture, whose zoological position is so uncertain, is found in Arabia and parts of Africa only.

There are only two species of elephant known, the Indian being from the Indian region, and the African from the Ethiopian. In very recent times they abounded in Siberia, and earlier still in many other parts of the world.

The Neotropical region abounds in peculiar Edentate animals, as the armadillos, sloths, and ant-eaters. The scaly ant eaters or Pangolins, and the ant-bears or Orycteropus, are found, the former in India and Africa, the latter in Africa only.

Among the Insectivora, the peculiar Solenodon inhabits St. Domingo; the gilded mole, South Africa; the Tenrec, Madagascar; and the Tupaias, the Malay districts.

Among the Rodentia the porcupines, divided into two well-distinguished sub-families, inhabit, one the Old and the other the New World. The Neotropical region, however, is the head-quarters of the *Hystricidæ*; the capybara, together with the agoutis, and numerous other forms being from that locality. There are also found the chinchilla and viscacha. The beaver abounds in the Nearctic region, and used to do so in Europe, till the increase of population has almost exterminated it. The hare and rabbits have a wider distribution, as have also the squirrels.

It will be noticed that Australia has been scarcely mentioned in the above remarks, and that the dog which is spoken of in connection with it is not known certainly to be indigenous. This is because the mammalian fauna is almost entirely represented by animals of the Marsupial order, the kangaroos, bandicoots, phalangers, wombat, koala, thylacine, and dasyures being peculiar to it and Van Dieman's land. Among Marsupialia the group of opossums is only found in the Neotropical region, extending quite through Mexico into the United States.

The Monotremata, including only the duck-bill or ornithorhynchus and the echidna, are confined to New South Wales and Tasmania.

(*To be continued.*)

THE FLUCTUATIONS OF THE AMERICAN LAKES AND THE DEVELOPMENT OF SUN-SPOTS

IN the course of an investigation, undertaken in my capacity as Geologist to the B.N.A. Boundary Commission, as to late changes of level in the Lake of the Woods, bearing on the accuracy of certain former surveys, I found it desirable to tabulate the better-known fluctuations of the great lakes for a series of years as a term of comparison. The observations of secular change in Lake Erie are the most complete, and these, when plotted out to scale, showed a series of well-marked undulations which suggested the possibility of a connection with the eleven-yearly period of sun-spot maxima. A comparison with Mr. Carrington's diagram of the latter confirmed this idea, and as I do not remember to have seen these phenomena connected previously, I have been induced to draw out the reduction of both curves here presented, and the table of the height of water in the lakes.

The changes of level affecting the great lakes are classed as follows by Colonel Whittlesey, who has given much attention to the subject:—

1. General rise and fall, extending through a period of many years, which may be called the "Secular Variation."
2. Annual rise and fall within certain limits, the period of which is completed in about twelve months.
3. A sudden, frequent, but irregular movement varying from a few inches to several feet. This is of two kinds, one due to obvious causes, such as winds and storms; another, described as a slow pendulum-like oscillation, has been somewhat fully discussed by Whittlesey in a paper read before the American Association at its last meeting, and is due probably to barometric changes in the superincumbent atmosphere.

The first class is the only one directly included in the present inquiry.

I.—*Table of Great Lakes.*—In Mr. Lockyer's new work on Solar Physics, chap. xxvi., entitled "The Meteorology of the Future," exhibits the parallelism of periods of solar energy, as denoted by the outburst of sun-spots, with the maximum periods of rainfall and cyclones, and for the southern hemisphere, by a discussion of his own and Mr. Meldrum's results. In the table (p. 505) I have arranged the more accurate numerical observations of the height of the lakes from registers kept for the last few years, in a method similar to that there adopted.

Prof. Kingston's observations of Lake Ontario were taken at Toronto, and measured upward from an arbitrary mark. They extend from the year 1854 to 1869, and include the minimum periods of 1856 and 1867, and the maximum of 1860. Taking the mean annual level for

each minimum and maximum epochal year, and one year on each side of it, as is done by Mr. Meldrum, and deducing a mean from each of three tri-yearly periods,

Table showing the height of water in the American Great Lakes, measured upward from an arbitrary mark, for the years surrounding periods of maxima and minima in the occurrence of Sun-spots.

Sun-spot Periods.	Year.	Lake Ontario, from Prof. Kingston's observations. Yearly means.	Lake Ontario, from Prof. Kingston's observations. Tri-yearly means.	Lake Ontario, from U.S. Lake Survey Observations. Yearly means.	Lake Ontario, from U.S. Lake Survey Observations. Tri-yearly means.	Lake Superior, from U.S. Lake Survey Observations. Yearly means.	Lake Superior, from U.S. Lake Survey Observations. Tri-yearly means.	Lake Michigan, from U.S. Lake Survey Observations. Yearly means.	Lake Michigan, from U.S. Lake Survey Observations. Tri-yearly means.	Lake Erie, from U.S. Lake Survey Observations. Yearly means.	Lake Erie, from U.S. Lake Survey Observations. Tri-yearly means.
Min.	1855 1856 1857	17·8 20·6 27·5	21·7								
Max.	1859 1860 1861	28·6 18·3 27·4	24·7	30·48 22·68 33·12	28·80	40·32 30·24 28·26	33·12	29·88 23·76 23·88	25·92	33·60 28·32 29·76	30·60
Min.	1866 1867 1868	9·3 19·7 4·6	11·2	18·36 28·86 13·68	19·20	18·12 20·16 18·24	18·84	3·72 7·68 4·32	5·28	17·76 18·00 13·80	16·56

Mean of maximum periods in Lakes Ontario, Superior, Michigan, and Erie, from U.S. Lake Survey Obs. 29·61
Mean of minimum ,, ,, ,, ,, ,, ,, 14·97
Difference 14·64

The measurements are in inches and decimals.

the agreement is close between the solar periods and those of fluctuation in the lakes.

The remaining observations are those of the U.S. Lake Survey, and include only one period each of maximum and minimum in solar spots. The measurements of the U.S. Survey are reckoned *downwards* from a mark representing the high water of 1838 in each of the lakes, but in the table here given they have been reduced so as to read upwards from an arbitrary line chosen 4 feet below that datum. They are thus rendered more intelligible and made to agree in sense with Prof. Kingston's measurements.

The result is the same in each of the lakes, only differing in amount by a few inches. A mean deduced from the U.S. Lake Survey observations in Lakes Superior, Michigan, Erie, and Ontario, gives a difference between the years surrounding the maximum of 1860 and the minimum of 1867 of 14·64 inches in favour of the former.

2. *Diagram of Curves.*—The curve representing the fluctuation of Lake Erie from 1788 to 1857 inclusive is constructed on a careful discussion of the evidence collected by Col. Whittlesey and given by him most fully in the "Smithsonian Contributions to Knowledge" for 1860.

From 1788 to 1814 there are no accurate measurements to any well-recognised datum line, and I therefore give below the measurements and approximations on which the general curve for these years has been constructed. The description of the fluctuation of the lake will be seen in many cases to apply with verbal accuracy to the sun-spot curve.

"1788—1790. By tradition derived from the early settlers very high; according to some as high as 1838, but this is doubtful.

"1796. By the first emigrants and surveyors reported as very low—5 feet below 1838.

"1797. Rising rapidly.

"1798. Water continues to rise, but 3 feet below June 1838.

"1800. Very high; old roads flooded.

"1801. Still high.

"1802. Very low; reported by old settlers as lower than 1797.

"1806. Very low; reported by old settlers as lower than 1801—2, and declining regularly to 1809—10 when it reached a level by many considered as low as that of 1819.

"1811. Rise of 6 inches in the spring over 1810, by measurement, and a fall of 2 inches.

"1812. Rise of 14 inches in spring over 1810, by measurement, and a fall of 3 inches.

"1813. Rise of 2 feet 2 inches in spring over 1810 by measurement.

"1814. Rise of 2 feet 6 inches in spring above general level of 1813."

From 1815 to 1833, both inclusive, occasional measurement to fixed data exist; the supplementary notes are here given.

"1815. Rise of 3 feet above average level of 1814. (This statement is not confirmed by an actual measurement made in August, and is probably exaggerated).

"1816. Water still high, but falling, and continued to fall till 1819.

"1819. Lowest well-ascertained level of the waters in Lake Erie.

"1820. Stated to be in August as low as 1819.

"1821. Rising.

"1822. Rising; in the spring 4 feet below June 1838.

"1823. Rising; in the spring 3 feet 3 inches below 1838.

"1824. Rising gradually.

"1825. Rising; lowest level 3 feet below June 1838.

"1826. Rising; lowest level 2 feet 10 inches below June 1838.

"1827. About the general level of 1815.

"1829. Water still rising.

"1830. General level same as 1828.

"1831. Lower than last year; yearly change at least 3 feet.—Col. Whiting. (Probably an error as this would place the water unprecedentedly low. Col. Whiting probably ascertained that the lake was falling and erred in taking some former high-water mark for that of the preceding year).

"1832. General average 2 feet 10 inches below June 1838.

"1833. General average 3 feet 2 inches below June 1838."

From this date to 1857 many actual measurements are given by Whittlesey, and from these the curve for those years has been constructed. The whole of the observations are reduced as nearly as possible to the average level for each year by comparison with a mean annual curve for about 10 years constructed from monthly averages of bi-five-day means given by the U.S. Lake Survey. 1859 to 1869 both inclusive are from yearly means derived from continuous observations at Cleveland by the U.S. Survey. 1871 to 1873 are from information kindly furnished by Gen. Comstock, Director of the Lake Survey. I have no data for 1870.

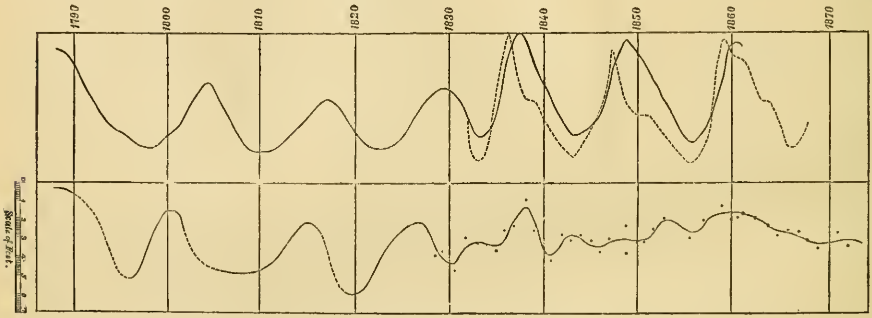
The earlier and less systematic observers of the fluctuations of the lakes would scarcely give attention to any but the more important changes of level, and it is possible that these in many cases may have been exaggerated in amount. It would seem improbable, however, from the

number of observations which have come down to us, that any variations of importance have escaped notice.

In the upper part of the diagram, the unbroken line represents Carrington's curve founded on the number of sun-spots. The broken line is a reduction of a mean curve based on the area of the spots given by De la Rue, Stewart, and Loewy in the Philosophical Transactions for 1870; and is introduced as showing the solar periods to a later date.

3. *General Remarks.*—The first four maxima of sun-spots represented in the table being separated by long intervals of years with few spots, and not being very intense, would appear to have been closely followed by L. Erie. More especially 1837, the year of greatest known intensity according to both spot curves (333 new groups of spots according to Schwabe), was marked in its effects on the lakes, giving rise in 1838 to the highest recorded level of the waters in Erie and Ontario, and probably also in Superior, though here the data are not so certain. The high-water mark of 1838 has since been employed as the datum to which all the measurements of the Lake Survey are reduced.

The three last periods of maxima of sun-spots are extreme, and the intervals characterised by their deficiency so short that the lakes seem to have been unable to follow them as closely as before. One period of high water being to a great extent merged in the next, and resulting in a general high state of the lakes for the last thirty years, which may be connected with the Wolfian Cycle of fifty-six years in the development of sun-spots. The lakes do not seem to have responded to the maximum of 1848, but by a reference to the curve of area of sun-spots, it will be seen that the intensity of this period was not so great as of those on either side of it, and the period of maximum was maintained for a very short time only. The important sun-spot maximum of 1859-60 was evident in its effect on the lakes even at their present general high level. With regard to the Lake of the Woods the data are slight, but it may be mentioned that this lake is known to have been very low in 1823, and in 1859 to have attained a point which it has never touched since, and which is about 3 feet higher than the present level. The lake is also known to have been for a good many years higher than usual, and at least one well-marked high water took place between 1823 and 1859, which may very probably have been synchronous with that of 1838 on the great lakes.



Comparative Diagram of the Fluctuations of Lake Erie, and Periods of greater or less Solar Activity as indicated by the occurrence of Sun-spots. 1. Solar Spot Curves. 2. High Water, June 1838. 3. Lake Erie.

This lake derives its water from the western slope of the same Laurentian range which feeds Lake Superior.

The correspondence between the periods of maxima and minima in solar-spot cycles and in the fluctuation of the great lakes, though by no means absolute, seems to be sufficiently close to open a very interesting field of inquiry, and to show the extension of the meteorological cycle already deduced by Messrs. Meldrum and Lockyer for oceanic areas in the southern hemisphere, to continental ones in the northern.

The great lakes in their changes of mean yearly level probably show a very correct average of the rainfall over a large area, and thus indicate the relative amount of evaporation taking place in different seasons. It is to be observed, however, that the actual mean annual outflow of the lakes would be a better criterion, and that from the form of the river valleys giving exit to the waters, this must necessarily increase in a much greater ratio than the measured change of level in the lake itself. It is much to be desired that such observations should be systematically made. The occurrence of seasons of great activity of evaporation and precipitation, as indicated by the lakes synchronously with those of maximum in solar-spot production, would tend to confirm the opinions previously formed as to the coincidence of the latter with periods of greater solar activity. Wolf, as quoted by Chambers, states from an examination of the Chronicles of Zurich, "that years rich in solar spots are in general drier and more fruitful than those of an opposite character, while the latter are wetter and stormier than the former." Gautier, from a more extended series of observations, including both Europe and America, has deduced an exactly opposite conclusion, which, from the evidence of the great lakes, would appear to be the correct one.

It is quite possible, however, that both may be true (see "Solar Physics," p. 430). The great lakes lying at the base of the Laurentides, where moisture-bearing winds from the southward and westward are interrupted in their course, and meet with cold currents journeying over these hills from the north, are essentially in an area of precipitation, and greater precipitation would here be the natural result of greater solar energy. In other regions excessive evaporation may result from the same cause, and this may account for the gradual desiccation which on the authority of many observers is going on at present over great areas of the inland plains of the west.

The observations here given cannot be accepted as conclusive, but derive additional importance from the large area which they represent, and may suggest more systematic investigation of the subject, and the accumulation of accurate observations, which in the course of years may lead to results of greater value.

G. M. Dawson

POLARISATION OF LIGHT *
VIII.

A QUARTZ plate cut parallel to the axis, when examined with convergent light, gives curves in the form of hyperbolas. These curves are wider in proportion to the thinness of the plate, but if the plate be thick enough to render the curves moderately fine, the colour becomes very faint. They may, however, be rendered distinct by using homogeneous light. The dark and light parts exchange positions when the analyser is turned through 90°. Two such plates with their axes at right angles to one another give coloured hyperbolas perfectly visible with the white light. Plates of Iceland spar exhibit similar phenomena, but the lines and curves are far more closely packed.

If the plate be cut in a direction inclined at 45° (or at any angle differing considerably from 0° or 90°) to the axis, the curves are approximately straight lines perpendicular to the principal section of the plate. Two such plates placed with their principal planes at right angles to one another give straight lines bisecting the angle between the principal planes. On this principle Savart constructed the polariscope which bears his name. It consists of two such plates and an analyser, and forms a very delicate test of the presence of polarisation. The lines are, of course, always in the direction described

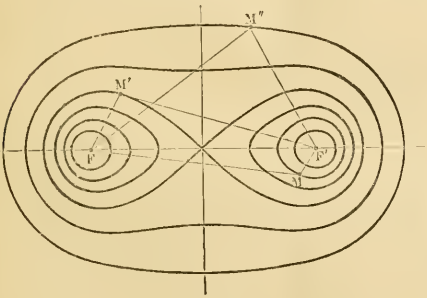


FIG. 26.

above, and the delicacy of the test increases in proportion as their direction becomes more and more nearly perpendicular to the original plane of vibration.

Bi-axal crystals exhibit a more complicated system of rings and crosses, or brushes as they may in this case be better termed. If such a crystal be cut in a direction perpendicular to the line which bisects the angle between the two optic axes (or the middle line, as it is called), the extremity of each of the axes will be surrounded with rings similar to those described in the case of the uni-axal crystals. The larger rings, however, are not strictly circles, but are distorted and drawn out towards one another; those which are larger still meet at a point midway between the centres, and form a figure of 8, or lemniscata; beyond this they form curves less and less compressed towards the crossing point, and approximate more and more nearly to an oval (see Fig. 26).

The vibrations of the two rays emerging from any point of a bi-axal crystal are as follows:—Of the two rays produced by the double refraction of a bi-axal crystal neither follows the ordinary law of refraction; but one does so more nearly than the other, and is on that account called for convenience the ordinary ray. And if through any point of the field of view we draw two lines to the points where the optic axes emerge, the directions of vibration of the two rays will be those of the bisectors of the angles made by the two lines. If, therefore, the crystal be so placed that the line joining the extremities of the two axes coincides with the plane of vibration of either polariser or analyser, it is not difficult to see that there will be a black cross passing through the centre of the field, with one pair of arms in the line joining the extremities of the axes and the other pair at right angles to it. But if the plate be turned in its own plane round the central point, the points, for which the vibrations are parallel or perpendicular to those of the polariser or analyser, will no longer lie in straight lines passing through the centre, but will form two branches of a hyperbolic curve, passing respectively through the extremities of the optic axes.

If the analyser be turned round, the dark hyperbolic brushes, or the black cross, will undergo the changes analogous to those shown in the cross in the case of uni-axal crystals; but the most interesting effects are those seen when the polariser and analyser are crossed, and the crystal is turned in its own plane.

The angle between the optic axes in different kinds of crystals varies very much; in those where the angle is small it is easy to exhibit both at once in the field of view, but in others where the angle is large it is necessary to tilt the crystal so as to bring the two successively into view. In the latter case the crystal is sometimes cut in a direction perpendicular to one of the axes. The rings are then nearly circular, especially towards the centre, and in that respect they resemble those of a uni-axal crystal;

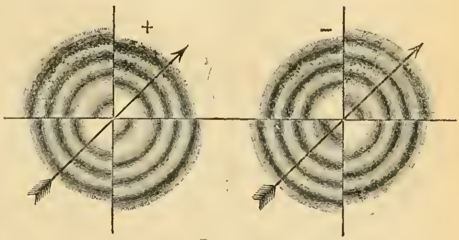


FIG 27.

but the character of the specimen can never be mistaken because the rings are intersected by a black bar, or two arms in the same straight line, instead of by four arms at right angles to one another, as would have been the case if the crystal had been uni-axal. The following are the angles made by the optic waves in a few crystals:—

	°	′
Carbonate of lead	5	15
Saltpetre	5	20
Talc	7	24
Titanite	30	0
Borax	28	42
Mica	30 to 37	0
Carbonate of Ammonia	43	24
Topaz of Brazil	49 to 50	0
Sugar	50	0
Gypsum	57	30
Felspar	64	0
Topaz of Aberdeen	65	0
Oxyde of Lead	70	25
Cyanite	81	48
Chrysolite	87	56

These angles are determined by placing the crystal for an examination into an apparatus adapted to show the rings, and attaching it to an arm whereby the plate can be turned about an axis in its own plane. The axis is furnished with a circle divided into degrees and seconds, and an index. If this axis be horizontal, the plate is so

* Continued from p. 466.

placed that the line joining the centres of the two systems of rings is vertical, and the crystal is first turned so as to bring one centre into the centre of the field of view (usually marked by cross wires); the index is then read, and the crystal turned so as to bring the centre of the second system of rings to the centre of the field. The index is again read, and the difference of the two readings noted. This, however, gives not the true angle of the optic axes, but the apparent angle in air, that is, the angle between the rays as affected by refraction on emerging from the crystal. (See Fig. 27.)

In some crystals the optic axes have different angles of inclination for the different rays of the spectrum. Of this titanite or sphene is an example. All rays have a common middle line, and lie in the same plane, but the optic axes for the red rays are more widely separated than those for the blue, and consequently the part of the field which would exhibit a dark brush if red light were used is deprived of the red rays but not of the blue. The brushes, therefore, appear broader than with ordinary crystals, and are tinged with blue on the edges farthest from the middle point, and with red on the edges nearest to it. It is said that a similar distribution of the optic axes, or its opposite in which the red rays are least separated and the blue most, is found in all crystals belonging to the rhombic system.

In other crystals, the axes all lie in one plane, but all have not the same middle line, so that the two ring systems are unsymmetrical. This is the case with borax. In others the optic axes for different colours lie in different planes, all of which pass through the middle line.

Lastly, we may mention the crystals brookite and tartrate of ammonia soda and potash, in which the optic axes for the two extremities of the spectrum lie in planes at right angles to one another, both passing through the same middle line. If the systems of rings be examined with light which has been so widely dispersed that the portion illuminating the field in any given position is practically monochromatic, and the position of the instrument shifted through the different parts of the spectrum (or what is more convenient, if the different parts of the spectrum be successively thrown on the polariscope by means of a totally reflecting prism), the optic axes will be seen to draw gradually together until the figure closely resembles that of a uni-axal crystal; after which the axes open out in a direction at right angles to the former, until they have attained their greatest expansion. This experiment requires a strong light, but it is instructive, as showing the exact distribution of the optic axes for different rays.

In some bi-axal crystals, notably in gypsum, the distribution of the optic axes varies with the temperature. When the crystal is heated the angle between the optic axes diminishes until the crystal appears uni-axal; with a further increase of temperature the axes again open out, but in a direction at right angles to the former. When the crystal is cooled the axes generally resume their original directions. Sometimes, however, when the heating has been carried to a great degree, or has been continued for a long time, the axes never completely return to their normal condition; and in such a case the crystal may appear permanently uni-axal. Such an appearance, when permanent, has been considered a test of former heating; and this phenomenon, when presented by crystals found in a state of nature, may be taken as evidence that the rocks in which they have been formed have been subject to high temperatures.

In the production and examination of the rings hitherto described, we have used light which has been plane-polarised and plane-analysed; but there is nothing to prevent our polarising the light or analysing it circularly, or indeed doing both.

If a quarter-undulation plate be placed between the polariser and the crystal to be examined, with its axis inclined at 45° to the plane of original vibration, the light will fall upon the plate in a state of circular polarisation; and as the polarisation will then have no reference to any particular plane of vibration, the black cross will disappear. A system of rings will be produced, but they will be discontinuous. At each quadrant, depending upon the position of the analyser, the rings will be broken, the portions in opposite quadrants being contracted or expanded, so that in passing from one quadrant to the next the colours pass into their complementaries. If either the direction of the axis of the quarter-undulation plate be changed from 45° on one side to 45° on the other side of the plane of vibration of the polariser; or if the crystal be changed for another of an opposite character (*i.e.* negative for positive, or *vice versâ*), the quadrants which were first contracted will be expanded, and those which were first expanded will be contracted. Hence for a given position of the quarter-undulation plate the appearance of the rings will furnish a means of determining the character of the crystal under examination.

Similar effects are produced if the quarter-undulation plate be placed between the crystal and the analyser; that is, if the light be analysed circularly.

In the case of bi-axal crystals under the action of light polarised or analysed circularly, the black brushes are wanting, but they are replaced by lines of the same form marking where the segments of the lemniscatas pass from given colours into their complementaries.

If the light be both polarised and analysed circularly, all trace of direction will have disappeared. In uni-axal crystals the rings will take the form of perfect circles without break of any kind; and in bi-axal they will exhibit complete lemniscatas.

To pursue this matter one step farther. Suppose that, the arrangements remaining otherwise as before (viz., first, the polariser; secondly, a quarter-undulation plate with its axis at 45° to the principal plane of the polariser; thirdly, a uni-axal crystal; fourthly, a quarter-undulation plate with its axis parallel or perpendicular to the first; and, lastly, the analyser), the analyser be turned round; then in any position intermediate to 0° and 90° the rings will be contracted and extended in opposite quadrants until at 45° they are divided by two diagonals, on each side of which the colours are complementary. Beyond 45° the rings begin to coalesce, until at 90° the four quadrants coincide again. During this movement the centre has changed from bright to dark. If the motion of the analyser be reversed the quadrants which before contracted now expand, and *vice versâ*. Again, if the crystal be replaced by another of an opposite character, say positive for negative, the effect on the quadrants of the rings will be reversed. This method of examination, therefore, affords a test of the character of a crystal.

A similar process applies to bi-axal crystals; but in this case the diagonals interrupting the rings are replaced by a pair of rectangular hyperbolas, on either side of which the rings expand or contract, and the effect is reversed by reversing the motion of the analyser, or by replacing a positive by a negative crystal. The test experiment may then be made by turning the analyser slightly to the right or left, and observing whether the rings appear to advance to, or recede from, one another in the centre of the field. In particular if, the polariser and analyser being parallel, the first plate have its axis in a N.E. direction to a person looking through the analyser, the second plate with its axis at right angles to the former, and the crystal be so placed that the line joining the optic axes by N.S., then on turning the analyser to the right, the rings will advance towards one another if the crystal be negative, and recede if it be positive.

W. SPOTTISWOODE

(*To be continued.*)

FLOWERS OF THE PRIMROSE DESTROYED BY BIRDS

WE have received a number of answers to Mr. Darwin's letter on this subject in NATURE, vol. ix., p. 482; these we have thought it advisable to bring together here. On the general question of the destruction of flowers by birds, Prof. Thiselton Dyer writes as follows :—

MR. DARWIN remarks that he has never heard of any bird in Europe feeding on nectar. There is perhaps one well-authenticated instance in Gilbert White's "Selborne" (illustrated edition, p. 186): "The petticheps . . . . runs up the stems of the crown imperials, and putting its head into the bells of those flowers, sips the liquor which stands in the nectarine of each petal." This is the more curious, because, according to Kirby and Spence ("Entomology," 7th edition, p. 384), this plant "tempts in vain the passing bee probably aware of some noxious quality that it possesses." I do not know how far this is true, but it has a peculiar odour which makes it rather unpopular as a garden plant.

I have, in my note-book, another instance, also from the *Liliaceæ*, of a plant visited for nectar in an extra-tropical country. Mrs. Barber relates that in South Africa "the long tubular flowers of the aloe are well supplied with nectar, and this provision affords during the winter season a continued store of food for our beautiful sun-birds," the numerous species of the genus *Nectarinia* (Journ. R. Hort. Soc., n.s., ii. 80).

Two other cases of the destruction of flowers by birds occur to me. I was assured this year that the flowers of the common crocus are persistently destroyed by sparrows, at least in the neighbourhood of Hammersmith. The base of the perianth tube, which is the usual seat of any secretion of nectar, is here beneath the surface of the ground; perhaps, however, the style and stigma are attractive to the birds. I did not investigate the matter at all closely, but my informant was an observant person, who I think would be likely to have satisfied himself that the sparrows really did the mischief, the effects of which were obvious enough. If so, we have a clear instance in crocus-eating of an acquired habit on their part.

The other case, that of the destruction of flower-buds of fruit-trees by bullfinches, is probably well known. The mischief is said to be out of all proportion to any benefit the birds can derive from it, as regards food. Such a visitation would obviously tell heavily against the plants in any country where they formed part of the indigenous flora, and had to take their chance with the rest.

Dr. J. H. Gladstone writes, that in his garden the flowers of the primroses have been similarly bitten off, and the crocuses also. He says—

ONE morning some weeks ago I especially remember seeing the beds and the gravel walks strewn with the yellow petals of the latter flower, which were severed from their stalks, and bore abundant marks of the sharp beaks which had torn them asunder. I cannot learn that anyone saw these London birds at their destructive work, which was probably done before any of us were stirring.

Mr. T. R. Archer Briggs, of Plymouth, writes—

I HAVE been familiar with the fact to which Mr. Darwin directs attention for as long a period as that during which he says it has engaged his own, without, however, my being able to point out the author of the mischief. In the neighbourhood of Plymouth it is no uncommon thing to find the flowers both of the primrose and polyanthus bitten off and lying around the plants exactly as Mr. Darwin has described; indeed, so often does this occur here, that I have known it a source of annoyance to cultivators of the latter plant. When residing some years ago at a house in the parish of Egg Buckland, about four miles from Plymouth, I remember to have repeatedly seen the polyanthus flowers in the grounds so destroyed, and to have heard it asserted that the redbreast was the culprit; but of this no proof was brought forward. The locality is a land of springs and streams, and it could not have been a want of water that led the destroyer to do the work there.

The tubular portion of the primrose is much infested by small insects (*thrips?*), and I have sometimes thought that a bird, for the sake of feeding on these, might be led to bite the flowers; but, on the other hand, they are so minute that one can scarcely think they would attract its notice.

I would say, in reply to Mr. Darwin's queries, that primroses are in profusion about Plymouth (at least beyond the immediate neighbourhood of the town, whence they have been rooted out by wretched fern- and wild flower-grubbers), but I have never seen the flowers bitten off to such an extent as in the small Kentish wood he refers to, or in a sufficiently large quantity to materially affect the numbers of the species here.

The Rev. H. C. Key, of Stretton Rectory, Hertford, says that primroses being in great abundance in his neighbourhood, he was led by Mr. Darwin's letter to make a careful search for flowers bittten off in the way he describes, but he failed to find even one.

IT is obvious that the abundance of other food for which birds have a preference—such as apple, pear, plum, and cherry blossoms afford—may possibly have saved our primrose flowers from destruction; but, taking into consideration the fact that animal food must necessarily be supplied to the young birds at this season, I should be disposed to suggest that the primroses Mr. Darwin speaks of have been mutilated by birds rather for the sake of procuring thrips and other beetles, which are attracted by the nectar, than for the nectar itself.

I find the untouched primrose flowers here swarm with beetles and acari; but the great profusion of apple, and pear-blossom, &c., close at hand, may prove more attractive to the birds from the flowers being more open, and therefore more easily accessible.

Mr. G. M. Seabroke writes—

I HAVE observed the same thing as he relates in my small garden in this town. Nearly all the early buds from some twenty primrose plants were bitten off, and birds of some sort were undoubtedly the perpetrators of the mischief. I laid the blame on the sparrows, but did not see them in the act. This is the first year that I have noticed this form of depredation.

Mr. T. R. Stebbing, of Torquay, writes as follows :—

A FORTNIGHT ago the bank on either side of the road from Kingsbridge Road Station to Salcombe were covered, for many miles, with a brilliant profusion of primroses in bloom. In all this long range of country, eighteen miles in all, there was no appearance anywhere of that destruction of blossoms as to which Mr. Darwin makes inquiry. The attention of my companion and myself was especially directed to the primroses throughout our route, not merely by the lavish and unexpected beauty of the display, but by the look-out which we were keeping up for white or red varieties. Among the myriads of plants with the ordinary yellow blossom we noted five with white and two with pinkish flowers. On returning over a portion of the same road ten days later, we detected as many as seven plants with the pale-red or pink flowers, but none of these were blooming freely like the white and the yellow flowering-plants in the same district.

It may be worth noticing that this great stream of primroses flowed down from the rather bleak upland near the railway right into the fertile and sheltered valley of Salcombe, so that in one district or the other the birds might have been expected to seek the nectar, had they been to the manner born, in this part of the country.

A correspondent, E. T. S., says that—

IN the north-west corner of Hampshire the birds have the same taste as in Kent for the nectar of primroses and polyanthuses. A few weeks ago a correspondent wrote thence that this spring the blackbirds "were as bad as peacocks," whose well-known habit of cutting off the blossoms of polyanthuses, carnations, lilies, and any particularly choice tropical plant that they can get hold of, makes them a gardener's despair. A peacock who resided for a short time in the neighbourhood referred to, might possibly have taught the native birds the trick, but this is hardly probable, as he died three winters ago, and the present year, when all spring flowers have bloomed earlier and more abundantly than usual, is the first in which his example has been extensively followed. I should doubt the practice being limited to a single species. Sparrows certainly gather flowers very carefully; I have seen them almost strip a bed of the variegated arabis, though in this case the flower-stalks were carried away and used, not for food, but in nest-building. Does any other bird use fresh flowers for that purpose?

JOHN PHILLIPS

BORN DECEMBER 25, 1800: DIED APRIL 24, 1874

THE daily press has already spread the sad tidings from Oxford that Prof. Phillip met with an accident which suddenly cut short his life while in good health and such full vigour that we still expected work from him. A few days ago he was here amongst us in London, bearing himself with form as erect and step as elastic as if the last ten years had but further mellowed though in no way lessened his energy. Now we learn that a stumble over a door-mat, on leaving a friend's rooms in All Souls, followed by a heavy fall, has deprived Oxford of one of her brightest ornaments, and men of science of a genial friend.

Another bond is broken which linked together by a living presence the geologists of to-day with those who watched the infancy of the science which, in place of wild phantasies of the imagination as to the origin of our planet, substituted a patient and careful investigation of its structure, as far as observation was possible. From the time when William Smith in 1792-3 surveyed the ground between High Littleton and Bath for the Somersetshire Coal Canal, and proved an unvarying sequence in the strata of England, and their identification by their fossil contents, every "cosmogomy" and "theory of the earth" was doomed. Fact henceforth took the place of fancy.

Among the earliest of those trained in the new school was young John Phillips. Born at Marden, in Wiltshire, on Christmas-day (N.S.) 1800, he lost his father when he was but seven years old, and his mother dying soon after, his training fell into the hands of his mother's brother, the renowned William Smith, "Father of English Geology."

We have never heard that there was anything to be recorded of his father beyond that he was the youngest son in a Welsh family, settled for many generations on their own property at Blaen-y-ddol, in Caermarthenshire, who was destined for the Church, but became an officer of the Excise, and that he married the sister of William Smith. Mr. F. Galton, a few weeks ago, read a paper at the Royal Institution, in which he gave statistics about eminent scientific men, showing the number of cases in which the greatness was due to the father, and the number of cases in which it was due to the mother. Whether Prof. Phillips was included we do not know, but he most certainly was an instance in which the influence of the mother preponderated. The mould of the features were distinctly those of the Smith family, and the likeness between Prof. Phillips and the busts and pictures of William Smith has often been remarked. His habit of thought was so much due to the direct training of his uncle that we cannot trace how much of it was hereditary. No particular school could have much influenced him, for he passed through four schools before he was ten, and then for a short time went to the excellent old school at Holt Spa, in Wiltshire. It is said that Latin, French, and Mathematics were his favourite studies, and the enjoyment of Latin authors seems to have grown on him, for in the writings of no other geologist will be found so many quotations from the Latin classics. The Rev. Benjamin Richardson, Rector of Farley Hungerford, near Bath, was one of his earliest instructors in natural history. Very little, indeed, is known of Mr. Richardson; he had the reputation of being in his time the best naturalist in the west of England, and the obituary notices at the time of his death mention that he was a member of Christ Church, Oxford. One fact about him which has an historical interest is certain, and that is that it was his hand which, from the dictation of William Smith, "first reduced to writing at the house of the Rev. Joseph Townsend, Pulteney Street, Bath, 1799" the table of "the order of the strata and their imbedded organic remains in the vicinity of Bath." The original document is in the keeping of the Geological Society, and is regarded as a memorial of the first step towards the examination of strata on a definite plan, the first step in the science of geology as contrasted with cosmogony. During the year that young Phillips spent at the pleasant rectory of Farley, he heard continually of the importance attached to the discoveries of his uncle and of the results which, in the estimation of Richardson and Townsend, were to flow from it. Under Mr. Richardson's direction he spent a large portion of his time in searching for fossils through the valleys around Farley, and in making drawings of the fossils he found and of the recent forms that were most nearly allied to them in Mr. Richardson's extensive collections. Prof. Phillips always spoke with pleasure of his recollections of Mr. Richardson, and attributed to him both his early taste for natural history and the ready use of his pencil, which so often not only reproduced faithfully a geological section but artistically included the foliage and background recording the pleasant accompaniments of the work which principally engaged his attention. Mr. Richardson though a kind was not a flattering guide to the young man, for a frequent remark on being shown the drawing of a fossil was, "Very good John, now put that in the fire and try and do even better."

At the end of the happy year at Farley, young Phillips went to live with his uncle in London, to share with him his labour, his hopes, and his disappointments. William Smith had then just removed to Buckingham Street, after the fire in Craven Street, which had so disarranged his work. Here, however, he rearranged his collection of fossils, the first collection in which fossils were placed in their stratigraphical sequence. Made first at Cottage Crescent, Bath, removed to Trim Street, then to Craven Street, and Buckingham Street, this historical collection finally found a resting-place in the British Museum. Each separate stratum recognised by Smith had one or more shelves sloping to represent the dip as he knew them in the typical ground of the Dunkerton Valley, near Bath, where he first studied them. This was the collection from which young Phillips first derived his ideas of a geological museum for teaching purposes, and which he saw so often referred to by his uncle in explaining to his many visitors his new ideas, when urging upon them the national importance of his iscovery as regarded agriculture and mining. William Smith was then working at his map of England, and to this his best energies were given and all his money devoted. In the "Memoirs" of his uncle, published in 1844, Prof. Phillips has described all the delays and trials that attended the production of this, the first geological map of England ever produced. The indomitable courage shown by Mr. Smith in the face of every discouragement could not fail to impress young Phillips with the importance of his uncle's work, and to win respect for him. How he was attached to him, and how he valued his teaching, is apparent in many places in his writings. In the preface to the "Memoirs" he speaks of himself as "an orphan who benefited by his goodness, a pupil who was trained up under his care." The map was issued in 1815, and Mr. Smith's professional engagements rapidly increased, requiring him to visit all parts of the county. He conceived the plan of producing county geological maps on a scale considerably larger than that of the map of England, and on almost every journey his nephew was his glad companion, "haud passibus æquis;" and according to an established custom on all such tours, was employed in sketching parts of the road and recording on maps the geological features of the country. In 1821, the map of Yorkshire, in four sheets, was published, which were prepared and coloured by his own hands. Throughout the "Memoirs" we have indications of the way in which he worked under his uncle's direction. Here is one which

gives an insight into the way in which he gained his intimate knowledge of the strata of the country. "The whole of the remainder of 1821 was devoted to long and laborious wanderings. Two lines of operation were drawn through the country which required to be surveyed. On one of these Mr. Smith moved with the due deliberation of a commander-in-chief; the other was traversed by his more active subaltern, who afterwards found the means to cross from his own parallel to report progress at head-quarters." In this way 2,000 miles were traversed in six months, and he thus learned to rely on his own judgment. His work delighted him. "Innumerable rambles," he says, "led up every glen and across every hill, now sketching waterfalls, anon tracing the boundaries of rocks or marking the direction of diluvial detritus." As greater accuracy in tracing the boundary of different strata was thus acquired, the successive issues of the map of England were modified. The lines of these alterations were mostly traced by Mr. Phillips himself, and thus it was that differences appeared in maps which apparently belonged to the same "edition."

At length, in 1824, Mr. Smith was asked to deliver a course of lectures on his geological work at the newly-formed Yorkshire Philosophical Society. For this "new maps were coloured, new sections drawn, and even the distant cabinet of Mr. Richardson at Farley was laid under contribution, to supply illustrations for these discourses." Lectures at Hull, Scarborough, and Sheffield soon followed. The share that Mr. Phillips took in the preparation of these lectures brought him under the notice of the executive of the Yorkshire Philosophical Society; he was offered the curatorship of the new museum, and accepted it. This was one of the important events of his life. His work no longer came before the public in his uncle's name, he had an individuality of his own, "and commenced to make his own reputation." I was delighted to find in the prosecution of this duty innumerable proofs of the truth of Mr. Smith's views respecting the distribution of organic fossils, and saw very clearly that many of the strata in the north-eastern part of Yorkshire might be confidently identified with well-known formations in the south of England. Soon after (in 1826) he read before the Society the first paper he wrote. His subject was: The Direction of the Diluvial Currents of Yorkshire, and it was thought worthy of being reprinted in the "Philosophical Magazine." From this time his pen was ever active. His early geological papers were on Yorkshire, and with that county his name is indissolubly connected. In addition to the curatorship of the museum he was appointed one of the secretaries of the Society, and delivered courses of lectures, and in 1829 he published his illustrations of the Geology of Yorkshire.

It was not till 1834 that Mr. Phillips communicated a paper to the Geological Society, and in the same year he published his "Guide to Geology," was appointed Professor of Geology in King's College, London, and was elected a Fellow of the Royal Society. His recommendature to election into the Society is of sufficient interest to be printed, and is as follows:—

"John Phillips, Esq., of York, Fellow of the Geological Society of London and Secretary of the Yorkshire Philosophical Society, a gentleman well versed in geology, meteorology, and various branches of natural science, and author of "Illustrations of the Geology of Yorkshire," being desirous of becoming a Fellow of the Royal Society, we whose names are hereunto subscribed do, from our personal knowledge, recommend him, as highly deserving of the honour he solicits, and likely to prove a valuable and useful member.

"Rod. I. Murchison, Wm. Buckland, G. B. Gresnough, William Clift, Edw. Turner, Adam Sedgwick, John Taylor, H. T. De la Beche, C. Daubeny, John Edw. Gray, Geo. Peacock, John Lindley, B. Powell.

"Elected April 10, 1834."

Not only was he associated in work with the "father" of Geological Science, from which such valuable practical results have flowed, but he was one of the band who, in his own words, "stood anxious but hopeful by the cradle of the British Association." It is well known how through his activity the first meeting at York was a success in September 1831, and how till 1863 he was the courteous assistant-secretary of the Society.

Among other posts Prof. Phillips has filled are the Chair of Geology at Dublin, to which he was appointed in 1844; the Presidency of the Geological Society in 1859-60; Rede Lecturer in Cambridge in 1860; and the Presidency of the British Association in 1866. The Chair at Oxford he has held since 1853.

He not only helped to lay the foundations of English Geology, he has been to the last an active worker and an industrious writer. Besides more than sixty papers communicated to Societies' proceedings and to magazines, he was largely a contributor to the "Penny Encyclopædia," the "Encyclopædia Britannica," and the "Encyclopædia Metropolitana."

In 1841 was published his "Palæozoic Fossils of Cornwall, Devon, and West Somerset, after he had examined the country in company with Mr. William Sandars.

In 1842 he began an examination of the Malvern district, and having settled his data at Malvern, Abberley, and Woolhope, he extended his observations to May Hill, Fortworth, and Usk. The work was given to the world in 1848 as one of the Memoirs of the Geological Survey. "The Rivers, Mountains, and Sea-coast of Yorkshire" appeared in 1853, and his Essay in the "Oxford Essays," in 1855.

His contribution to the Palæontographical Society on the Belemnitidæ, and his "Geology of the Thames Valley," are well known; and he has also written many smaller works which we have not space to notice.

For many years he has been Keeper of the Museum at Oxford, and his lectures have had such a reputation for being popular that they have been largely attended by ladies. The Professor had also given much time to meteorology and astronomy, and had made many observations in his own observatory. He was an honorary M.A. and D.C.L. of Oxford, and LL.D. of Cambridge and Dublin.

NOTES

Dr. Lyon Playfair, C.B., has given notice that, on the House of Commons going into committee on the Education Estimates, he will call attention to the deficient ministerial responsibility under which the Votes for Education, Science, and Art are administered, and will move for a Select Committee to consider how such ministerial responsibility may be better secured. We believe that Dr. Lyon Playfair's views are strictly in accordance with those of the best scientific men of the country, namely, that the only satisfactory way of dealing with the subject will be by the appointment of a Minister for Education, Science, and Art.

The 15th or 16th of June has been fixed for the inauguration of the physical laboratory, the gift of the Duke of Devonshire to the University of Cambridge.

The following is a list of candidates selected and recommended by the Council of the Royal Society for election as Fellows:—Isaac Lothian Bell, F.C.S.; W. T. Blanford, F.G.S.; Henry Bowman Brady, F.L.S.; Dr. Thomas Lauder Brunton, Sc.D.; Prof. W. Kingdon Clifford, M.A.; Augustus Wollaston Franks, MA.; Prof. Olaus Henrici, Ph.D.; Prescott G. Hewett, F.R.C.S.; John Eliot Howard, F.L.S.; Sir Henry Sumner Maine, LL.D.; Edmund James Mills, D.Sc.; Rev. Stephen Joseph Perry, F.R.A.S.; Dr. Henry Wyldbore Rumsey; Alfred R. C. Selwyn, F.G.S.; Major Charles William Wilson, R.E.

It is stated that Dr. J. H. Gladstone, F.R.S., has been nominated to succeed Dr. Odling at the Royal Institution.

The funeral of the late Professor Phillips will be solemnised at York to-day at 11 A.M. It is understood that this locality was fixed on by himself, other members of his family being buried there.

A deputation, consisting of Sir Bartle Frere, president of the Royal Geographical Society, Sir James Watson, Lord Provost of Glasgow, Sir William Stirling Maxwell, M.P., and several other members of Parliament, waited on Lord Derby last Friday, to lay before him the claims which exist for an official recognition of the late Dr. Livingstone's arduous services in the cause of humanity and of Science during his long tenure of office as one of Her Majesty's Consuls. The memorial, which was handed to Lord Derby, was signed by many eminent and well-known names, and his lordship said he agreed with the deputation that something ought to be done for the members of Livingstone's family. There seems no doubt that Government will meet the wishes of the country in this matter.

On Monday night, at the usual meeting of the Royal Geographical Society, the principal business of the evening consisted of reading extracts from the letters of Dr. Livingstone to Sir H. Rawlinson, to Sir R. I. Murchison, to Sir Bartle Frere, and to some private friends. This correspondence extended over six or seven years. Very voluminous materials have been preserved, but the work of editing them has yet to be performed. Sir Bartle Frere was happy to say that the son of the illustrious traveller accepted the duty of editing the materials left by his father, and had resigned a promising career in Egypt for that purpose.

The *Spectator* proposes that as an appropriate memorial to the late Dr. Livingstone, some Exploration Scholarships should be founded, to be called by the explorer's name.

Mr. F. J. Schuster has made a donation of 225*l.* to the Physical Laboratory of Owens College, Manchester, for the purpose of buying apparatus.

The Royal Irish Academy has sanctioned the following grants from the fund at its disposal for aiding scientific researches by providing suitable instruments and materials :—30*l.* to Messrs. Studdert and Caldwell for the chemical analysis of the mineral waters at Lisdoonvarna, in the county of Clare; 30*l.* to Prof. Macalister, to be expended in the purchase of rare insectivora and other mammals for dissection, in order to enable him to report on the myology of mammals; 40*l.* to Mr. W. H. Bailey, to investigate the fossils of the coal districts in Ireland, with a view to their comparison with those of British and other coal-fields; 50*l.* to Prof. Haughton, to complete an investigation into the chemical and mineral composition of the successive lava-flows of Vesuvius; 39*l.* 17*s.* 11*d.* (being the remainder of the fund) to Dr. David Moore, for the investigation and cataloguing of the Irish Hepaticæ. Gentlemen purposing to undertake scientific researches during the coming year, and desirous to obtain grants from this fund, are invited to send in their applications to the secretary of the Academy without delay.

The Ogham inscribed stones, ten in number, purchased by the Royal Irish Academy from the representatives of the late Mr. Windele, have been arranged in the crypt of their Museum with the other Ogham stones belonging to the Academy, one being set vertically in the floor, and the others placed either on iron stands in the bays at the south side, or on the dwarf walls forming the bays. These stones are now all easy of access, and, in the daytime, have the advantage of a light well adapted to the examination of their respective inscriptions. The Academy is in possession of 134 photographic negatives of Ogham inscriptions, representing about eighty different texts. It is intended to print these in autotype, and thus to afford to inquirers in this curious branch of study authentic copies of considerably more than half the whole number of such inscriptions known to exist. They will be accompanied by short notices, strictly limited to a statement respecting the localities where the inscriptions were found, and other matters of fact respecting them; the philological discussion and interpretation of them being left to the free competition of scholars.

Rear-Admiral Charles H. Davis was ordered, on Feb. 23, to the duty of superintendent of the Naval Observatory at Washington, U.S., in place of Rear-Admiral Sands, who has been detached and placed on the retired list, in accordance with the rules of the service. Admiral Sands, during his tenure of office, has merited the respect and goodwill of British Astronomers, who will view with regret the necessary termination of his functions.

Amongst the estimates passed by the House of Commons on Friday last was 80,000*l.* to continue the works on the New Natural History Museum at South Kensington, with which rapid progress is now being made.

In answer to a question in the House of Commons on Tuesday Viscount Sandon stated that arrangements consequent on the retirement of Mr. Cole were now the subject of consideration by the Science and Art Department, but had not yet been completed.

The Council of the Paris Observatory is said to have protested against a ministerial decision which allowed the Bureau des Longitudes to take the half of the astronomical library, which has been forming during centuries, and which is one of the richest in the world. It is almost certain that the decision will be cancelled, M. Leverrier having given the alternative of leaving the whole of the books in the hands of the Bureau, and refusing to be a party to such a mutilation. When the library shall be saved, it will be open to the public under certain regulations.

We recently announced the oppressive treatment to which M. Alglave, editor of *La Revue Scientifique* and Professor of Law at Douai, had been subjected; there is no doubt now that his suspension by the Minister of Public Instruction has been caused by his refusal to resign the editorship of the journal just mentioned and of the *Revue politique et littéraire*, of which he is also editor. On Monday week, on his going to open his class for the term, he received a letter from the Under-Secretary of the Education Department informing him that his course would be suspended until further notice. Science has many difficulties to contend with in this country, but happily vexatious interference on the part of the State is not one of them.

A paper on the grasses and fodder plants which may be beneficial to the squatter and agriculturist in South Australia, by Dr. Richard Schomburgk, director of the Adelaide Botanic Gardens, has been officially published by order of the Governor.

It is stated in the *Scientific American* that the well-known and much admired Japan lacquer-work, the secrets of which were supposed to be known only to the Easterns, has been successfully reproduced, or rather imitated, in Holland. The lacquer is prepared from Zanzibar copal, coloured black with Indian ink. The articles are painted with several coats of this lacquer, in which the pieces of mother-o'-pearl or other substances used for ornamentation are placed before it becomes hard. The lacquer is then dried by placing the articles in a heated oven or furnace, after which another coat of lacquer is applied, and when dry smoothed with pumice, which is repeated until all cracks are filled up and the surface has become perfectly smooth, when the whole is polished, or rather burnished, with tripoli.

THE Russian Scientific Expedition to the Amu Daria was to set out on Monday last. The expedition will be commanded by the Grand Duke Nicholas Constantinovitch, assisted by Colonel Stoletoff and Dr. Moreff, secretary. It will include 25 persons, whose work will be divided into four sections :—(1) The Trigonometrical and Topographical. (2) The Meteorological Section, which will construct two stations on the Amu Daria, at one of which hourly observations will be made of all the meteorological phenomena. (3) The Ethnographical Statistical Section. (4) The Natural History Section.

THE meeting of French Astronomers took place last week at the Ministry of Public Instruction, under the presidency of M. Leverrier. It was composed of M. Dumeril, director of the *Enseignement*, the astronomers from Paris, Toulouse, and Marseilles Observatories, and Officers from the General Staff of the Trigonometrical Survey. Four sittings were held, and an account of them will be issued shortly. Steps have been taken for the determination of the latitude of Algiers, by telegraph. M. du Barail, Minister of War, and M. Saget, his Staff-Officer, visited the Observatory last Saturday, in order to see for themselves how the work may be begun without further delay.

THE additions to the Zoological Society's Gardens during the last week include four Bladder-nosed Seals (*Cystophora cristata*) from Greenland, presented by Capt. Alex. Gray; a White-winged Whydah Bird (*Urobrachya albonotus*) from West Africa, presented by Mr. J. Fairchild; a Rose-crested Cockatoo (*Cacatua moluccensis*) from the Moluccas, presented by Mr. H. Baldwin; an Azara's Fox (*Canis azaræ*) from South America; a Snowy Owl (*Nyctea nivea*) from South America; a Green-cheeked Amazon (*Chrysotis viridigenalis*) from Columbia, purchased.

ON THE REFRACTION OF SOUND*

THE principal object of this paper is to show that sound, instead of proceeding along the ground, is lifted or refracted upwards by the atmosphere in direct proportion to the upward diminution of the temperature; and hence to explain several phenomena of sound, and particularly the results of Prof. Tyndall's recent observations off the South Foreland.

The paper commences with the explanation of the effect of wind upon sound, viz., that this effect is due to the lifting of the sound from the ground, and not to its destruction, as is generally supposed. The lifting of the sound is shown to be due to the different velocities with which the air moves at the ground and at an elevation above it. Owing to friction and obstructions the air moves slower below than above, therefore sound moving against the wind moves faster below than above, and the bottom of the sound waves will thus get in advance of the upper part, and the effect of this will be to refract or turn the sound upwards; so that the rays of sound which would otherwise move horizontally along the ground actually move upwards in circular or more hyperbolic paths, and may thus, if there is sufficient distance, pass over the observer's head. This explanation was propounded by Prof. Stokes in 1857, but it was discovered independently by the author.

The paper then contains descriptions of experiments made with a view to establish this explanation.

These experiments were made with an electric ball, over a nearly flat meadow, and again over the same when it was nearly covered with snow, and it was found (as indeed it was expected) that the condition of the surface very materially modified the results in two ways. In the first place, a smooth surface like snow obstructs the wind less than grass, hence over snow the wind has less effect in lifting the sound moving against it than over grass; and it is inferred that a still greater difference would be found to exist in the case of smooth water. In the second place, the ends of the waves of sound travelling along in contact with the rough ground are continually destroyed by the roughness, and the sound from above slowly diverges down to replace that which is destroyed, and this divergence gradually weakens the intensity of the lower parts of the waves, so that, under ordinary circumstances, the sounds which pass above us are more intense than those we hear. The general conclusions drawn from these experiments are :—

1. The velocity of wind over grass differs by ½ at elevations of 1 and 8 feet, and by somewhat less over snow.

2. That when there is no wind, sound proceeding over a rough surface is destroyed at that surface, and is thus less intense below than above; owing to this cause the same sound would be heard at more than double the distance over snow at which it could be heard over grass.

3. That sounds proceeding *with* the wind are brought down to the ground in such a manner as to counterbalance the effect of the rough surface (2), and hence, contrary to the experiments of Delaroche, the range of sound over rough ground is greater with the wind than at right angles to its direction or than when there is no wind. When the wind is very strong it would bring the sound down too fast in its own direction, and then the sound would be heard farthest in some direction inclined to that of the wind though not at right angles.

4. That sounds proceeding against the wind are lifted off the ground, and hence the range is diminished at low elevations. But that the sound is not destroyed and may be heard from positions sufficiently high (or if the source of sound be raised) with even greater distinctness than at the same distances with the wind.

5. In all cases where the sound was lifted there was evidence of diverging rays. Thus although on one occasion the full intensity was lost when standing up at 40 yards the sound could be faintly and discontinuously heard up to 70 yards. And on raising the head the sound did not at once strike the ear with its full intensity nor yet increase quite gradually; but by a series of steps and fluctuations in which the different notes of sound were variously represented, showing that the diverging sound proceeds in rays separated by rays of interference.

On one occasion it was found that with the wind sound could be heard at 360 yards from the bell at all elevations, whereas at right angles it could be only heard for 200 yards standing up, and not so far at the ground; and against the wind it was lost at 30 yards at the ground, at 70 yards standing up, and 160 yards at an elevation of 30 feet, although it could be distinctly heard at this latter point from a few feet higher.

It hence appears that these results agree so well with what might be expected from the theory as to place its truth and completeness beyond question.

The author then goes on to argue from the action of wind upon sound to another phenomenon which admits of a somewhat similar explanation. The effect of wind together with that of a rough surface in lifting the sound may be shown to account for many of the apparently capricious variations in the intensity with which sounds can be heard at different times; and it gives a reason for the custom which prevails of elevating church bells, platforms, &c., where the sounds are intended to be heard at a distance. But it does not explain a fact, which has often been observed, namely, that distant sounds can be heard much better during the night than during the day, and on dull cloudy days better than on bright hot days. This phenomena has engaged the attention of Humboldt, Delaroche, and recently of Prof. Tyndall, who have all assumed that the sound is obstructed or destroyed in the bright hot air, and have suggested causes which they thought might produce this effect. These suggestions are all more or less open to objection, and none of them meet the difficulty that any heterogeneous condition of the air which could obstruct sound must more or less refract or reflect light and so render vision indistinct. In this paper the author gives another explanation, in which he shows how, as in the case of wind, the sound may be lifted and not destroyed.

It is argued that since wind raised the sound simply by causing it to move faster below than above, any other cause which produces such a difference in velocity will lift the sound in the same way. And since the velocity of sound through air increases with the temperature—every degree from 32 to 70 adding 1 foot per second to the velocity—therefore an upward diminution in the temperature of the air must produce a similar effect to that of wind and lift the sound. Whereas Mr. Glaisher has shown by his balloon observations that such a diminution of temperature exists, and further he has shown that when the sun is shining with a clear sky the variation from the surface is 1° for every

* On the Refraction of Sound by the Atmosphere. By Prof. Osborne Reynolds, Owens College, Manchester. Abstract of paper read before the Royal Society April 23.—Communicated by the Author.

100 ft., and that with a cloudy sky it is only half what it is with a clear sky. These results were from the mean of his observations; under exceptional circumstances the variations were both greater and less. It is hence shown that rays of sound otherwise horizontal would be bent upwards in the form of circles, the radii of which with a clear sky are 110,000 ft., and with a cloudy sky 220,000 ft., so that the refraction is double as great on bright hot days as it is when the sky is cloudy, and still more under exceptional circumstances, and comparing day with night.

It is then shown by calculation that the greatest refraction—110,000 ft. radius—is sufficient to render sound from a cliff 235 ft. high inaudible on a ship's deck 20 ft. high at $1\frac{3}{4}$ miles, except such sound as might reach the observer by divergence from the waves above, whereas when the refraction is least—220,000 ft. radius—or where the sky is cloudy, the range would be extended at $2\frac{1}{2}$ miles with a similar extension for the diverging waves. It is hence inferred that the phenomenon which Prof. Tyndall observed on July 3, and other days—namely that when the air was still and the sun was hot he could not hear guns and sounds from the cliffs of South Foreland, 235 ft. high, for more than two miles, whereas when the sky clouded, the range immediately extended to three miles, and as evening approached much farther,—was due, not so much to stoppage or to reflection of the sound by invisible vapour as Prof. Tyndall has supposed, but to the sounds being lifted over his head in the manner described; and that had he been able to ascend 30 ft. up the mast, he might at any time have extended the range of the sound by a quarter of a mile at least. Or had the instruments on the top of the cliff been compared with similar instruments at the bottom, a very marked difference would have been found in the distances at which they could be heard.

It seems that there were instruments at the bottom, and it is singular that throughout his report Prof. Tyndall makes no comment on their performance, unless they were at once found to be so inferior to those at the top that no further notice was taken of them; this seems possible, since beyond mentioning that they were there, Prof. Tyndall throughout his report never refers to them.

It also seems that besides those results of Prof. Tyndall's experiments, there are many other phenomena connected with sound, of which this refraction affords an explanation, such as the very great distances to which the sound of meteors has been heard as well as the distinctness of distant thunder. When near, guns make a louder and more distinctive sound than thunder, although thunder is usually heard to much greater distances. In hilly countries, or under exceptional circumstances, sounds are sometimes heard at surprising distances. When the Naval Review was at Portsmouth, the volleys of artillery were very generally heard in Suffolk, a distance of 150 miles. The explanation being that owing to refraction (as well as to the other causes) it is only under exceptional circumstances that distant sounds originating low down are heard near the ground with anything like their full distinctness, and that any elevation either of the observer or of the source of sound above the intervening ground causes a corresponding increase in the distance at which the sound can be heard.

SCIENTIFIC SERIALS

Memorie della Societa degli Spectroscopisti Italiani, February.—Father Secchi contributes a paper On his Observations of Solar Prominences from April 23 to October 2, 1873. From his tables it appears that the sun was observed on 127 days, when 1,052 prominences were seen, being more than 8 a day, the maximum number visible on any one day was 13, and the minimum 2. The greatest number of prominences over 64″ high occurred in lat. 30° 40′ N. and 20° 30′ S. The greatest number of prominences of all kinds were in lat. 20° 30′ N. and 10° 20′ S. The same author also makes some remarks on the spectroscopic observations of the transit of Venus.

Astronomische Nachrichten, Nos. 1,980–1,981.—These numbers contain a large quantity of observations of positions of the minor planets and comets made in 1873 by Leopold Schulhof. He also gives the positions of more than 100 variable stars, with remarks on a new variable position for 1850, RA 23° 10′ 35″ Dec. − 19° 39″·7. Prof. Peters gives the position of Planet 135, Feb. 18, 1874, at 14h. 37m. 40s., Hamilton College, M.T., RA 11h. 19m. 42·7s. Dec. + 4° 25′ 5″·11 mag. G. Spoerer gives the positions of spots and prominences for February last. J. Palisa gives the position of the planet discovered by him on March 18, 4h. 46m. 39s. RA 12h. 22m. 2·12s. Dec. − 3° 19′ 33″·4.

No. 1,982 contains a long paper On a Method of Computing Absolute Perturbation, being in great measure similar to that of Laplace.

Journal of the Franklin Institute, March.—This number contains an account, by Mr. Crew, of the "prismoidal" one-rail railway (of his invention), of which he has made two years' trial in Alabama, with encouraging results. The cars are kept securely on the prismoidal track by a combination of wheels; a centre one, at either end, on the rail, kept on the track by revolving flanged wheels at either side; and wheels on the sides of the prismoid, with strong wrought-iron bars to the side of the car; these keep the car upright. One proposed application of the system is that of elevated rapid transit by steam through crowded streets in populous cities. As to speed, Mr. Crew thinks even 100 miles an hour would be possible; there is no oscillation through lateral motion.—Mr. Richards continues his Principles of Shop Manipulation for Engineering Apprentices; treating of belts, gearing, hydraulic and pneumatic apparatus as means of transmitting power, and of "machinery of application" of power.—Mr. Isherwood points out a method of ascertaining what portion of the feed-water admitted to a boiler is entrained in the form of spray by the escaping steam.—Details with reference to the Girard Avenue Bridge (which will form the chief entrance to the West Park, at Philadelphia), are furnished by Mr. Hering.—Prof. Thurston claims for Count Rumford a higher place in connection with thermo-dynamics than has hitherto been assigned to him; affirming that he first, and half a century before Joule, determined with almost perfect accuracy the mechanical equivalent of heat, while the sole credit of discovering the true nature of heat is due to him.—We may note, in addition, a paper On Railway Crossings and Turnouts, by Mr. Evans, and one On the Sanitary Care and Utilisation of Refuse in Cities, by Dr. Leas, who describes, more especially, the system followed in Baltimore.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, April 23.—On some points connected with the Circulation of the Blood, arrived at from a study of the Sphygmograph Trace, by A. H. Garrod, B.A., Fellow of St. John's College, Cambridge.

The author commences by giving a table containing a fresh series of measurements of the ratio borne by the cardiosystole * to its component beat in the cardiograph trace. These tend strongly to substantiate the law previously published by him, viz., that the length of the cardiosystole is constant for any given pulse-rate, and that varies as the square root of the length of the pulse-beat only, being found from the equation $xy = 20\sqrt{x}$ when $x =$ the pulse-rate and $y =$ the ratio borne by the cardiosystole to the whole beat.

A similar series of fresh measurements are given in proof of the law previously published by him, that in the sphygmograph trace from the radial artery at the wrist, the length of the sphygmosystole † is constant for any given pulse-rate, but varies as the cube-root of the length of the pulse-beat, it being found from the equation $xy' = 47\sqrt[3]{x}$, where $x =$ the pulse-rate, and $y' =$ the ratio borne by the sphygmosystole to the whole beat.

By measurement of sphygmograph tracings from the carotid in the neck and posterior tibial artery at the ankle, it is then shown that the length of the sphygmograph in those arteries is exactly *the same* as in the radial; so that the above-stated law as to the length of the sphygmosystole in the latter applies to them also, and must therefore equally apply to the pulse in the aorta.

Such being the case, by comparing the equations for finding the length of the cardiosystole with that for finding the aortic sphygmosystole, the relation between the whole cardiac systolic act and the time during which the aortic valve remains open can be estimated with facility; for by subtracting the shorter sphygmosystole from the longer cardiosystole a remainder is obtained which can be nothing else than the expression of the

* The *cardiosystole* is the interval between the commencement of the systole and the closure of the aortic valve in each revolution.

† The *sphygmosystole* is the interval between the opening and closure of the aortic valve in each cardiac revolution.

time occupied by the ventricle at the commencement of its systole in raising its internal pressure to that of the blood in the aorta, which must occur before the aortic valve can open up. This interval is named the *syspasis*. Its length is found to decrease ve y rapidly with increase in the pulse-rate, and to become *nil* at a pulse-rate of 170 a minute. An attempt is made to explain these phenomena.

If the above considerations are correct, certain independently obtained measurements ought on comparison to correspond; for by reference to one of the papers in the Society's Proceedings it is shown that the length of the there-termed second cardio-arterial interval (which may be called the second cardio-radial interval, as the artery under consideration was the radial), can only represent the time taken by the second or dicrotic wave of the pulse in travelling from the aortic valve to the wrist. This being so, there is every *à priori* reason in favour of the earlier primary wave taking the same time in going the same distance; which can be expressed in other terms by saying that the length of the first cardio-radial interval, from which that of the syspasis has been subtracted, ought to be exactly the same as that of the second cardio-radial interval. That such is the case is proved by the two measurements, which have been arrived at independently, agreeing in all cases *to three places of decimals*, which is great evidence in favour of the accuracy of the methods and arguments employed.

The latter part of the paper is occupied with the description of and the results obtained by the employment of a double-sphygmograph, by means of which simultaneous tracings are taken from two arteries at very different distances from the heart. The arteries experimented on are the radial at the wrist and the posterior tibial behind the ankle, 29 and $52\frac{1}{2}$ inches respectively from the aortic valves. From the resulting traces the time occupied by the pulse-wave in travelling the difference of distance—$(52.5 - 29) = 23.5$ inches is given—is found to be 0·0012 of a minute in a pulse of 75 a minute, and it is shown that this varies very little with difference in pulse-rate, as other considerations would lead us to expect; it is also proved that *there is a marked acceleration of the pulse-wave as it gets further from the heart.*

By superposing the simultaneous trace from the wrist on that from the ankle, direct verification is obtained of the earlier proposition, that the sphygmosystole at the wrist and at the ankle are of exactly similar duration. The peculiarities of the ankle trace are also referred to.

Geological Society, April 15.—John Evans, F.R.S., president, in the chair.—The following communications were read: About Polar Glaciation, by J. F. Campbell. The author commenced by referring to a reported statement of Prof. Agassiz, to the effect that he supposed the northern hemisphere to have been covered in glacial times from the pole to the equator by a solid cap of ice. He described his observations made during thirty-three years, and especially those of last summer, when he travelled from England past the North Cape to Archangel, and thence by land to the Caucasus, Crimea, Greece, and the south of Europe. His principal results were as follows:—In advancing southwards through Russia a range of low drift hills occurs about 60° N. lat., which may perhaps form part of a circular terminal moraine left by a retreating polar ice-cap; large grooved and polished stones of northern origin reach 55° N. lat. at Nijni Novgorod, but further east and south no such stones could be seen. The highest drift beds along the whole course of the Volga seem to have been arranged by water moving southwards. In America northern boulders are lost about 39°, in Germany about 55°, and in Eastern Russia about 56° N. lat., where the trains end and fine gravel and sand cover the solid rocks. Ice-action, in the form either of glaciers or of icebergs, is necessary to account for the transport of large stones over the plains, and the action of moving water to account for drift carried farther south. There are no indications of a continuous solid ice-cap flowing southward over plains in Europe and America to, or nearly to, the equator; but a great deal was to be found on shore to prove ancient ocean circulation of equatorial and polar currents, like those which now move in the Atlantic, and much to prove the former existence of very large local ice-systems in places where no glaciers now exist.—Note regarding the Occurrence of Jade in the Karakash Valley, on the southern borders of Turkestan, by Dr. Ferdinand Stoliczka, Naturalist attached to the Yarkund Mission. In this paper the author described the jade-mines on the right bank of the Karakash river formerly worked by the Chinese. There are about 120 holes in the side of the hill, and these at a little distance look like pigeon-holes. The rocks are a thin-bedded, rather sandy syenitic gneiss, mica- and hornblende-schists, traversed by veins of a white mineral, apparently zeolitic, which in turn are traversed by veins of jade.

Zoological Society, April 21.—Viscount Walden, F.R.S., president, in the chair.—The secretary read a report on the additions that had been made to the Society's Menagerie during the month of March 1874. Amongst these particular attention was called to a scarce Parrot (*Chrysotis finschi*), of which a specimen had been presented by Mrs. Chivers.—A communication was read from Mr. Morton Allport On the capture of a Grilse in the River Derwent, in Tasmania, showing that the salmon had really been successfully introduced into the colony.—Communications were read from Dr. J. E. Gray, F.R.S., On the very young of the Jaguar, *Felis* (*Leopardus*) *onca*; On the short-tailed Armadillo, *Muletia septemcincta*; On the young of the Bosch Vark, *Potamochœrus africanus*, from Madagascar; and On the Skulls of the Leopard in the British Museum.—A communication was read from Dr. O. Finsch, containing the description of a new species of Penguin, from New Zealand, which he proposed to call *Eudyptula albosignata*.—Mr. Edwin Ward exhibited the skull and horns of a fine specimen of the Persian Stag (*Cervus maral*) from the Crimea.—A communication was read from Capt. W. H. Unwin, containing an account of the breeding of the Golden Eagle (*Aquila chrysaetos*) in North-Western India.—Mr. J. E. Harting read a paper On a new species of *Tringa*, from St. Paul's Island, Alaska, which he proposed to name *Tringa gracilis*.—A communication was read from Lieut. R. Wardlaw Ramsay, giving the description of an apparently new species of Woodpecker, which he had obtained in a teak-forest, about six miles to the north of Tanghoo in British Burmah. Mr. Ramsay proposed to name it *Gecinus erythropygius*.—Messrs. W. T. Blanford and H. E. Dresser read a monograph of the genus *Saxicola*, Beechstein, being an attempt to reduce into some order the excessively confused nomenclature of the species composing this genus.

Royal Horticultural Society, April 15.—Scientific Committee.—M. T. Masters, M.D., F.R.S., in the chair.—Mr. Worthington Smith exhibited a drawing of a very curious fasciation in the aërial roots of *Aerides crispum*, in which the roots presented the curious flattened appearance so often met with in the branches of the ash, the shoots of asparagus, &c.—Mr. W. G. Smith also showed a drawing of the very rare *Angræcum ellisii*, from the collection of Mr. Day, of Tottenham. Mr. Smith remarked that the flowers turn brown when bruised.—Mr. Smith also showed a wood-engraving made on the wood of green ebony, *Brya ebenus*. Mr. Smith reported that for engraving purposes this was as good as bad box.—Prof. Thiselton Dyer showed dried specimens of a variety of *Hibiscus rosa-sinensis* from Zanzibar, where it was found wild by Dr. Kirk. The petals are palmately cut, as in *Clarkia*, *Schizopetalum*, &c. Dr. Masters made some remarks on the analogy the divided petals of this plant presented with the stamens of mallows, which it is now supposed consist of five primary organs, subsequently dividing into numerous anther-bearing filaments. It is doubtful whether *Hibiscus rosa-sinensis* has been heretofore observed in a truly wild condition. The discovery of the plant in east tropical Africa is therefore particularly interesting. It is possible, however, that it may prove a distinct species.—Prof. Thiselton Dyer also showed an elegant white fungus, having the appearance of lace, from Santarem. The Rev. M. J. Berkeley considered it probable that it was the fungus published by Kunze as *Rhizomorpha corynephora*.—Mr. Andrew Murray exhibited a fungoid production existing on trees over a considerable space in the Yosemite Valley, in California. Mr. Berkeley considered it near to the fungus called *Dothidea morbosa*, but there was also a gall on the same shoot.—Mr. Murray exhibited larvæ of a beetle closely allied to *Hammaticherus heros*, a beetle very destructive to timber in Germany, found feeding on the roots of fir near Enfield. Specimens of the perfect living insect have from time to time been found in the gun-stocks of walnut wood in the small-arms factory. It seems, therefore, a fair inference that the insects had escaped thence, and may perhaps have become naturalised—a most undesirable thing, for the larva is very destructive to timber. Mr. Blenkins remarked that he was familiar with the insect in the Crimea.

General Meeting.—H. Little in the chair.—The Rev. M. J. Berkeley commented on the plants exhibited. *Arthropodium cirrhatum* was an interesting plant of striking habit from New Zealand. When first introduced into this country, some years ago, it was supposed to have come from New Holland.

Physical Society, April 18.—Dr. Gladstone, F.R.S., in the chair.—Dr W. H. Stone read a paper On Wind Pressures in the human chest during performance on wind instruments. The author's object was to ascertain (1) what was the extreme height of a column of water which could be supported by the muscular act of expiration transmitted by the lips: this was found to be about 6 ft.; and (2) what was the actual pressure corresponding to the full production of a note on each of the principal wind instruments. It was found that with the majority of wind instruments the pressure required for the high notes is considerably greater than that required for the low notes, each instrument having a pressure-ratio of its own. The clarinet is an exception to the rule.—Mr. Tribe illustrated by experiments the action of hydrogen upon finely divided metals, such as are produced by precipitation.

Edinburgh

Royal Physical Society, April 22.—R. Scot Skirving, president, in the chair.—Recent Modes of determining the Impurity of Milk, by J. Falconer King, City Analyst. The only sure way to determine the quality of milk is to make a proper and careful chemical analysis of it.—Additional Note on the Suspension of Clay in Water, by Wm. Durham. Finely-powdered silica was found to behave in a manner generally similar to clay. Experiments seem to show that each solution has a specific capacity of sustaining clay, and also that this capacity varies in a specific manner according to the strength of the solution.—Note on the Formation of Boulder Clay, by D. J. Brown. Mr. Brown advocated that the usually accepted theory of the land origin of boulder clay would not explain the nature of this remarkable deposit, and considered that it was formed at the line of junction of the Arctic glacier with the sea.—On Fused Stones, showing Columnar Structure from a Pictish Tower, by the Rev. Jas. M. Joass, Golspie. These stones, in their columnar structure, illustrate, though on a small scale, an important geological phenomenon. The instance usually cited in illustration of the development of columnar structure in a melted mass is that of grain-tin, which forms rude columns on cooling. The author ventures to think that these fused stones afford a new and rather better illustration of the geological phenomenon, more closely analogous to the case of lavas, inasmuch as we have, in fact, a fused silicate, an artificial lava, forming columns the same in character as those of the Giant's Causeway, Samson's Ribs, or the pillars of Fingal's far-famed cave.

Paris

Academy of Sciences, April 20.—M. Bertrand in the chair.—The following communications were read:—Letter relating to a calculation, by Pouillet, on the cooling of the sun's mass, by M. Faye. The author showed that Pouillet's calculation tacitly implied that the sun's mass was not susceptible of contraction, and again restated his belief that solar radiation is not maintained by external causes, but is to be looked for in the formation of the sun itself, and in the enormity of its mass.—Observations concerning a communication, by M. Crocé Spinelli, on the lines of aqueous vapour in the solar spectrum, a letter from P. Secchi to the perpetual secretary. The author stated, that although the elements of water would be dissociated at the high temperature of the sun, their combination might take place in the ascending currents accompanying spots and eruptions owing to the lowering of temperature in these currents produced by expansion.—Tenth memoir on the formation of various crystalline substances in capillary spaces, by M. Becquerel.—New researches on the cyanogen series, by M. Berthelot. A continuation of this author's valuable researches in thermo-chemistry.—Heat of formation of the Cyanogen compounds, by M. Berthelot.—On Phylloxera and the American vines at Roquemaure (Gard), a note by M. J. E. Planchon.—Collimating level and its employment for foggy horizons, by M. G. M. Goulier.—On Orometric dials, specially applicable to pocket barometers, by the same author.—On partial differential equations which can be integrated without arbitrary functions, by M. de Pistoye.—On the "singular points" of algebraical plane curves, by Mr. Halphen.—On the rôle of salts in the action of potable waters on lead, by M. Fordos. The author recommended, as the results of his experiments, the filtration of all water issuing from lead conduits.—Mode of preservation of the wood employed in large manufactures and in railways, by M. Hubert. The preservative is hydrated ferric oxide.—On the absorption of oxygen and the emission of carbonic acid by leaves kept in darkness, by MM. P. P. Dehérain and H. Moissan. The authors have proved that leaves kept in the dark give off a quantity of CO_2 increasing with the temperature, that the quantity of CO_2 given off is comparable to that given off by cold-blooded animals, that the leaves absorb more oxygen than they give off CO_2, and that they continue to evolve CO_2 in an atmosphere deprived of oxygen.—Facts concerning the vibration of the air in sonorous pipes, by M. E. Gripon.—On a new thermo-electric pile, by M. C. C. Clamond.—On a volume regulator for gas currents, by M. H. Giroud.—On tetra-iodide of carbon, by M. G. Gustavson. This substance has been obtained by the action of tetrachloride of carbon upon dialuminic hexiodide, according to the equation $3CCl_4 + 2Al_2I_6 = 3CI_4 + 2Al_2Cl_6$; the two substances being dissolved in carbon disulphide. It was described as a red crystalline substance decomposed by heating in the air into CO_2 and free iodine.—New researches on black phosphorus, by M. Blondlot.—Action of pure hydrogen on silver nitrate, by M. H. Pellet. The author stated that a neutral or slightly acid solution of the salt is not reduced in the cold by pure hydrogen, and that an alkaline solution is reduced in the cold to an extent proportional to its alkalinity, elevation of temperature increasing the reducing action.—Researches on soluble phosphates used in agriculture, by M. A. Millot.—On the direct determination of the degree of intensity of explosive mixtures: application of the method to gunpowders, by M. Chabrier.—Action of bromine on dibromsuccinic acid; tribromsuccinic acid, by M. E. Bourgoin. The following substances are obtained by the action of bromine and water on the acid: tribromsuccinic and dibrom-maleic acids and dibrominated ethylene dibromide.—On the alcohols contained in the acid liquors of starch manufactories and in the products of the butyric fermentation of glucose, by M. G. Bouchardat. These are ethylic, normal propylic, and butylic alcohols.—On the determination of alcohol in water, wines and saccharine liquors, by M. Salleron.—General method for the transformation of alcohols into nitric ethers, by M. P. Champion. The reagent employed is nitro-sulphuric acid.—On phenyl-allyl, by M. B. Radziszewski.—On pyrogallol in presence of iron salts, by M. E. Jacquemin.—On the colouring matter of wine, by M. E. Duclaux.—On the volatile acids of wine, by the same author.—Movements excited in the stamens of *Mahonia* and *Berberis*; anatomical conditions of this movement, by M. E. Heckel.—On the direction of the wind in the high and low (atmospheric) regions during the storm of April 13, 1874, by M. Chapelas.—During the meeting a commission was appointed to prepare a list of candidates for the vacancy of foreign associate caused by the death of M. De la Rive.

BOOKS RECEIVED

English.—Handbook of Practical Telegraphy. 6th edit.: R. S. Culley (Longmans).—Mental Physiology: W. B. Carpenter (H. S. King & Co.).—The Design and Construction of Harbours: Thos. Stevenson (A. & C. Black).—Our Inheritance in the Great Pyramid: C. Piazzi Smyth (Isbister & Co.).—Longevity: John Gardner (H. S. King & Co.).—The New Chemistry: Josiah P. Cooke (H. S. King & Co.).—Hydrostatics and Pneumatics: Lardner and Loewy (Lockwood).—Geology of Suffolk: J. R. Taylor (White).—The Universe and the Coming Transits: R. A. Proctor (Longmans).—Haydn's Dictionary of Dates. 14th edit.: B. Vincent (Moxon).

CONTENTS

INDEX

NATURE

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

VOLUME X.

MAY 1874 to OCTOBER 1874

"*To the solid ground*
Of Nature trusts the mind that builds for aye."—WORDSWORTH

London and New York:
MACMILLAN AND CO.
1874

LONDON
R. CLAY, SONS, AND TAYLOR, PRINTERS
BREAD STREET HILL

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH

THURSDAY, MAY 7, 1874

LEWES'S "PROBLEMS OF LIFE AND MIND"

Problems of Life and Mind. By George Henry Lewes. First Series: The Foundation of a Creed. Vol. I. (Trübner & Co.)

IN this volume Mr. Lewes speaks in an attractive, if rather conversational way, on a great many philosophical and psychological topics; but the most striking feature of the book is the many announcements of discoveries and original views to be proved and elaborated in future volumes. And the author's opinion that the work is of "somewhat ambitious pretensions" is, we think, likely to be shared by his readers.

We are promised a Psychology, but introductory thereto Mr. Lewes has produced two volumes (the second is now under final revision), in which he aspires to lay the Foundation of a Creed. "The great desire of this age is for a doctrine which may serve to condense our knowledge, guide our researches, and shape our lives, so that Conduct may really be the consequence of Belief." Perhaps there is a general, certainly not a universal, longing for something of this kind. The first question is, what is to be the fate of this hunger of the soul? Is this longing doomed to perish for want of an object? or is it destined to be satisfied? If so, how? Religion, thinks Mr. Lewes, is not to die, but to be transformed.

According to Mr. Lewes this new Religion, "Instead of proclaiming the nothingness of this life, the worthlessness of human love, and the imbecility of the human mind, will proclaim the supreme importance of this life, the supreme value of human love, and the grandeur of the human intellect." The first half of this fine sentence is entirely negative; it tells us that the new creed will not seek to suppress or degrade human nature, after the manner imputed to some of the old religions. This is well, and, as it seems to us, sufficient for all that Mr. Lewes, so far as we can make out, has in view.

Before this new doctrine, which is to reconcile the claims of Religion and Science, can be established, it is necessary as a preliminary to transform Metaphysics. Accordingly Mr. Lewes has applied himself to this task. Defining Metaphysics as the "Science of the most general conceptions," to be pursued solely by the method of Science, he discards "all inquiries whatever which transcend the ascertained or ascertainable data of experience." As a name for the province which he thus excludes from metaphysics, he suggests the word *metempirics;* and as *metempirical* has much to recommend it, besides its being the exact correlative of empirical, it will, we hope, establish itself as a useful addition to the language of philosophy. Mr. Lewes anticipates very large results from systematically keeping in view as a principle of research the necessity of clearly and completely eliminating from the statement of each problem all metempirical elements. In the light of this method all mystery, it seems, will vanish from the universe, as the shadows of the morning fly before the rising sun:—"When rationally stated there is no greater mystery in the existence of an external world, or the relations between object and subject, than the relation between activity and waste in the tissues." For, though as Mr. Lewes observes, "it may seem a very bold thing to say," yet he believes and hopes to show that "we not only know that an external Not-self exists,—know it with the same assurance that we know an internal Self to exist, but we also know the manner in which the two are combined in Feeling and Thought." Mr. Lewes will certainly have philosophised to some purpose if he put us in possession of a principle of research that will enable us so completely to transcend what at present appears to be the highest reach of our powers. One condition of understanding the manner of a combination has hitherto been a knowledge of the elements in separation. If we know how oxygen and hydrogen combine to form water, it is because we know these gases otherwise than combined in water. But of the Self and Not-self we know nothing, and can never know anything save as feeling and thought. In the author's own words, "all that we can know of the external is what we have felt or might feel." Nor do we see at this moment that this criticism would lose its point even were we to accept Mr. Lewes's peculiar doctrine of

the subject and object. When explaining how men came to lose faith in the reality of the objective, he points out that by dwelling on the fact that the same subject produces various sensations at different times, they at last "reversed their primary and instinctive judgment, and instead of saying 'qualities belong to objects,' they now said, 'It is we who invest objects with the qualities of our feelings.'" This he seems to regard as giving an undue predominance to the "subjective aspect." We venture to think that it would be more in accordance with the established use of language to describe the error referred to as a failure to observe that the sensations varied, not only with changes in the object, but also with changes in the material organism called our body,—which never was the "*we*" of the philosophers who hold that it is *we* who invest objects with the qualities of our feelings. Looked at from this point of view, the whole truth within our reach is simply this, that with the same external object and the same bodily condition, the same state of consciousness will invariably arise. The peculiarity of Mr. Lewes's position, if we understand it, is that he means by the *Self* the living body, the "sentient organism" *as we know it*, and by the Not-self the external surrounding *as known to us;* for his *reasoned realism* forbids him to seek after any deeper reality of things,—the absolute is what we see and hear. So far are we, as it appears to us, from knowing how the action of external forces on the living organism results in *feeling*, that we cannot make the very least approach to a conception of such a thing. Recognising that each feeling is related to certain vibrations set up in the nervous structure by the action of external agents, which vibrations Mr. Lewes describes as expressed by the feeling, this, as far as we can see, brings us no nearer to a conception of any sense in which "the feeling *is* what it expresses"—is the vibrations. Mr. Lewes will have to say much more than he has yet said, before we shall be able to see with him that stimuli plus mechanism can ever yield an explanation of sensation.

We regret that our space will not permit us to notice any other of the many important topics touched on in this volume. The whole demands, and will fully repay, a careful reading from every student of these matters. Only the first of Mr. Lewes's problems—the Limitations of Knowledge—is worked out at full length, the chapter on Necessary Truths being perhaps the most interesting. In the last chapter Mr. Lewes considers the place of sentiment in philosophy. What he has to show is that Sentiment, or Emotion, is one important source of knowledge. But what he says is more likely to impress his readers with its power of obscuring vision and obstructing research.

DOUGLAS A. SPALDING

OUR BOOK SHELF

Report of the Rugby School Natural History Society for the year 1873. (Rugby: W. Billington, 1874.)

THIS Report is on the whole very satisfactory, and the tone of the preface exceedingly hopeful. At no time in its past history of seven years, the retiring president tells us, does the Society seem to him to have contained more promising workmen. It appears that it has been resolved to construct a geological model of the Rugby district, and for this *magnum opus* many volunteers from the Society have offered their assistance. The appended reports of the various sections are on the whole satisfactory, showing that real work is being done. One of the most valuable features in the Report for 1873 is the number of papers which have been read by the young members themselves, there being seven printed here in greater or less fulness, and a number of others mentioned as having been read at the regular meetings of the Society. One of the most interesting of the published papers is one by Mr. H. N. Hutchinson On Home-made Electrical Apparatus, showing that the author possesses very considerable originality and ingenuity. The apparatus described was made by his brother and himself five years ago, and includes some of the most essential parts of an electrical equipment, the cost of the whole not being more than a few shillings. He thus tells us how the cylinder of an electrical machine may be manufactured. "Choose a tall glass jar, such as you see in confectioners' shop-windows. Next get two wooden caps turned to fit on to the ends of the cylinder, about an inch deep, with projecting pivots. The caps are next to be cemented on to the ends of the cylinder. The cement is composed of resin, beeswax, red ochre, and a little plaster of Paris, and must be heated over a slow fire. The open end of the cylinder must be first covered over with a piece of silk to prevent bits falling in." The conductor was made of deal wood turned to the proper shape and covered very smoothly with tinfoil; the Leyden jars were made from ordinary plum jars. We recommend the paper with its accompanying sketches to those who cannot afford to buy an electrical apparatus. W. B. Lowe describes some carefully made experiments On Cohesion of Water at Various Temperatures; and other papers by pupils, evincing considerable power of observation, are—On an Excursion of Mr. Wilson's Geological Class to Mount Sorrel, by C. M. Kerr; On a Botanical Expedition to Princethorpe, by H. W. Trott; On a Geological Expedition to Atherstone and Nuneaton, by E. Mann; On an Entomological Expedition to Frankton Wood, by H. A. Bull; and On the Chameleon, by J. S. Beuttler, giving an account of the author's own observations on two specimens belonging to himself. Besides these there are several other papers by masters and outsiders; one of the latter is a very instructive paper by Mr. R. H. Scott, F.R.S., On the Weather. The Report also contains four plates by pupil members of the Society.

The Surface Zones of the Globe. A Handbook to accompany a Physical Chart. By Keith Johnston, F.R.G.S. With two Maps and six Illustrations. (W. and A. K. Johnston, 1874.)

THIS little volume will form an interesting and valuable addition to our educational manuals, either as a lesson-book for pupils or as a handbook for teachers. The author divides the surface of the globe into seven great zones, and shows that, without considering the particular species of plants, or the more minute details of the forms of natural life which occur in these belts, and which may differ in one continent from another, there is a resemblance in character throughout the whole extent of each zone, whether of forest, or pasture, or desert, which cannot be mistaken. Mr. Johnston names these zones as follows:—1. The Equatorial Forest Region; 2. The Equatorial Pasture Lands; 3. The Deserts; 4. The Temperate Pasture Lands; 5. The Temperate Forests; 6. The Barren Tundra Regions; 7. The Icy Polar Regions. He describes in detail the characteristic appearance and productions of each region, and in doing so manages to convey a considerable amount of useful information. The manual is intended to accompany a large chart of the world on which these surface zones are distinguished, and a minute copy of which forms one of the diagrams of the work. Another very curious and interesting diagram is intended to show the surface zones on the supposition of a change of 90° in the position of

the earth. The coloured illustrations showing the characteristic appearances of the various zones are as successful as anything of the kind we have seen, although, what perhaps cannot be avoided in coloured illustrations of this kind, there is a little too much of "the light that never was on sea or land" upon them.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Necessary Truths—Physical and other

I AM not about to continue a controversy which I regret having been provoked into by the misrepresentations of one who ignored the contents of works he professed to review. Reply and rejoinder may go on endlessly. I could not, to much purpose, argue with Mr. Hayward, who, instead of taking such unconsciously-formed preconceptions as those resulting from the infinite experiences of muscular tensions and their effects, proposes to exemplify unconsciously-formed preconceptions by a consciously-formed hypothesis concerning the relation between weight and motion. Nor should I care to discuss any question with my new anonymous assailant; who, when certain examples given show the "exact quantitative relations" spoken of to be those of direct proportion, describes me as "intensely unmathematical" because I subsequently use the more general expression as equivalent to the more special—which, in the case in question, it is.

The first of my objects in now writing is to remind "some bystanders, who may from their antecedents be presumed competent to judge," that the essential question is not a mathematical one, but a logical and psychological one, in respect of which I am not aware that senior wranglers, as such, can claim any special competence. Further, even admitting the assumption that the question is mathematical, I have to warn the reader that he will be much misled if he infers that there are not "some bystanders who may from their antecedents be presumed" *more* "competent to judge," who concur in the opinion that the laws of motion cannot be demonstrated experimentally.

My second object is to inclose, for publication in NATURE, a passage now standing in type to be added to future impressions of "First Principles" in further elucidation of necessary truths, and our apprehensions of them.

HERBERT SPENCER

"The consciousness of logical necessity, is the consciousness that a certain conclusion is implicitly contained in certain premisses explicitly stated. If, contrasting a young child and an adult, we see that this consciousness of logical necessity, absent from the one, is present in the other, we are taught that there is a *growing up* to the recognition of necessary truth, merely by the unfolding of the inherited intellectual forms and faculties.

"To state the case more specifically:—Before a neceesary truth can be known as such, two conditions must be fulfilled. There must be a mental structure capable of grasping the terms of the proposition and the relation alleged between them; and there must be such definite and deliberate mental representation of these terms as makes possible a clear consciousness of this relation. Non-fulfilment of either condition may cause non-recognition of the necessity of the truth; and may even lead to acceptance of its contrary as true. Let us take cases.

"The savage who cannot count the fingers on one hand, can frame no definite thought answering to the statement that 7 and 5 make 12; still less can he frame the consciousness that no other total is possible.

"The boy adding up figures inattentively, says to himself that 7 and 5 make 11; and may repeatedly bring out a wrong result by repeatedly making this error.

"Neither the non-recognition of the truth that 7 and 5 make 12, which in the savage results from undeveloped mental structure, nor the assertion, due to the boy's careless mental action, that they make 11, leads us to doubt the necessity of the relation between these two separately-existing numbers, and the sum they make when existing together. Nor does failure from either cause to apprehend the necessity of this relation make us hesitate to say, that when its terms are distinctly represented in thought, its necessity will be seen; and that apart from any multiplied experiences, this necessity becomes cognisable when structures and functions are so far developed that groups of 7 and 5 and 12 can be intellectually grasped.

"Manifestly, then, there is a recognition of necessary truths, as such, which accompanies mental evolution. Along with acquirement of more complex faculty and more vivid imagination, there comes a power of perceiving to be necessary truths what were before not recognised as truths at all. And there are ascending gradations in these recognitions. Thus a boy who has intelligence enough to see that things which are equal to the same thing are equal to one another, may be unable to see that ratios which are severally equal to certain other ratios, that are unequal to each other, are themselves unequal; though to a more developed mind this last axiom is no less obviously necessary than the first.

"All this, which holds of logical and mathematical truths, holds, with change of terms, of physical truths. There are necessary truths in Physics, for the apprehension of which, also, a developed and disciplined intelligence is required; and before such intelligence arises, not only may there be failure to apprehend the necessity of them, but there may be vague beliefs in their contraries. Up to comparatively recent times, all mankind were in this state of incapacity with respect to physical axioms; and the mass of mankind are so still. Various popular notions betray inability to form clear ideas of forces and their relations, or carelessness in thinking, or both. Effects are expected without causes of fit kinds; or effects extremely disproportionate to causes are looked for; or causes are supposed to end without effects. But though many are thus incapable of grasping physical axioms, it no more follows that physical axioms are not knowable *à priori* by a developed intelligence, than it follows that there is no necessity in logical relations because many have intellects not developed enough to perceive the necessity.

"The ultimate physical truth of which clear apprehension is eventually reached, is that force can neither arise without an equivalent antecedent, nor disappear without an equivalent consequent. Along with power of introspection there comes recognition of the fact that existence cannot be conceived as beginning or ending: the Laws of Thought themselves negative any such mental representation. And if it be asked why this intuition, which all physical axioms indirectly imply, and which is postulate in every physical experiment, is to be taken as authoritative because its negation is inconceivable, the answer is that no argument which sets out to discredit it can do this without logical suicide; since there is no other warrant for asserting the dependence of any conclusion on its premisses than the inconceivability of its negation."

This passage forms part of a revised version of the chapters on Matter, Motion, and Force, which I have contemplated making for this year past. When those chapters were written and stereotyped in April 1861 (see Preface), the modern doctrines concerning Force and its transformation were so imperfectly developed, that some of the leading technical words now currently used were not introduced. The reorganisation of "First Principles," which I made in 1867, for the purpose of more truly presenting the general Theory of Evolution, did not implicate these chapters, and I believe I did not even re-read them: the stereotype plates, in common with those of many other chapters, with the numberings of pages and sections altered, were used afresh, and continue still to stand as they originally did. But while now rectifying defects of statement which it was scarcely possible to avoid thirteen years ago, I find no reason for changing the essential conception set forth in those chapters; nor is the need for changing it suggested to me by those on whose judgments I have the best reasons for relying.—H. S.

Royal Society Soirée

WITH reference to your account of the Royal Society's soirée (NATURE, vol. ix. p. 502), will you allow me to explain that all I "promised" concerning the missing pair of Paradise-birds was to deliver them when sent for.

They were not sent for, owing to some mistake, and consequently not exhibited.

May 5 P. L. SCLATER

Father Secchi's Work on the Sun

WITH great surprise I read in NATURE, vol. ix. p. 390, the following note:—

"Father Secchi is preparing at Gauthier Villars a second

edition of his work on the Sun, on an enlarged scale. He has quoted so largely from Mr. Lockyer's 'Solar Physics' that an intended translation of this work is abandoned for the present."

I have the honour to inform you that the complete original of my second edition has been in the hands of M. Gauthier for more than a month, so far as that part which may have something in common with Mr. Lockyer's work is concerned, and that I had not seen Mr. Lockyer's work until a fortnight ago, when I bought it from M. Loescher here in Rome. Mr. Lockyer of course is quoted, but only from his original memoirs, and not from his new publication, nor in such a manner that his publication will render my work useless.

Rome, March 23 P. R. SECCHI

[The following explanation has been sent us by the Paris correspondent who furnished us with the note referred to by Father Secchi:—

"I was told by his (P. Secchi's) editor himself, when I spoke to him about publishing a French edition of Mr. Lockyer's 'Solar Physics,' the substance of what I have written to you. I think that the note I have written is a recommendation of Father Secchi's work; but not so his statement that he did not possess 'Solar Physics' until it was too late to use it. There is nothing whatever dishonourable in quotation."—ED.]

Spontaneous Generation Experiments

SINCE October 1870 I have, as opportunity offered and other work permitted, made a series of experiments bearing on the question of spontaneous generation. They seem to me to tell so plain a story that I am anxious to relate it.

The thoughts which led to the experiments were briefly these:—

The occasional or even frequent presence of living growths in fluids after they have been exposed to a temperature of 212° F. and are contained in closed tubes or flasks is rather an indication of the imperfection of a method than the proof of a theory; for under like circumstances living organisms ought either always or never to develop; the conditions being uniform, the results should be uniform.

When the tubes are closed at a blow-pipe flame after boiling, steam cannot be escaping from the aperture at the time of actual closure, and it is conceivable that in the momentary collapse of the contents which then occurs some atmospheric air containing organic matter may pass into the tube and invalidate the experiment.

The contained air, if any there be after the sealing of the tubes, must be vastly rarefied, and the ordinary atmospheric conditions, other than purity, which are essential, must be absent or greatly modified.

I attempted to devise an experiment which would be free from these possible sources of error; one in which the atmospheric pressure should be normal, in which the physical structure of the air should be unaltered, and in which there should be no chance of organic contamination after heating. Further it seemed a good thing to be able to show at the same time and in the same apparatus two distinct specimens of the boiled fluid, the one exposed only to cleaned air, the other exposed also to common air; and also to use a fluid which would indicate to the naked eye by change of colour, or of clearness, or of consistence, the time at which living growths made their appearance.

The latter condition was secured by using a fluid (for the idea of which I am indebted to Mr. Heisch's experiments on water-impurities) composed of 10 cc. of urine, 1 gramme of white sugar, and 90 cc. of distilled water. This when boiled and filtered is a clear transparent liquid, which becomes milky on the occurrence of organic growth during fermentation in thirty to forty hours, according to the heat to which it is exposed.

The other conditions were effected by using a glass tube of the shape of the capital letter M, with curved bends instead of the angles; a tube which may be described as having four straight legs joined to each other by two loops on the upper side and one on the lower; the first leg closed and the last leg open and short.

This tube, so bent, was made very hot, so as to expel as much air as possible from it; the open end was then plunged into the boiled and filtered urine-sugar fluid, and such a quantity allowed to flow in on the cooling of the tube as left the first, second, and third legs about half full when the tube was held upright. The tube was again heated to the boiling of the contained fluid in order to expel as much air as possible by the generation of steam. It was then allowed slowly to cool, so that the first leg was about one-third filled with fluid; and such an amount was left in the lower loop as would rise in the second and third legs to about the same extent as the tube cooled (and the cooling was designedly prolonged); air passed through the fluid in the lower loop to fill the space in the first upper loop, between the two masses of fluid, left vacant by the condensation of steam.

The tube was then hung up, away from direct sunlight, and exposed to the ordinary changes of temperature of my study.

If I have been able to describe intelligibly this very simple matter, it will be seen that I had here two portions of the same fluid separated from each other; both having been heated to the same temperature and both exposed to atmospheric air.

The conditions were precisely similar with one exception; intentional and crucial. The air in the first upper loop, to which air only the fluid in the first leg was exposed, had passed through and been washed by the fluid in the lower loop; and the fluid of this loop was on one side exposed to the washed air and on the other side to the ordinary atmosphere.

In experiments with this apparatus the phenomena were, in eight cases, as follows:—On the second or third day the fluid in the loop was milky, and the fluid in the first leg was bright. At the end of a week, a month, four months, indeed as long as the tube was kept, the one continued clear, the other was turbid. At the expiration of a time, varying in different experiments from four days to four months, I tilted over the least drop of the turbid fluid in the loop into the clear fluid in the first leg, when at once the milkiness began, and in a day the whole of the leg fluid was turbid also.

In many cases I examined the two fluids, clear and turbid, with a twelfth-inch object-glass, and found Bacteria in the turbid fluid; nothing in the clear fluid.

Twice I left (once unintentionally, once intentionally) so little fluid in the loop that, there being a small aperture, it did not fulfil its purpose as a filter and a valve, and in both cases the two masses of fluid became turbid at the same time.

In six other experiments I used urine; in four instances the loop fluid showed symptoms of putrefaction, and became turbid in four or five days, but the leg fluid remained clear. On the closure of the experiment, at varying periods from a week to four months, the bright urine appeared, on microscopic examination, to contain no organic growth, but underwent putrefaction as ordinary urine when exposed to the air.

In the two other experiments both urines putrefied at the same time. In one case I hastened the cooling by cold; in the other I left very little fluid in the loop.

In four experiments I used Dr. Charlton Bastian's turnip-cheese fluid. In all cases the solution was milky when made; twice it was filtered and twice unfiltered, and in all cases, when examined by the microscope after the lapse of some days or weeks, the fluid in both leg and loop contained organic growth.

The experiments on urine and urine-sugar fluid show, in my view, both positively and negatively, that there is something in the ordinary air which is a necessary condition of the origin of organic growth in these liquids.

Positively this position is demonstrated when, after six months, the fluid in contact with unwashed air is seen to be full of organic growth, and the fluid in contact with washed air is still unchanged.

Negatively it is supported when both fluids are seen to grow turbid at the same time from imperfect washing of the air, by reason of too rapid cooling or too scanty a supply of fluid for the washing.

The experiments with Dr. Bastian's turnip-cheese fluid were for some time a puzzle to me, and made me fear that there was an undetected fallacy in my other experiments. But now it is clear that the contradiction is only apparent. Dr. Burdon Sanderson has shown that this fluid contains within itself the elements of organic growth which are not destroyed at 212° F., the temperature at which my experiments were necessarily conducted.

I am anxious not to press these experiments unduly, but they seem to me to range themselves unequivocally in opposition to the theory of spontaneous generation; although they touch no great extent of the subject.

That the something in the ordinary air necessary for the origin of organic growth in the fluids used is a gaseous impurity of the air is supported by no fact of which I am aware; but whether it be living organised germ or dead unorganised matter, these experiments do not explain or attempt to explain.

LEONARD W. SEDGWICK

The Fertilisation of Fumariaceæ

It was with great pleasure and interest that I read the communications from Mr. Darwin and Dr. Hermann Müller in Nature, vol. ix. p. 460.

It so happens that, since writing the note on the tardy and apparently useless assumption of colour by *Fumaria capreolata* var. *pallidiflora*, I have chanced to see the flowers of this plant visited, on two occasions, by a bee in the daytime.

This insect was, on both occasions, I believe, a mason-bee, and certainly neither a hive nor a humble bee, and, as it confined its attentions to this one variety of fumitory, and was engaged for some time at its work, I had a favourable opportunity of watching the mode of operation.

The bee ranged from plant to plant, but, in every case, would only alight on and suck those flowers which, though still white, had assumed the horizontal position, these flowers alone affording a comfortable landing-stage for the insect.

The bee then clasped the lower part of the tube with its feet, and prized open the flower by thrusting its sheathed proboscis underneath the upper petal, when the tube split lengthwise, and gaped widely open, the style and stamens rising up and emerging from the cap formed by the inner petals, much as they do from the keel in many papilionaceous flowers, and rubbing against the underside of the bee's body.

I may observe that it is precisely in the short period during which the flower maintains itself in the horizontal position that the emission of pollen takes place, and this coincidence of the plant bidding for the visits of insects at that particular moment has much the appearance of special adaptation.

But an examination of the flowers certainly shows that they are capable of self-fertilisation, and Dr. Hermann Müller tells us that Dr. Hildebrand states that this is habitually the case in *F. capreolata*.

I regret that I am only acquainted with Dr. Hildebrand's paper through a review which appeared in the *Bulletin* of the Société Botanique de France, where but few of the details are given.

I have not paid special attention to the structure and habits of the *Fumariaceæ*, and I am therefore unable to say whether the plant to which I have alluded is commonly visited by insects in the daytime, or whether, as Mr. Darwin suggests, its flowers, the nearly white colour of which would render them peculiarly conspicuous in the dusk, may not prove especially attractive to moths and other night-fliers.

While watching the bee whose operations are described above, I noted with interest that it confined its attention exclusively to plants of this single variety of fumitory, winding its way through flowering masses of other fumitories and weeds.

In the same way a honey-bee, at the same spot on a later day, exclusively visited the wild mignonette (*Reseda phyteuma*), passing by the fumitories, marigolds, &c.

J. Traherne Moggridge

Maison Gastaldy, Mentone, April 20

Allow me shortly to resume the different views which have been proposed in your columns, as giving a possible explanation of the fact that the flowers of *F. pallidiflora* attain their brightest colouring when the time for fertilisation has passed, and to point out the observations indispensable to be made, in order to ascertain which of the proposed views is right. 1. It is possible that nocturnal Lepidoptera are the fertilisers of the fumitory; in this case it would be most probable that the pale colour of its flowers has been acquired by natural selection, pale flowers being most conspicuous in the dusk. 2. Diurnal insects may be the fertilisers, and the pale hue may be sufficiently conspicuous or even more attractive for them than the brighter one. In this case, also, the former must be considered as acquired by natural selection; the latter, on the contrary, as in the first case, merely as the result of chemical processes. 3. Under the same supposition of diurnal insects being the fertilisers, it is possible that the older flowers, by their brighter hue, serve to attract insects to the younger and paler ones; in this case the bright hue of the older flowers may be looked upon as acquired under the influence of natural selection, the pale colour of the younger flowers at the same time being useless. 4. It is possible that self-fertilisation is the rule with the flowers of this fumitory, and that cross-fertilisation by insects takes place only very exceptionally; in this case not only, as in No. 3, the paler colour, but also the brighter one would be nearly independent of the influence of natural selection. In order to decide definitely which of these views is right, it is indispensable to watch perseveringly the flower of this plant, and to ascertain what kind of fertilisation naturally takes place. In case diurnal insects should prove by direct observation to be the fertilisers, it would be possible to decide whether supposition 2 or 3 is correct, by removing from many specimens every older flower as soon as its colour begins to grow brighter, and by observing whether these specimens or those with older and brighter flowers are more frequently visited by insects.

It would be a great pleasure to me to make these observations, but I do not know whence seeds of *Fumaria pallidiflora* can be obtained. Perhaps some reader of this letter may be good enough to give me information on this point.

Lippstadt, April 28 Hermann Müller

Mr. Comber's suggestion (vol. ix. p. 484) that the coloured flowers of *Fumaria* attract insects to the uncoloured ones is very ingenious. Supposing that they are cross-fertilised, the case of *Poinsettia* is very pertinent, and is enforced by that of *Dalechampia*, also euphorbiaceous, in which the bracts, a beautiful rose colour before fertilisation, gradually assume afterwards the same green hue as the foliage when the bright colour is no longer needed. The chemical changes that take place in the flower at and after the period of its complete expansion must necessarily be complex, as well as varied in different cases. Rapid oxidation is probably one very effective agent in producing them, but the results will necessarily depend on what is operated upon. *Hibiscus mutabilis* is white in the morning, deep red by night. Species of *Lantana*, like *Myosotis versicolor*, pass through a whole series of colours as they expand. On the other hand all the beautiful species of *Franciscea* rapidly lose the tints with which their flowers open, and become nearly white. The final stages in the life of all the parts of the flower which are not accessory to the formation of the fruit are more or less processes of decay, and there is no absolute law that these should always be accompanied by inconspicuous or displeasing tints. The white flowers of *Calanthe veratrifolia* blacken when they are bruised; on the other hand, according to Kingsley, the crimson flowers of *Couroupita guianensis* turn blue when torn, as the pulp of the fruit is also known to do on exposure to the air. In the same way some fungi exhibit when bruised striking tints which yet can be of no service to them. *Agaricus georginæ* changes from snow-white to blood-red wherever it is touched, and the white flesh of *Boletus cyanescens* when broken changes instantly to the "most beautiful azure blue."

In fact if a chemical change is set up—if it produces a change of tint at all—it must *sometimes* produce a pleasing one; that it should do so is not necessarily advantageous to the plant, though open to be taken advantage of by it.

W. T. Thiselton Dyer

Fertilisation of Corydalis claviculata

With regard to the flowers of *Corydalis claviculata* (of the discovery of which species in this neighbourhood I have sent a note to the *Journal of Botany*), I think Mr. Bennett (vol. ix. p. 484) will find his suspicion that the styles may have been broken off in dissecting to be correct. This may easily be shown by floating off in water the petals, &c., of a withered flower, in which the process of fertilisation has been completed, when the style will be seen adhering to the ovary, though the gentlest touch will be sufficient to separate it. In the bud the anthers cover the stigma, but at the time of maturity the latter projects slightly, so that it would be first touched by the proboscis of an insect. I suspect that it is also slightly protogynous, though self-fertilisation may probably be of frequent occurrence. The manner in which the style is embraced by the stamens and petals protects it from too rough a shock from the struggles of insects in the narrow entrance to the flower. I have not, however, observed them to visit it.

W. E. Hart

Kilderry, co. Donegal, April 28

Lakes with two Outfalls

Since writing my letter of April 24, with which I forwarded a copy of the new Inch Ordnance map of Arran, I have received other copies from Mr. Stanford, showing, as I presume, that the early copies of General Sir H. James's admirable work have been revised. For, besides the elaborate system of contour lines, which did not appear in the first copies, *two* outlets are given to Loch-na-Davie, instead of one only. So that, as to the "matter

of fact" touching the new Inch Ordnance map, Mr. Christie and I are both right. That is, he has a copy to show for his assertion; I have one to sbow for mine. But the great question is not what is the "matter of fact" as touching maps, but what is the matter of fact in nature; and I assert that Loch-na-Davie has but one outlet, to the south, to Glen Iorsa. My words in the *Athenæum* are—"The water-parting is a few yards to the north of the loch, I should *guess* at the spot where a heap of stones stands, apparently lately thrown up;" and from there there is a slight trickling *inlet* to the loch. I ended my letter thus—"Most gracious reader of the *Athenæum*, go take a tourist ticket to Glasgow from Euston Square. Then a lovely run in a Clyde steamer to Arran, and *judge for yourself*." May I repeat this advice to the "gracious reader" of NATURE, for assuredly there is no *arguing* as to a "matter of fact."

As a matter of opinion, I do not think that any quantity of rain could turn the northern inlet into an outlet. That is, I think that at the southern end there is room to emit any overflow before the northern end could be flooded. Mr. Christie seems to suppose a constant double outlet. Dr. Bryce, more modest, only claims this in "winter and wet summers" (3rd edition, p. 3), or "when it rises about eighteen inches above its level in dry weather" (p. 130).

Alresford, May 1 GEORGE GREENWOOD

I OBSERVE that a correspondence has been going on in the columns of NATURE on the subject of lakes with double outlets. It may interest your readers to learn that some glaciers afford instances of the same phenomenon. One of the most remarkable of these is the Glacier d'Arsine, in the old French province of Dauphiné (now the Département des Hautes Alpes). This glacier is broad and short; its moraines are extraordinarily large. It ends just on the watershed between the Romanche and Guizanne, and consequently streams flow from it in both directions. On one side, the stream forms a branch of the Romanche, which fall into the Drac, the united stream entering the Isère below Grenoble. On the other side, the stream flows down to the Guizanne, which, after receiving the Clairée near Briançon, assumes the name of the Durance, and falls into the Rhone below Avignon. This watershed is a prolongation of that over which the magnificent route impériale (magnificent in point of engineering and of scenery) of the Col du Lautaret has been carried. This glacier is very rarely visited, though the above-mentioned phenomenon has been remarked before. Perhaps some of your readers can supply the names of other glaciers which present a similar phenomenon. I need only add that these observations were made during personal visits to the Glacier d'Arsine on July 15 and 17, 1873.

Exeter College, Oxford W. A. B. COOLIDGE

Trees "Pierced" by other Trees

THE natural phenomenon of one tree within another is very frequently witnessed in India in the case of the "pípal" (vulg. *peepul*) and the palmyra. The first instance which drew my attention to it was one in which a very large specimen of the former with a stem some 4 ft. thick was surmounted by a towering palm which *seemed* to grow out of, and in continuation of, the solid trunk at a height of about 30 ft., and rose to a height of 30 to 40 ft. more. I speak from recollection only. An amicable dispute took place between two natives, of whom I inquired about it—both strangers to the locality—the one declaring that the palm grew up *inside* the tree from the ground, and the other that it grew *upon* it. Subsequently I saw numbers of others in all stages, and recognised the fact that the fig grows up by the side of the palm and gradually *encloses* it, so completely as to defy examination of the resulting trunk. The tree that I speak of was by far the most remarkable specimen of the kind, and therefore I give its locality. It is a little south of the town of Kodangal, in the Hyderabad country, long. 77° 40′ E., lat. 17° 6′ N. J. HERSCHEL

May 5

COLONEL GREENWOOD's solution of the beech-tree pierced by a thorn plant is undoubtedly correct. The New Forest affords many cases of the branches of that tree growing together and forming holes apparently through the trunk. Ivy gives the most striking and familiar examples of its runners crossing and uniting; it is not unusual to find a triangular arrangement of runners which cross each other at intervals of a few inches apart. It may be as well to draw your readers' attention to the spasmo ic way in which the leaves of the beech burst in spring: sometimes an entire branch, at others a single twig with less than twenty leaves, will be in full leaf a week or ten days before the buds have generally burst. G. H. H.

IN reference to this subject I many years ago met with an instance of a birch growing out of the fork of an oak.

The trunk of the oak at perhaps 8 ft. or 9 ft. from the ground divided into two large arms from between which a birch sprung. The oak was of very considerable age but apparently was not hollow (of this, however, I am not positive). The birch was perhaps 12 ft. or 14 ft. high. P. P. C.

The Antipathy of Spiders to the Wood of the Spanish Chestnut

CAN any of your readers establish the truth of the following assertion? Spiders' webs are never found upon beams from the Spanish or sweet chestnut tree, even when the timber is several centuries old. The keeper of the ruins of Beaulieu Abbey, in Hampshire, asserts that this is a fact, and the buildings of the Abbey, where beams of Spanish chestnut are used, are free from the invasion of spiders. His attention was drawn to this four years ago, and since then his observations have not thrown any doubt upon its accuracy.

Birkenhead, April 23 G. H. H.

FLOWERS OF THE PRIMROSE DESTROYED BY BIRDS

WE have received several additional letters on this subject, the important statements in which we have brought together here, in continuation of last week's article (vol. ix. p. 509).

Prof. Newton of Cambridge, in reference to Prof. Thiselton Dyer's letter of last week, writes as follows:—

Allow me to remark that the observation of Gilbert White (quoted by Prof. Dyer in NATURE, vol. ix., p. 509) respecting the bird said to "sip the liquor which stands in the nectarium" of the crown-imperial, has not, so far as I know, been confirmed by anyone else. Yielding to no man in my general trust in White's wonderful accuracy, I think that here we ought to suspend our belief, caution being perhaps the more needed, since, as has been pointed out by several of his editors, it is almost certain that the bird he saw was not the bird he supposed it to be.

Major E. R. Festing writes:—

A month ago I saw a caged hen bullfinch that would treat any quantity of primroses which were given to her in precisely the way described by Mr. Darwin in NATURE, vol. ix. p. 482. She gave one snip only to each flower, not again touching the remains of it, which fell to the floor of the cage.

My experience in trying to keep a small garden in London some years ago was, that the yellow crocus flowers were always destroyed by the sparrows as soon as they come into full bloom, no doubt with the same object as the finches have in destroying primroses. I do not remember that the purple or white flowers suffered in the same way.

A correspondent, dating from Exeter College, Oxford, writes as follows:—

Your article on the destruction of primroses brought to my mind several facts which came under my notice lately in a manse-garden in the south of Scotland. Under a cherry-tree the ground was thickly planted with primroses, all the flowers of which were picked by the sparrows. As not only was this cherry-tree in flower at the time, but there was also a good show of flower on the various other fruit-trees in the garden, in this instance, at least, the flowers of the fruit-trees seem not to have exercised a superior attraction.

Again, I myself saw that the work was done by sparrows.

Another writer in your article asks, if any other birds besides sparrows have been seen to use fresh flowers in nest-building? In this same manse-garden, some weeks ago, I watched some jackdaws busily plucking and carrying to their nests in a neighbouring chimney the leaves, flowers, and stalks of a variegated form of the common *Glechoma hederacea*.

Mr. J. Southwell states that in his garden in the suburbs of Norwich, the yellow crocuses are yearly destroyed by sparrows. He says:—

Formerly I have seen these mischievous birds pulling

the petals in pieces and scattering them on the ground, to enable them to reach the nectary, which is situated about on a level with the soil; but of late they have altered their tactics and simply bruised the perianth tube sufficiently to extract the nectar, leaving the bloom uninjured but fallen over as though killed by severe frost. The primroses have hitherto escaped, but this spring for the first time the sparrows have attacked the blooms of a cherry-tree, bruising the nectary between their mandibles, and generally detaching the blossom from the foot-stalk close to the calyx. That in both cases this is the work of sparrows I have had ample opportunities of observing. Some years ago a border of Virginian stock which was in full bloom appeared mysteriously to be growing thinner every day. I accidentally saw from a window the sparrows vigorously engaged in pulling up the plants, which they could only do by great exertion, and flying off with them to form their nests. This lasted till the whole were carried away. The fact of the sparrows having altered their form of attack on the crocuses, going direct to the nectary instead of pulling the flowers to pieces, would seem to indicate that the habit is acquired, and not inherited; it also appears, so far as I can learn, to be an increasing habit with them.

Mr. A. F. Buxton, of Cambridge, has frequently observed the same fact about primroses in a wood near Ware. He says:—

I could give no satisfactory explanation of the phenomenon, if it were not that I have noticed the propensity of tame bullfinches to act in the same way towards flowers, especially primroses. In the wood I speak of, bullfinches are abundant; but whether or not they are the only birds which act thus I am of course unable to decide.

Mr. W. E. Hart, of Kilderry, co. Donegal, states that the primroses there suffer much every spring in the manner described by Mr. Darwin. The cowslips and oxlips are seldom, if ever, touched. Mr. Hart says:—

The blame is commonly laid upon the chaffinch, though I have only been able to gather circumstantial evidence against it. I have frequently disturbed both chaffinches and greenfinches from primrose-beds, and found the cut-off flowers strewn about. One lady tells me that she once saw a thrush deliberately cut off a number of primrose flowers in her garden, turning each time to stare defiantly at her. Another has frequently seen hedge-sparrows do so. Thus it appears that several different species of birds have acquired the same habit.

J. M. M. has cultivated polyanthuses at Sidmouth, South Devon, for seven or eight years, and each year they have been more or less destroyed by birds, as described by Mr. Darwin. She does not remember to have noticed it till she came to Sidmouth. The wild primroses suffer also, but not, she thinks, to any great extent, though they are abundant in the neighbourhood.

Another correspondent, writing from Poplar, informs us that many years ago he became aware of the fact that flowers containing nectar are attacked by some small animal; having had a bed of crocuses in his garden, the flowers of which were morning after morning destroyed by, he believes, the sharp bills of the sparrows. He, however, suggests that mice frequently might have been the depredators, "as last year," he says, "they destroyed all the grapes in my greenhouse. They are just able to reach such flowers as the crocus and primrose, and they are very hard up at the early season when these delights appear."

M. T. M. mentions, "on the authority of a good observer," that the flowers of the laburnum are sometimes utilised in nest-building by suburban sparrows, "whose destructive habits in the matter of crocuses," he says, "are only too well known to suburban gardeners."

Mr. C. H. Beasley, of Liverpool, writes, that he had a canary some years ago which was particularly fond of primroses, and always bit them in the manner described by Mr. Darwin, usually leaving everything but the part containing the honey untouched. As this peculiarity was exhibited by a domesticated bird, he thinks it highly probable that it was inherited.

THE LECTURES AT THE ZOOLOGICAL SOCIETY'S GARDENS

III.

MR. SCLATER commenced his fifth and concluding lecture on the geographical distribution of the mammalia, by impressing the importance of precise definition of the exact localities from which zoological specimens are obtained. He showed that by further careful collecting, new animals, even of considerable size, most probably remain to be discovered, considering that a previously unknown rhinoceros and a fresh genus of deer had been made known within the last three years.

The importance of the geographical distribution of the larger divisions of the mammalia is well illustrated in the case of the *Bassaris* of Mexico, an animal supposed for a long time to belong to the civet cats, which are peculiar to the Ethiopian and Indian regions, but now known in its internal structure to agree with the racoons, which are typically American forms. So also the so-called musk deer are often said to inhabit northern Asia, India, and Africa, but there is only a single species of the true musk deer, which is from northern Asia, whilst the Tragulidæ (with which it has been erroneously united) form quite an independent group, found in India and Africa.

The facts given in the preceding lectures suggest the question as to how the world may be most naturally divided according to the distribution of the animal life upon it, which is part of the great problem of the distribution of organic life generally; and it is evident that all great deductions made from any one group must in the long run correspond with those from other groups.

At the outset it is evident that the ordinary geographical divisions of the world do not hold. Europe must be combined with the northern part of Asia, and also with Africa north of the Atlas Mountains. In the same way central America and part of Mexico have to be included with South America. Taking the division of the mammalia into Monodelphs, Didelphs, and Ornithodelphs, the peculiarities of their distribution are very instructive: dividing the surface of the earth into four major divisions —1. *Arctogæa*, or North Land; 2. *Dendrogæa*, or Tree Land; 3. *Antarctogæa*, or South Land; and *Ornithogæa*, or Bird Land.

Arctogæa is divisible into four minor regions—(α) the Palæarctic, (β) the Ethiopian, with the Lemurian subregion of Madagascar, (γ) the Indian, and (δ) the Nearctic. The Palæarctic region possesses few characteristic families and genera. Its boundaries, as are those of all regions except when sea-bound, are ill-defined; Palestine, for example, is doubtful. Quadrumana are almost entirely absent; *Rhinopithecus*, a Thibetan form, belonging, apparently, to the region. The genera *Ælurus* and *Capra* are characteristic forms. Bears are mostly confined to it, some being, however, found in North America and one in South America. Among the Ungulata, the genus *Equus* is more truly Palæarctic than otherwise, and *Cervi* are abundant.

The Ethiopian region embraces Africa south of the Sahara. The genera Troglodytes, Colobus, Cercopithecus, and Cynocephalus are characteristic, as are Hyæna, Proteles, Lycaon, Hippopotamus, Camelopardus, and others. Madagascar forms a well-marked sub-region, containing no antelopes nor cats, but Lemur, Chiromys, and Cryptoprocta. It is the true home of the lion.

The Indian region extends along Southern Asia to Wallace's line in the Malay Archipelago. The only ruminant animal in the Indian Archipelago is the peculiar *Anoa depressicornis*.

The Nearctic region is very much like the Palæarctic. Castor, Gulo, and Lynx are common to the two. Taxidea, Procyon, and Antilocapra are characteristic, whilst Didelphys has entered from the south.

The Neotropical region (*Dendrogæa*) possesses great individuality, Cebus, Hepale, Icticyon, Nasua, and

Cercoleptes being characteristic. Hystricidæ abound, and Ruminants are very badly represented, only lamas, peccaries, and tapirs being found. Sloths, armadillos, and opossums are not found elsewhere, and there are no frugivorous bats, Insectivores, Viverridæ, nor elephants. The West India Islands form a well-marked (Antillean) sub-region, possessing Solenodon, and peculiar Rodents.

The Australian region, including Australia and the Malay Archipelago up to Wallace's line (or *Antarctogœa*), is characterised by the presence of the Monotremes and Marsupials. Lastly New Zealand (*Ornithogœa*) has no Mammals at all except two Bats.

Mr. Sclater, in conclusion, explained the different answers which had been given to the question: Why are animals thus distributed? showing that the Darwinian hypothesis is a key to the whole subject, rendering quite simple most of those difficulties which were previously insurmountable.

CAMPHOR

THE camphor of commerce, it is well known, is the produce of *Camphora officinarum* Nees., a tree of China and Japan. To obtain it the wood is cut up into pieces and boiled in water, when the camphor is deposited. It is afterwards purified by sublimation, and further refined after its arrival in this country. Immense quantities of this article are imported from Singapore, and though so valuable in European commerce, in Sumatra and Borneo a much higher value is put upon that known as Sumatra camphor, which is obtained from *Dryobalanops aromatica* Gaert. (*D. camphora* Coll.), which does not come to this country as an article of trade. Besides these there is a third kind of camphor, known in China as Ngai camphor; this, in point of value, stands between the ordinary commercial article and the Malayan or Sumatra camphor. Its botanical source has for a long time been doubtful, but it has generally been attributed to an unknown species of *Artemisia*. Mr. D. Hanbury, however, who has done so much in clearing up doubts on the botany of many of our important articles of trade, more especially in relation to drugs, has recently, in a paper read before the Pharmaceutical Society, identified the plant with *Blumea balsamifera* D.C. It is a tall, herbaceous plant, and has long been known for the powerful smell of camphor emitted from the leaves when bruised. It is common in Assam and Burma, and indeed throughout the Indian islands.

The materials from which Mr. Hanbury has been enabled to solve the problem of the origin of this peculiar camphor were sent him from Canton, and consisted of a small branch of the plant, and specimens of the camphor itself. These specimens, he says, "represented two forms of the camphor—the one a perfectly colourless crystalline substance, in flattish pieces as much as an inch in length;" the other, which was sent as crude camphor, was a crystalline powder of a dirty white colour, mixed with some fragments of vegetable tissue. "The purer sample has an odour scarcely distinguishable from that of ordinary camphor; but the odour of the other is perceptibly contaminated with a smell like that of wormwood." This camphor, though seldom seen in this country, was at one time attempted to be brought into commerce, one hundred pounds of it having been made in Calcutta. It is used in the East, both in medicine and in the manufacture of the scented Chinese inks. It is stated that "about 15,000 dols.' (3,000*l*.) worth is annually exported from Canton to Shanghai and Ningpo, whence it finds its way to the ink-factories of Wei-chau and other places."

Though it is now proved that *B. balsamifera* is the plant yielding the bulk of Ngai camphor, it is not improbable that some other plants lend their aid, for the term "Ngai" is, it appears, applied to several belonging to the Labiatæ and Compositæ. JOHN R. JACKSON

THE "SPAR CAVES" OF THE NORTH BRIDGE, EDINBURGH

THE North Bridge, which spans the deep valley lying between the Old and New Towns of Edinburgh, was built upwards of a hundred years ago, and its huge arches must be familiar to all who have entered Edinburgh from the south by railway, the terminus for the main southern lines being situated just below. Between the arches of the bridge and the roadway above are a number of chambers or vaults which have not been opened, till recently, since the bridge was built. In carrying out the operations necessary for the widening of the now too narrow bridge, these vaulted chambers have been opened up, and one of them has been visited by Prof. Geikie, who, in a communication to the *Scotsman*, describes the wonderful sights he saw.

"The chamber we examined," he says, "was about eight or ten feet broad, and varied in height according to the rise and fall of the floor over the arch underneath, the floor coming sometimes so near the roof that we needed to stoop low to get through. From the vaulted ceiling, and especially from the joints of the masonry, hung hundreds of 'stalactites'—delicate spar icicles of snowy whiteness. In many cases they reached to the floor, forming slender thread-like pillars. In making our way we were under the necessity of brushing down many of these pendant masses. Now and then we seemed to be marching through a grove of white and brittle canes. The longest entire one we could see measured rather more than six feet in length. Usually they were slim stalks somewhat like thick and not very well-made tobacco-pipes, but towards the sides of the vaults they became thicker and stronger, one which we carried off measuring about four feet in length, and as stout as an ordinary walking-stick. The same material as that forming the stalactites spread in ribbed sheets down the sides of the vault. The floor, too, was dotted all over with little monticules of the same snow-white crystalline spar.

"A more illustrative example of a stalactitic cavern could not be found. The whole process was laid open before us in all its stages. Along the joints of the masonry overhead could be seen here and there a drop of clear water ready to fall. At other places the drop hung by the end of a tiny white stone icicle, to which it was adding its own minute contribution as it evaporated. From the mere rudimentary stumps the stalactites could be traced of all lengths until they were found firmly united to the spar hillocks on the floor. Every one of these hillocks, too, lay directly beneath the drip, catching the remainder of the stone dissolved in the dropping and evaporating water. In every case the stalactites were tubes; even the thickest of them, though it had undergone great changes from deposit on its outer surface, retained, nevertheless, its bore. Usually there hung a clear water-drop from the end of the stalk, ready to descend upon its white stony mound beneath.

"So far, except for the undisturbed perfection of the whole, there was nothing which may not be seen under many an old vault. But what astonished me most was the evidence of a continuous growth and destruction of these slim stalks of stone during an actually known period. In a great many cases the little 'stalagmite' mounds were each surmounted by a short slender stalk, as the Calton Hill is by Nelson's monument. There could be no doubt that these monumental-looking objects were merely the lower ends of once-continuous stalactite pillars. And indeed, searching round the mound I could usually find fragments of the broken column imbedded in the growing stalagmite. What had broken them? Perhaps a heavy omnibus thundering overhead, or a laden lorry or a deftly-fired royal salute. Anyhow, for a hundred years

this delicate tapestry has been hanging and growing, and breaking and growing again, quietly in darkness, beneath the grind of our carriage wheels, and yet high in air, with the stream of human life flowing underneath it too. Alike in the pendant stalks, on the walls, and in the mounds on the floor, the prevailing colour of the crystalline incrustation is pure white. These caves in middle air have been shut up from the contamination from town smoke. Now and then, however, the dripping water has come upon soluble iron as well as lime. Hence the mounds on the floor are sometimes curiously coloured yellow, brown, and red.

"As the bridge is built of sandstone, wholly or almost wholly free from lime, it is evident that the material which has converted these vaults into such picturesque caverns has been derived from the mortar. All rainwater, as is well known, takes up a little carbonic acid from the air, and of that acid there is in the air of a town usually more than the normal proportion. Filtering through the masonry, it dissolves the lime, carrying it downward in solution, and, if made to halt and evaporate, depositing it again in the form of the white crystalline substance which we call spar. It would be a curious question for the architect how long his masonry could resist this action. Certainly, in spite of what these vaults in the North Bridge reveal, the masonry of that structure is to all appearance as solid and firm as ever. It is evidently impossible, however, that the mortar, if necessary at all, can be piecemeal removed without in the end causing the destruction of a building."

REPORT OF PROF. PARKER'S HUNTERIAN LECTURES "ON THE STRUCTURE AND DEVELOPMENT OF THE VERTEBRATE SKULL" *

III.

IN the types already considered, the exo-skeleton consists of small placoid scales having the structure of teeth, and imbedded in the skin, but being altogether irrelative to the true cartilaginous endo-skeleton. In the group of fishes which form so perfect a mean between these Elamobranchs and the osseous fish—the Ganoids—the body is covered with close-set "ganoid" scales, which consist of two layers, a deeper one of bone (dermostosis), and a superficial one of enamel, covered only by a thin layer of epidermis. In the head these scales pass insensibly into a set of bones in close relation with the chondro-cranium, and having the connections, positions, &c. which characterise the roofing-bones of one of the higher skulls (parietals, frontals, nasals, &c.). In many cases these bones are so deeply imbedded in the subcutaneous tissue as to deserve the name rather of parostoses than of dermostoses, but are always easily removed by maceration or boiling. They are evidently of an entirely different nature to another series found in the same skulls, but in intimate connection with the cartilage, and only separable by its entire destruction. These last are ossifications of the chondro-cranium, and are often spoken of as "cartilage-bones;" the former kind have only a secondary relation to the primordial skull, and are known as "membrane-bones."

In the osseous fish both these varieties of bone appear, but the investing or membrane-bones are all true parostoses developed in the deeper subcutaneous tissue, and the place of the ganoid dermostoses is taken by cycloid or ctenoid scales. Still the insensible gradation between scales and skull-bones is very apparent: along the side of the trunk passes a series of curious tubular or grooved bones containing mucous glands and known as the "lateral line series;" these, on reaching the head, branch out so as to produce a tree-like arrangement instead of a single row, and the burrowing is now, not in a set of modified scales, but in true cranial bones, some belonging to the opercular apparatus, some to the series above and below the eye.

IV.—*Skull of the Salmon* (Salmo salar).—In the Teleostean the investing bones attain a greater development than in any other group, and, in the description of the salmon's skull, will be considered before the cartilage-bones which they overlie, and from which they come away with great ease by maceration.

There are, in the first place, on the upper surface of the skull, three pairs of bones and a single median ossification. Of these, a pair of small bones, separated from one another by a considerable interval, and lying over the auditory region, answer to the parietals (Fig. 7, Pa); a much larger pair roofing over all the central portion of the brain case, from the parietals behind to the nasal region in front, are the frontals (Fr); and a very small and insignificant pair situated just above the nasal sacs the nasals (Na). All these are well known from their occurrence in the higher animals; but the bone marked S.Eth (super-ethmoid), which lies between the nasals and over the cartilage separating the olfactory organs, is peculiar to certain osseous fishes.

Above the eye is a small bone, known as the supra-orbital (S.Or), and below and at its sides a chain of bones, deeply excavated by slime-glands, the sub-orbitals (Sb.Or); the most anterior of these (Lch) seems to answer to the lachrymal bone of the higher animals. The gape of the mouth, instead of being formed, as in the shark and ray, by the naked pterygo-palatine and Meckelian cartilages, is bounded entirely by membrane-bones, three in the upper jaw, the pre-maxilla (Pmx), maxilla (Mx), and malar or jugal (Ju), and one in the lower, ensheathing Meckel's cartilage, the dentary (D). The maxilla, unlike that of most typical Teleosteans is dentigerous, and takes a large share in the formation of the gape. Immediately below the angle of the lower jaw is situated a small bone, the angular (Ang).

Two very important parostoses occur on the under surface of the skull, where they clamp and strengthen the cartilage; these are the vomer (Fig. 8, Vo), which bears a few teeth, and the para-sphenoid (Pa.S), the enormous development of which is so characteristic of the bony Ichthyspsida.

Lastly there are the bones supporting the gill-cover, or operculum proper, and branchiostegal membrane, each of which has its own set of osseous strengthenings. In the first set are included the opercular (Op), sub-opercular (S.Op), pre-opercular (P.Op), and inter-opercular (I.Op); in the second, the branchiostegal rays (Brs.R). The operculars are also divisible into two categories; two of them—the pre- and inter-opercular—are developed in the fold of skin growing from the mandibular arch, which covers the cleft (existing only in the embryo) between it and the hyoid (Fig. 1, p. 425, Ty.Eu), while the remaining two belong in like manner to the operculum of the hyoid arch covering the branchial slits (Fig. 1, Cl^1). The pre-opercular is interesting as being the homologue of the lower part of the mammalian squamosal, and the inter-opercular as representing the tympanic, the two membrane-developed ossifications of the complex temporal bone of human anatomy. The branchiostegal rays are flat sabre-like bones, twelve in number, attached to the hinder edge of the hyoid apparatus. In most Teleostei these bones are seven slender terete rays, the four upper of which are attached to the outer and the three lower to the inner side of the hyoid. At the point where the branchiostegal membranes of opposite sides meet below the throat a median ossification is developed in the subcutaneous tissue; this is the so-called uro-hyal, or basi-branchiostegal (B.Brs).

* Continued from vol. ix. p. 468.

When all the foregoing bones are stripped off, the salmon's skull is far more comparable than in its perfect state with that of an Elamobranch, being reduced to the chondro-cranium, a cartilaginous structure, with certain endogenous ossifications, but retaining to a remarkable extent the characters of a "primordial skull." A side view of the chondro-cranium is shown in Fig. 9 : viewed from above it presents, like that of the ray, expanded sense capsules, and a narrowed inter-orbital region ; the walls of the brain-case are, however, much thicker, and its cavity relatively smaller than in the preceding type (see Fig. 8) ; the rostrum also is short, and the roof of the skull or tegmen cranii produced into a strong ridge (culmen cranii). The end of the snout divides into two short processes (hypo-trabeculars, H.Tr), on each of which two labial cartilages are borne (l^1, l^2).

The bones developed in the chondro-cranium of the salmon very rarely come together so as to form sutures, but are usually separated by considerable tracts of cartilage or synchondroses. Ankylosis only takes place in the case of a single pair of bones—the orbito-sphenoids—which are fused together in the mid-line, so as to form a structure not unlike the "girdle-bone" of the frog.

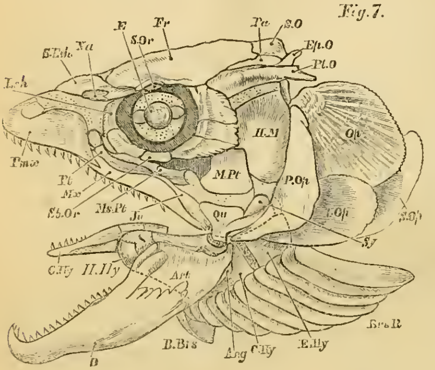


FIG. 7.—Skull of Salmon. Pa, parietal ; Fr, frontal ; Na, nasal ; S.Eth, supra-ethmoidal ; S.Or, supra-orbital ; Sb Or, sub-orbitals ; Lch, lachrymal ; Pmx, pre-maxilla ; Mx, maxilla ; Ju, jugal ; D, dentary ; Ang, angular ; Op, opercular ; S Op, sub-opercular ; I.Op, inter-opercular ; P.Op, pre-opercular ; Brs.R, branchiostegal rays ; B.Brs, basi-branchiostegal ; S.O, supra-occipital ; Ep O, epiotic ; Pt.O, pterotic ; Pl, palatine ; Ms Pt, meso-pterygoid ; Art, articular ; Sy, symplectic ; G Hy, glosso-hyal. The cartilaginous parts are dotted.

The hinder or occipital region of the skull is ossified by four bones, which surround the foramen magnum, and together form the "occipital segment ;" these are the basi-occipital (Figs. 8 and 9, B.O) below, the exoccipitals (E.O) at the sides, and the supra-occipitals (S.O) above. The first of these bears a concave surface or condyle (O.C) for articulation with the first vertebra, the space between the two being filled up with the remains of the notochord. The auditory capsules are strengthened by no less than five bones : the prootic (Pr.O) formed in the anterior part of the capsule ; the opisthotic (Op.O) over the ampulla, and the epiotic (Ep.O) over the arch of the posterior semicircular canal ; the pterotic (Pt.O) over the arch and ampulla of the horizontal, and the sphenotic (Sp.O) over the ampulla of the anterior canal. The prootics of opposite sides meet in the mid-line (Fig. 8), and form a bridge of bone on the base of the skull, in front of the basi-occipital. Anterior to this "prootic bridge," and completing the basis cranii, is a small bone, Y shaped in section, the basi-sphenoid (B.S), which, curiously enough, has no cartilaginous predecessor, but is ossified directly from membrane. Above this bone, and in front of the sphenotic, the ali-sphenoids (As) are found in the side-walls of the brain-case, and, together with the basi-sphenoid below and the parietals above, form the "parietal segment" of the skull. The "frontal segment" has no basal element, the pre-sphenoid being absent, but its side-pieces are represented by the coalesced orbito-sphenoids (O.S) The only remaining bone in the skull proper is the large lateral ethmoid (L.Eth), which occurs immediately behind the depression for the nasal sac (Na).

Certain very constant relations exist between these bones and the cranial nerves. The trigeminal (V.), for instance, always determines the prootic, as its third division makes its exit just in front of that bone, or, in other

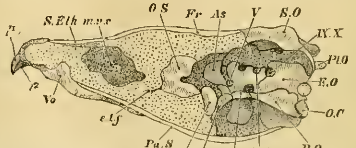


FIG. 8.—Longitudinal section of Salmon's Skull. Pa.S, para-sphenoid ; Vo. vomer ; B.O, basi-occipital ; E.O, exoccipital ; Pr.O, prootic ; B.S, basi-sphenoid ; As, ali-sphenoid ; O.S, orbito-sphenoid ; O.C, occipital condyle ; l^1, l^2, labial cartilages ; m.n.c, middle nasal cavity ; e.t.f, ethmo-trabecular fissure.

words, between the anterior boundary of the auditory capsule and the parietal segment. The glosso-pharyngeal and vagus (IX. and X.) in like manner limit the posterior boundary of the ear capsule, passing out either between it and the exoccipital, or through the front part of the latter. The optic nerve (II.) passes between the parietal and frontal segments, usually being bounded in front by the orbito-sphenoid, and behind by the orbito-sphenoid. In the salmon a bar of bone grows across the trigeminal notch of the prootic, so that part of the nerve passes through a complete foramen.

An interesting instance of the retention of embryonic characters is seen in the slit marked e.t.f in the sectional view, Fig. 8. This is a fissure in the otherwise solid cartilage running forwards for a short distance from the lower anterior angle of the orbito-sphenoid, and indicating

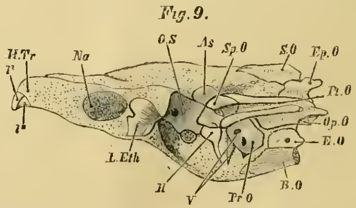


FIG. 9 —Skull of Salmon, with investing bones and facial arches removed. Op.O, opisthotic ; Sp.O, sphenotic ; L.Eth, lateral ethmoid ; H Tr, hypo-trabecular.

the line of separation between the trabecular portion of the skull and the part produced by the chondrification of its originally membranous walls ; this structure is called the ethmo-trabecular fissure. In front of and above this fissure is a large cavity (m.n.c) filled with fat, and opening on the surface of the chondro-cranium beneath the supra-ethmoidal bone ; there is no doubt that this seemingly useless space represents the single nasal chamber of the lamprey or hag.

The structure of the facial arches, and the chief points in the development of the salmon's skull, will be considered in the next paper.

(*To be continued.*)

THE COMING TRANSIT OF VENUS*

III.

IN the previous articles various methods have been indicated by means of which we may discover the scale upon which the plan of the solar system is drawn. The last article concluded by illustrating the nature of the methods of employing a transit of Venus, as proposed by Halley. It will be noticed that this method can be utilised in the way there indicated only when Venus passes nearly across the diameter of the sun. Halley, in fact, founding his calculations upon erroneous data, was led to conclude that this would be the case in 1761. In this he erred, and another slight but important mistake having been made in his calculations, it followed that at Hudson's Bay, his northern station, the transit was invisible.

The present article will be devoted to a description of the methods to be employed in the coming transit for determining the solar parallax. In subsequent articles the

FIG. 11.

preparations which have actually been made for observing the transit of 1874 will be described; and the difficulties encountered in this kind of observation enumerated.

Let the reader now examine Fig. 11 and pay particular attention to the description of it, and he will thus be enabled better to understand what follows. The earth, Venus, and the sun are here represented in their relative positions; and lines are drawn to show the directions in which two observers at opposite sides of the earth will see Venus upon the solar disc. It follows from this that an observer on the southern portion of the earth will see Venus trace a path D E F upon the sun's disc farther north than the path A B C which a northern observer on the earth sees it trace. Now Venus will be three times as far from the sun as from the earth on that date. From this it follows that the distance between the two lines A B C and D E F will be three times as great as the distance N S. But the distance N S upon the earth can be

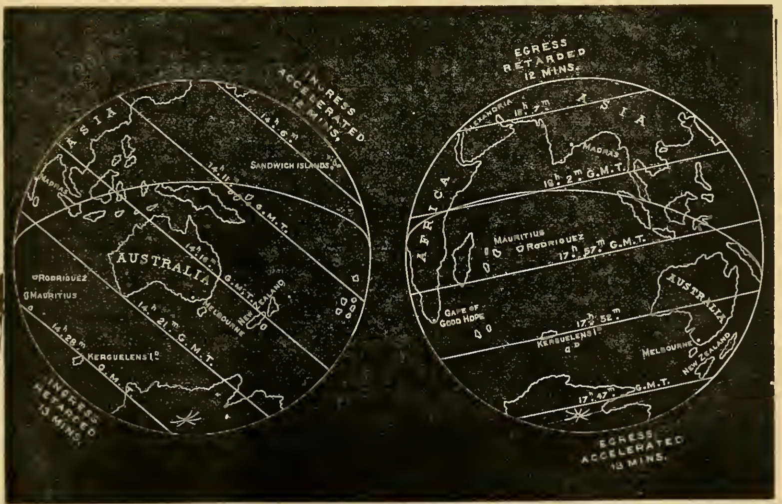


FIG. 12.

easily found out. Suppose it to be 6,000 miles. In that case the distance between A B C and D E F is known to be 18,000 miles. But it needs no demonstration to convince us that if we have a distance of 18,000 miles measured out for us upon the sun's surface we can determine the distance of the sun from the earth.

Now the apparent distance between the two lines A B C and D E F is the least observed distances between Venus' centre and the sun's during the transit. *If then, we can measure accurately the least distance between the centres of Venus and the sun, at two stations suitably chosen, we can determine the sun's distance.*

There are three methods by means of which this may

* Continued from vol. ix. p. 489

be effected; the photographic method, the heliometric method, and the method of durations. We shall consider these in order.

I. *The Photographic Method.*—It is easy to see that by continuing during the transit to take photographs of the sun, in which Venus will be represented as a black spot, these photographs may be so combined as to indicate definitely the apparent path of Venus as seen at these two stations. This method is looked forward to with much interest, because it is the first time that photography has been extensively employed in delicate astronomical measurements. It is not generally known how extremely accurate a means of observation photography is. We owe much to Mr. De la Rue, whose success in the application of photography to astronomy has been unequalled, for having given us a most clear account of what has been done in this way.* The method has been employed in America to measure the distances between double stars. The double star is photographed and the distance is afterwards measured as accurately as possible. Prof. Bond finds that the probable error of such a measurement is 0″·072 or $\frac{1}{3}$ of the probable error of a similar measure made with a filar micrometer as estimated by Struve. Photographic pictures of the sun were for many years daily taken at Kew, and it was found that an extremely accurate measure of the sun's diameter could thus be made. If the lens of a common telescope were used to produce an image of the sun upon the sensitive plate the picture would be too small for accurate measurement. Hence a special instrument called a photoheliograph must be devised to give an enlarged picture upon the sensitive plate. Two perfectly distinct kinds of instruments are to be used for this purpose, the one English, the other American. Mr. Dallmeyer has, under the superintendence of Mr. De la Rue, constructed photoheliographs for the English and Russian expeditions. In these instruments the image of the sun produced in the focus of an ordinary telescope is enlarged by a special arrangement so as to give a picture of the sun about four inches in diameter. This instrument, based upon the principle of the Kew photoheliograph, is very perfect in its results and convenient in actual practice. It is mounted equatorially so as to follow the motion of the sun. The sensitive plate, which is prepared in an adjoining room, can be readily inserted and exposed. The intensity of direct solar light is so great that special means are necessary to give a short enough exposure. Before a photograph is taken a sliding shutter in the interior of the instrument cuts off all light from the sensitive plate. This shutter is held in its place by a cotton thread. So soon as this thread is cut, a strong spring draws down the shutter, in which is a slit about $\frac{1}{40}$th of an inch wide. The time taken by this slit to pass over any part of the sun's image is the whole interval required for an exposure.

The other method of obtaining a large picture of the sun is by employing a lens of great focal length. This method was originally proposed by Mr. Rutherford, of New York, and will be employed by the Americans, and also by Lord Lindsay in his observations at the Mauritius. The focal length of the lens is forty feet. But a telescope of such dimensions could not be conveniently mounted in the ordinary way. To overcome this, a siderostat similar to the one originally constructed by M. Foucault for the Observatory of Paris is employed. This instrument consists of a plane mirror so mounted as to send the sun's rays always in the same horizontal direction. In the path of these rays, and close to the siderostat the lens is placed, and at a distance of forty feet an image of the sun about four inches in diameter is produced. At this place a window is arranged in the photographer's hut, and by means of this arrangement the photographer need never leave his dark room. After preparing a plate he places it in position at the window; when exposure has been made he may remove the plate and develop it.

* Address to the Mathematical and Physical Section of the British Association, Brighton, 1872.

Considerable advantage is likely to accrue to the employment of dry plates, which will diminish the labour of the photographer. Researches upon this matter have been undertaken by Prof. Vögel, in Holstein, Col. Smysloff, at Wilna, and by Capt. Abney, at Chatham. The employment of a dry process prevents all danger from the shrinking of the collodion-film. Herr Paschen * and Mr. De la Rue have made experiments upon this point. The latter gentleman finds that all shrinkages take place in the thickness of the film, so that the measurements would not be affected by it But the more convenient dry plate process is undoubtedly safer. Judging from the data furnished by Mr. De la Rue, this photographic method will give results of the utmost value.

II. *The Heliometric Method.*—The exact measurement of the distances of the edges of Venus from opposite edges of the sun would enable us easily to determine what is required, viz., the least distance between the centres of the sun and planet. But the ordinary astronomical means are useless in measurements of this magnitude. To obviate this, a special instrument, called a heliometer, will be employed by the Germans and Russians, and by Lord Lindsay. This instrument was originally invented for measuring the diameter of the sun. The object-glass of a common telescope is divided so as to form two semicircles. A screw adjustment allows us to slip one-half of the lens past the other one along their line of junction; a fine scale measures this displacement. When the two halves of this object glass are relatively displaced, two images of the sun are seen overlapping. The distance between the two images is proportional to the relative displ cement of the two halves of the object-glass. This instrument has been brought to a state of great perfection by Mr. Repshold, of Hamburg. It is a very troublesome instrument to manipulate, and the corrections due to the influence of temperature are extremely difficult to apply. Yet with great care there is little doubt that very accurate measurements can be made. The nature of the measurements required to obtain the distance between the centres of Venus and the sun will readily be understood. The method has been most ably discussed by Lord Lindsay and Mr. Gill in the Monthly Notices of the R.A.S., November 1872. At the same time it is difficult to conceive that this direct method will give results of equal value with the methods hereafter described. In fact, an opposition of Mars would be expected to give equally good results; for the distance of Mars from a fixed star can be more accurately observed with a micrometer than the distance between the centres of Venus and the sun; and a larger number of observations could be made.

III. *The Method of Duration.*—The third method of determining the least distance between the centres of the sun and Venus is less direct than either of the preceding methods; but it has stood the test of a previous trial, and we cannot say but that it will be more satisfactory than the other methods in the coming transit. The method of duration closely resembles the method originally proposed by Halley. The duration of the transit, as viewed from two distinct stations, is accurately determined. But the difference in this duration is affected by choosing stations upon a different system. Nevertheless this method is frequently called Halley's method. His method consisted in choosing two stations, so that during the transit the one should be moving eastward and the other westward. It is further essential for success that Venus should pass nearly along the diameter of the sun. In the method employed last century, the two stations were chosen—the one far north, and the other far south. On referring to Fig. 11 it will be seen that in each case Venus appears to pass along a chord of the sun. But in

* *Astronomische Nachrichten*, 1872, lxxix. 161.

the one case this chord is farther from the sun's centre, and consequently shorter than the other. The duration of the transit, so far as this effect is concerned, is directly proportional to the length of the chord traced out by Venus. Thus from observation we obtain the lengths of these chords; and by geometry we can deduce the least distance between the centres of the sun and Venus at each of the two stations, and hence we can determine the sun's parallax. Fig. 12 illustrates this point very clearly. The duration is determined by two distinct observations made at each station, the internal contact at ingress and the internal contact at egress. The time of an internal contact is the time at which Venus appears to be just wholly within the sun's disc. These two times must be accurately determined; they will be separated by an interval of nearly four hours. Fig. 12 represents the illuminated hemispheres of the globe at the time of ingress and at the time of egress respectively in 1874. At either of these epochs the sun will be visible from every place marked on the corresponding map. The sun will be vertical at the place occupying the centre of the map; at all stations near the edges of the map the sun will at that time be near the horizon. The point from which the phenomenon will be first observed is there indicated, and likewise the point at which it is last seen. Straight lines are drawn across each map, and the hours marked upon them indicate the time at which the phenomenon will be seen.

Fig. 13, taken from Lockyer's "Popular Astronomy," shows the same facts for the transit of 1882.

Take now the case of two particular stations. At some point on the east coast of China the ingress is accelerated by 6 minutes, but at the same point the egress is retarded 7 minutes; consequently the duration of the transit is lengthened 13 minutes. Again, at Kerguelen's Island the ingress is retarded 10 minutes, while the egress is accelerated 5 minutes. Here then the duration of the transit is shortened 15 minutes. The difference in duration as observed from these two stations will therefore be about 28 minutes. These maps have no pretension to great accuracy. They are calculated upon a certain assumption as to the value of the solar parallax which is probably not far from the truth.

In 1761 considerable preparations were made for observing the transit of Venus in this manner. The English were represented by Messrs. Mason and Dixon at the

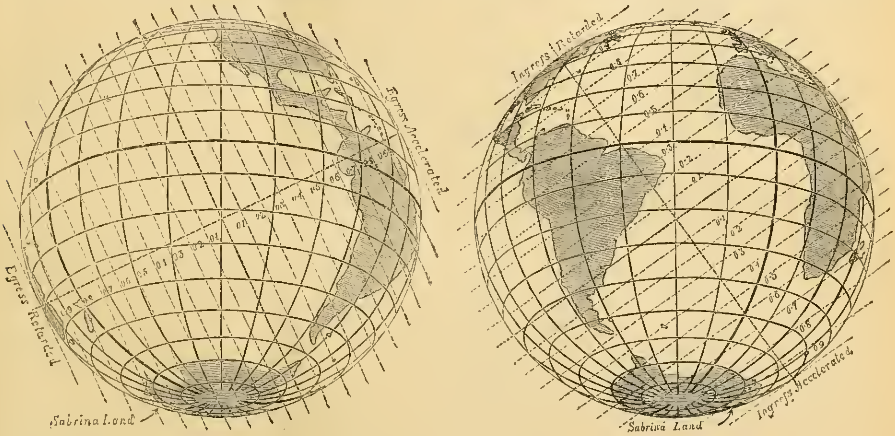


FIG. 13.

Cape of Good Hope, and the French by the celebrated Pingré at the island of Rodriguez. A host of observers watched the phenomenon from northern regions. Unfortunately at scarcely a single station was the transit seen completely. Hence the method of durations was inapplicable, and another, originally proposed by De l'Isle,* came into use. This takes advantage of the fact that the ingress will take place later when seen from some parts of the earth than from other parts, as explained above; so with the egress of the planet from the sun's disc. Hence, if the absolute time of contact of Venus with the sun's edge at ingress or at egress be observed at two places suitably chosen, the difference in time will be a measure of Venus's parallax.

The method of De l'Isle will perhaps be better understood by looking upon the orbit of Venus as a vast protractor for measuring small angles. Venus passes relatively to the earth round the sun, that is through 360° in 584 days. From this it follows that she passes over $1''\cdot 5$ in one minute of time. Now conceive two straight lines to be drawn from the sun's edge, the one to the Sandwich Islands, where the ingress is most accelerated, and the other to Kerguelen's Island, where it is most retarded. Venus passes across these two lines like the radial arm of a protractor. The observed difference in the time of observing the phenomenon at these two stations will be about 21 minutes. Of this about 11 minutes is due to the fact that the Sandwich Islands are north of Kerguelen's Island, as before explained; the remaining 10 minutes or so will be a measure of the angle between the two lines drawn from the sun's edge to the two stations. Since Venus passes over $1''\cdot 5$ in 1 minute, 10 minutes gives us $15''$ for the effect of parallax looked at in this light.

It is a comparatively easy matter to set one's clock accurately to local time by astronomical observations. But it is a matter of considerable difficulty for an observer in Kerguelen's Island to set his clock accurately to the local time of the Sandwich Islands, or *vice versâ*. Consequently there will be some difficulty in determining the absolute difference of time of contact as observed at these two stations. The difficulty simply consists in determining the longitude accurately. This is a matter involving a long series of astronomical observations even now; still

* Histoire de l'Acad. des Sciences, p. 112.

more so in 1761. Such observations were then wanting. Hence the application of this method was not successful, and results of that transit were unsatisfactory.

Not daunted by the comparative failure of that attempt, the astronomers of last century made vigorous efforts to make the transit of 1761 successful. The transit of 1761 was utilised in so far as it pointed out the difficulties in this kind of observation and gave them an approximate value of the sun's parallax to help them in choosing the most advantageous stations from which to observe the next transit.

Halley had no conception, when he proposed this kind of observation, of the difficulties attending it. The difficulty chiefly consists in determining accurately the exact instant when the contact seems to take place. The values which have been deduced from the observations of last century, and especially of the year 1761, have varied considerably according to the mode of reducing the observations. Thus in 1761 Lalande * found, from the observations of Pingré, 9″·4 for the solar parallax, while Maskelyne found from the work of Mason and Dixon 8″·6; Short † made it 8″·65; Wargentin, 8″·1 to 8″·3. Encke ‡ showed that the differences were partly due to an error in the longitude of Rodriguez. This question will be capable of further discussion after this year, as Rodriguez is one of the stations chosen by the English from which to observe the coming transit.

Since the observers are likely to differ considerably in the manner in which they observe the contact, and since it is difficult for us to be sure that all observers have really actually noted the same phenomenon, photography is once more brought to our aid. Some time ago M. Janssen proposed a method for determining by the aid of photography the exact instant of contact. The value of his method was immediately recognised, and steps have been taken to utilise it. The method consists essentially in exposing different parts of a prepared photographic plate in succession to the sun's light, so as to photograph that portion of the sun's limb at which the planet is visible. By the aid of no very complicated mechanism a circular plate is so arranged that sixty different portions of its surface near the circumference are successively brought into position, and exposed to the action of the sun's rays. The plate completes a revolution once in a minute, so that sixty photographs are taken at intervals of one second. A person who is observing with a telescope can easily give a signal to commence these photographic operations at the proper time. Thus one of the photographs will be sure to give us an indication of the time of true contact. Furthermore each one of the photographs taken at one station can be compared with a corresponding one taken at another station, so as to give us a means of deducing the sun's parallax. The advantages of this method are enormous. The uncertainty which exists with respect to eye observations is in a great measure due to fluctuations arising from tremors in the instruments, and variations in the density of the intervening air. In the photographic method, means have been taken to avoid these tremors as far as possible; and the instantaneous manner in which the photographs are taken will reduce these uncertainties to a minimum.

Various suggestions have been made as to the possibility of observing the exact time of the external contact by using a spectroscope in a beautiful manner originally executed by Mr. Lockyer and M. Janssen for observing the solar protuberances. Father Secchi has, in a very able memoir, pointed out a way by means of which this can be done; M. Zöllner has likewise pointed out the advantages of this method.

The observation of external contact is doubtless very useful as supplementary to the internal contact. The chief difficulty consists in the uncertainty of fixing the telescope in the proper position, so as catch the exact point of the sun's limb. This difficulty would certainly be to a large extent obviated by the employment of the ingenious adjustible ring-slit devised by Mr. Lockyer. This device has, we believe, been fully tested, with satisfactory results. It is much to be regretted that more observations to test its utility have not been made; as on this account it is not likely to be employed in the coming transit.

We have now completed the geometrical examination of the nature of the observations on the transit of Venus, by means of which the sun's parallax will be deduced. The complete examination of the question, including analytical methods, cannot be here dwelt upon. Anyone who is interested in this should consult the valuable work "Les passages de Vénus sur le disque Solaire," by M. Edmond du Bois, lately published, in which the theoretical part of the question is very fully investigated.

RECAPITULATION.—Before leaving the technical view of the matter it will be well to recapitulate what has hitherto been stated.

1. We know the *relative dimensions* of the solar system accurately; but we do not know the *scale*.

2. The determination of the distance of the earth from the sun or from any of the planets, at a fixed date, fixes the scale.

3. This may be determined (1) by the aid of a transit of Venus; (2) by an opposition of Mars; (3) by a knowledge of the velocity of light combined with observations of eclipses of Jupiter's satellites; (4) by the velocity of light and the constant of aberration; (5) by the calculated effects of the sun's disturbance upon the lunar motions.

4. A transit of Venus may be utilised:—

   (α) By the determination of times of contact at different stations, combined with a knowledge of the longitudes of these stations.

   (β) By determining the least distance between the centres of the sun and Venus during the transit, observed from different stations.

5. This last determination may be made by either of these methods:—

   (1) The Photographic Method.
   (2) The Heliometric Method.
   (3) The Method of Durations.

GEORGE FORBES

* Phil. Trans., vol. lii., p. 647.
† *Ibid.*, p. 648.
‡ Zach. Corresp. ii., 1810, p. 367

NOTES

THE Board of Trinity College, Dublin, have appointed R. Ball, LL.D., F.R.S., to be Royal Astronomer of Ireland, on the foundation of Dr. Andrews. The announcement of this appointment will be received with every satisfaction, as Dr. Ball has already, while acting as assistant to Lord Rosse, distinguished himself as a practical observer. We feel sure he will not forget to profit, or omit to allow astronomical science to profit too, by the excellently appointed observatory at his command. This vacates the chair of Applied Mathematics in the Royal College of Science, Dublin.

AT a meeting of the donors of the Yorkshire College of Science (see NATURE, vol. ix. p. 157) held at Leeds last Thursday, the constitution of the College was agreed upon, and a board of governors elected. The sum required to establish a College of Science in any way worthy of Yorkshire would be 60,000*l.*, of which only about 25,000*l.* has as yet been collected. With this sum, however, we are glad to see that it has been resolved to make a start, and we have no doubt that when the practical benefits of the institution become evident there will be little difficulty from lack of funds. We trust with Lord F. Cavendish that, ere long, the institution just organised will occupy in Yorkshire a position similar to that occupied by Owens College in Lancashire. Several speakers referred to the fact that in the

practical applications of Science Britain is being distanced by Germany and other countries, and that the only means by which we can hope to compete with foreign rivals is the spread of scientific education. It is hoped that, before the close of the year, a staff of thoroughly competent professors will be giving their lectures in Leeds.

THE annual general meeting of the Iron and Steel Institute commenced yesterday in the rooms of the Institution of Civil Engineers, under the presidency of Mr. Lowthian Bell, F.R.S.

THE Port Louis *Overland Commercial Gazette* (Mauritius) of April 4 contains the report of a violent cyclone which embraced Mauritius in its sweep on March 27 and 28. Indications of the approaching hurricane were observed on the 22nd in a falling barometer and a gradually rising wind, which increased until it reached its height on the two days mentioned. Its greatest force was 11 (Beaufort scale), and the barometer sank as low as 28·566 at 3.30 P.M. on the 28th. The mischief done to the growing canes was not nearly so great as was anticipated, though in several places considerable damage has been sustained. Shops in many parts of Port Louis were closed, and on the 27th two of the local newspapers did not appear. The town itself presented a very sad appearance after the storm was over, the roofs and *débris* of fallen houses and dependencies, and broken trees innumerable, partially obstructing all but the main streets. The cellars of a great many houses were inundated, and a certain amount of valuable goods has been destroyed. There were very few houses in the upper part of the town but were more or less injured; verandahs, kitchens, stables, gates, palings, and such like light constructions having been blown down by the hundreds. The museum at the Royal College was unroofed, but the curiosities it contained have received no damage. The suburbs of the town were devastated, most of the smaller wooden houses, huts, and camps having disappeared. As was unfortunately to be expected, many lives were lost.

THE Royal Academy of Belgium proposes the following subjects for prizes to be awarded in 1875:—(1) To examine and discuss on the basis of new experiments, the perturbing causes which influence the determination of the electromotive force and the internal resistance of an element of the electric pile: to estimate in numbers these two quantities for some of the principal piles. (2) To show the present state of our knowledge on the relations of heat to the development of phanerogamous plants, particularly in respect to the periodic phenomena of vegetation; and, in this connection, to discuss the value of dynamical influence and of solar heat upon the evolution of plants. (3) To make experiments on the development of the *Tunicata*. (4) To show by new researches the composition and relations of albumenoid substances. (5) To describe the coal system of the basin of Liége. Each prize consists of a gold medal, of the value of 1,000 francs for subjects (4) and (5), and of 600 francs for the first three subjects. The papers may be written in Latin, French, or German, and must be sent to the Secretary of the Academy before August 1, 1875.

ON Saturday last the extensive works for the manufacture of telegraphic cables, belonging to the Messrs. Siemens, at Charlton, were thrown open to a select party of visitors, among whom were Lord Bury, Lord Rosse, Baron de Reuter, Professors Abel, Maxwell, Odling, Tyndall, and Williamson, Sir Charles Wheatstone, Mr. C. F. Varley, and Messrs. Culley and Preece, of the Engineering Department of the Postal Telegraph Service. These works comprise nearly every branch of telegraphic manufacture, but public interest becomes mainly centred on that part of the operations connected with the manufacture of submarine cables. The *Faraday*—the new ship to be employed in laying the direct United States cable, and the property of Messrs. Siemens— is undoubtedly a novelty in cable ships. It is an iron ship of 5,000 tons register, but equal to carrying a gross burden of nearly 6,500 tons. She is 360 ft. long, 37 ft. deep, and has a breadth of beam of 52 ft. Her capacity for cable storage is immense, consisting of three tanks, two of which are 45 ft. in diameter, the other 37 ft. in diameter, and each 27 ft. deep. Five thousand tons of cable can be thus stowed away, and it is calculated that this will be equal to about 1,500 miles of the cable, which is now being taken on board.

MR. HENRY WILLETT, F.G.S., has published another letter in reference to the Sub-Wealden Exploration. He says:—"We have now run through about 400 ft. of Kimmeridge clay. Nearly every inch contains numerous fossil shells in various stages of growth, each of which has been born, has grown, and died. Our little 2-inch column has contained several thousands. There is no reason to doubt that this bed of clay extends uninterruptedly beneath Brighton, Chichester, Southampton, Sussex, Hampshire, and Dorsetshire, to Kimmeridge on the west, and beneath Hastings and the English Channel to the Boulonnais district in France, and that throughout the whole of this vast area, the same conditions of birth, life, and death have existed."

A TELEGRAM from Aden to Vienna announces the death of Richard Brenner, the celebrated African traveller, which took place at Zanzibar on March 22.

IN a pamphlet on "Agricultural Schools and Experimental Farms" (Blackwood), Mr. David Milne Home points out very forcibly how immensely far behind all the rest of the world is this country, so far as the teaching and practice of scientific agriculture is concerned. For many years, in Germany and Austria, institutions supported by the state have been at work, not only for giving those who intend to follow agriculture as a vocation a thorough education in the scientific principles of that art, but also for scientific education in the principles and materiel of agriculture in all its branches. Other continental countries are following the example of Germany and Austria, and, more recently, numerous institutions of a similar kind, partly aided by Government, have been established on the best models in the United States. The consequence is that Britain is being out-distanced in a department which used to be deemed peculiarly British; and the only means by which she can regain and keep her place as an agricultural country is by getting Government to take the initiative in founding agricultural institutions similar to those of the countries we have named. "Every civilised country except Britain," Mr. Milne Home tells us, "has its Minister of Agriculture, to look after and promote its agricultural interests."

M. GAUTHIER VILLARS will publish very shortly the 10th volume of the "Annals of the Observatory." This is almost exclusively occupied with a paper by M. Leverrier On the Mutual Actions of Jupiter and Saturn; a paper by MM. Wolf and André, On the black drop, has been reprinted from *Memoirs* of the Academy, and annexed to it. Tome XI. contains a paper On a special theory of Jupiter and Saturn, and secular inequalities; it will also be published very shortly. Tome XII. is nearly all printed; it contains the tables of Jupiter, reduced from M. Leverrier's theory. All the numerical results were obtained at the Bureau de Calculs of the Observatory. The positions of Jupiter were taken from these for 1878 and 1879, and sent to Mr. Hind for publication in the *Nautical Almanac*. It will contain also a paper by M. Rayet, On Magnetical Observations, which have been taken at the Observatory during these last two centuries.

THE *Times* New South Wales Correspondent writes that an explanation of the fate of the lost Australian explorer Leichhardt

has been offered, which, however, is considered very unsatisfactory. The Leichhardt expedition set out in 1844 and never returned. Andrew Hume, who was despatched by the Sydney Government in 1872, to recover some relics of the expedition has returned, and reports that he found Classen, Leichhardt's second in command, living with the blacks at the head of the waters of Stewart's Creek; Classen, Hume says, is detained by the blacks as a sort of wonder-man. Classen, according to Hume, states that Leichhardt's party mutinied at the head of Victoria River, and that after the struggle with their leader they left him when pushing on to the north-west coast. During this affair Classen was always seeking for water. When he returned, he says that Leichhardt was insensible, and died five days after the mutiny. The camp had been broken up and the horses taken away by the men. Hume says that he possessed himself of Leichhardt's quadrant and watch, and about seventy-five pages of the traveller's records. He also affirms that he saw the remains of the dead man concealed in a tree. The mutineers, he reports, were all killed at Ayer's Creek. Hume, it seems, has not shown to any one the relics he says he has recovered, and his story, as we have said, is generally discredited. Leichhardt's last letter is dated "Darling Downs, February 22, 1848."

In a report on the trade of Tamsay, China, we are told that the Camphor trees (*Cinnamomum camphora* F. Nees et Eberm.) are not found within the district marked on maps of Formosa as Chinese territory. They occur only within the country of the aborigines, or upon the immediate border. The manufacture of camphor necessitates the destruction of the trees, which are never replanted; as the country becomes denuded the aborigines recede, and the Chinese effect a corresponding encroachment. As a consequence, the border country is in a continuous state of disturbance, and fearful outrages are committed by both sides on every opportunity.

A petition signed by twenty-six Professors in the Universities of Scotland has been presented to the Prime Minister, calling his attention to the treatment of the ladies admitted to matriculate as students of medicine in the University of Edinburgh, and afterwards refused the right to graduate, and urging the Government to take the whole subject of the University education of women into consideration, with the view of devising a remedy for the present anomalies.

The General Local Committee which has been formed in Belfast for the purpose of making arrangements for the ensuing meeting of the British Association is already busy at work, and 3,000*l.* is being raised for the purpose of giving a proper reception to the Association: of this amount upwards of 1,600*l.* has already been collected. It has been arranged to prepare a list of lodgings for members who might not be otherwise accommodated, and other details are being attended to with regard to excursions, &c. The business meetings of the Association will be held in the Queen's College.

Mr. J. H. Lewis of Liverpool proposes to issue twenty sets of British Rubi, if names of subscribers are to hand by June 1. Each set will contain examples of twenty forms. Each example will show two flowering shoots—in flower and in fruit—and two pieces of barren shoot—young and old. In gathering, avoidance will be given to hedgerow-clipped plants, and preference shown, in this fasciculus, to those that exhibit characters corresponding to Prof. Babington's species and varieties, as described in "British Rubi," 1869. Printed tickets will be given containing remarks on most of the forms by Prof. Babington, Rev. A. Bloxam, Mr. Baker, and Hon. J. L. Warren. If encouragement be given to this fasciculus, others will be issued having more regard to intermediate and dubious forms. The price will be 1*l.* per set.

Dr. J. E. Gray has expressed his opinion that so far as he can judge from the description and drawing of the whale taken off Otago Head, New Zealand, in October last, it is a specimen of *Neobalæna*, of which only the skull has been known before. He established the genus *Neobalæna* from drawings of a skull in the museum at Wellington, which had been found at the island of Kawan, and in the An. and Mag. of Nat. Hist., vol vi. p. 156, he wrote, "the difference in skull makes us anxious to have a description of the entire animal and its skeleton, as the animal may prove to be the type of a new family of whales between the true whales and finners." This capture affords an opportunity for the first time of examining an entire skeleton, and a description is promised by Dr. Gray. The measurements taken by Prof. F. W. Hutton, of the Otago Museum, Dunedin, gave the length 16 ft. 2½ in., girth at pectoral 10 ft., pectoral flipper 2 ft. 7 in. long, caudal flipper 1 ft. 6 in. Weight 27 cwt.

The recently issued number of the *Bulletin* of the Geological Society of France contains an abstract of a paper On a Comparison of the Inferior Eocene of the Basins of Paris, Belgium, and England. The paper will appear in full in the fourth volume of the *Annales des Sciences Géologiques*. The correlation adopted is as follows:—

Paris Basin.	Belgium.	England.
Sables à nummulites planulata	Panisélien	Lower Bagshot sands
Sables sans fossiles	Yprésien supérieur	
Gap	Argile d'Ypres	London clay
Gap	(?)	Oldhaven beds
Argile plastique	Landénien supérieur	Woolwich beds
Sables de Bracheux	Landénien inférieur	Thanet sands

In the same bulletin M. Pouech describes an incomplete humerus, a fragmentary maxilla, and a molar belonging to *Elephas primigenius*, found by him in the ravine of Vicaria, near Pamiers. He believes it to have been contemporaneous with the Troglodytes of Vezère, d'Aurignac, and Clermont. There is also a description by M. Gaudry of the anterior part of the head of *Anthracotherium* found at St. Menoux. A full-size drawing is given showing the teeth of the upper and lower jaws interlocking.

M. de Billy, who had been appointed president of the French Alpine Club, has been killed by a railway accident, even before his nomination was notified to him. M. Cezane, an engineer of the Ponts et Chaussès, and one of the most promising members of the National Assembly, has been appointed to fill the vacancy created by the unexpected demise of the learned gentleman. M. Cezane is one of the members for the department of Hautes-Alpes; he has written an admirable work on the "Degradation of Mountains by Waterfalls."

M. A. Fouqué will deliver, at the College de France, a series of lectures on the volcanic emanations of Etna, Santorin, and Açores, where he has been sent by the French Academy to report upon these most interesting phenomena.

The French Association for the Advancement of Science has voted to M. W. de Fonvielle a sum in order to encourage him to recommence his course of systematic balloon ascents. M. de Fonvielle intends to study the differential direction which it is possible to give to an aërostat in varying the altitude for taking advantage of several directions of winds. It is not known yet whether he will practise his method for travelling in Europe or in America.

The eighth number of Mr. Hermann Strecker's work on the Lepidoptera has just been published by him at Reading, Pennsylvania, and upon a closely filled plate are to be found illustrations of eight species of butterflies, one of them but recently described as new by Mr. Strecker.

The annual report of the Academy of Sciences of Philadelphia announces the final completion of the labour upon which Mr.

Tryon and his associates have been engaged for several years past, namely, the arranging, labelling, and mounting of a very extensive collection of shells belonging to the Academy. The total number by actual count is 14,161 species, in something less than 100,000 specimens. The collection is stated to be one of the finest extant.

THE Cambridge Natural Science Club held six meetings during the past Lent term; there are now fourteen members Undergraduates and Bachelors, nearly all of whom were in residence and attended regularly, often bringing friends as visitors. The following were the subjects discussed:—Climbing Plants, introduced by Mr. Stone, St. Peters; the Functions of the Cerebral Hemispheres, introduced by Mr. Bridge, Trinity; Precious Stones, a paper by Mr. Alfred Buxton, Trinity; Zoological Colonies, a paper by Mr. A. J. Jukes Brown, St. John's; Metamorphosis, a paper by Mr. A. M. Marshall, St. John's; Allotropism, a paper by Mr. C. P. Clough, St. John's. The meetings commence again on Saturday the 25th inst., and will be continued during the present term, and through the Long Vacation, should a sufficient number of members be in residence.

AT the last monthly meeting of the Manchester Geological Society, Mr. Plant exhibited a large collection of remains of *Bos priscus* and *Rangifer*, obtained from Castleton, Derbyshire. The largest bones were portions of the skull, with the horn-cones attached, femora, and vertebræ, all much incrusted.

THE additions to the Zoological Society's Gardens during the last week include a Common Crowned Pigeon (*Goura coronata*), hatched in the Gardens; a Prince Alfred's Deer (*Cervus alfredi*) and a Vulpine Phalanger (*Phalangista vulpina*), born in the Gardens; and a Great Kangaroo (*Macropus giganteus*) from Australia, deposited.

THE METEOROLOGICAL CONGRESS AT VIENNA *

THE Meteorological Congress, which held its meetings in Vienna from the 2nd to the 16th of September last, had its origin in a wide-spread conviction that since meteorology can be prosecuted with success only when it is treated internationally, uniformity of procedure among different nations is indispensable; and it was to bring about this uniformity that the Congress was convened. A preliminary Conference was held at Leipsig in August 1872, for the purpose of preparing the programme for the Congress. The Austrian Government issued invitations to other Governments to send delegates to the Congress. To these invitations every European country, except France, responded, and the United States and China were also represented.

The questions which were discussed, and the names of the delegates, have already appeared in NATURE.† The following is the deliverance of the Congress on these questions:—

1. A decision regarding the best mercurial barometer for stations of the second order was postponed to a future Congress. Aneroids should not be employed at stations where there is no other barometer, but they may be used as interpolation instruments alongside the barometer.

2. It was considered impossible to lay down fixed rules for general adoption in the protection of thermometers, on the ground that regard must be had to local conditions, and that the mode of exposure which is most to be recommended, in a space which is open and accessible to all winds, and at a height of 4½ to 6 ft., cannot be used everywhere.

3. Casella's minimum, and Hermann and Pfister's metallic thermometer, since they are found to become frequently deranged, cannot be recommended for stations at which they cannot be kept in proper order and their errors ascertained. For minimum thermometers, amyl-alcohol is to be preferred to ordinary alcohol, as being less liable to distillation. It is recommended that maximum and minimum thermometers be read at the last observation of the evening, and entered on the day on which they are taken.

4. Reference having been made to the experiments on radiation by Symons, Stow, and Soret, further experiments were recommended to be undertaken by physicists, so that the subject might be brought into the sphere of the regular observations.

5. Lamont's method of observing earth temperatures, which consists of a wooden tube, to the bottom of which the thermometer is let down, and up which it is drawn in order to be read, was recommended as giving more trustworthy results than thermometers with long tubes fixed in the ground. New experiments should be made in different countries, in order to decide the question at what depths observations should be taken.

6. The use of the wet- and dry-bulb hygrometer is in the meantime recommended, and the attention of physicists is drawn to the invention of some new apparatus by which the humidity of the air may be more accurately determined. Hair hygrometers can only be used with safety where care is taken to have their indications compared with those of the wet- and dry-bulb hygrometer, so as to determine their corrections, especially near the point of saturation, where the readings are often too low.

7. It was agreed to introduce the English designations of the directions of the wind:—N. = North, E. = East, S. = South, and W. = West, and to give only sixteen directions of the wind; and in the case of intermediate directions being observed, it is proposed to count them alternately to the one or the other. Lambert's formula is not to be recommended in deducing the mean direction of the wind; but, on the other hand, the frequency and mean force of the winds which correspond to the different directions should be given in numbers. In the distribution in the windrose, those winds whose velocity is less than ½ metre per second, or 2½ English miles per hour, are not to be regarded, but counted as calms. The direction of the cloud-drift should be observed and noted.

8. No general scale for the estimation of wind-force is yet recommended, but it is desirable that a gradual advance be made towards giving the velocity of the wind in metres per second.

9. Wild's apparatus for measuring the force of the wind, already in use in Switzerland, Baden, and Russia, was recommended for introduction at stations of the second order. The velocity of the wind obtained by anemometers should be expressed in metres per second, and tables should be prepared for the mutual conversion of metres per second, kilometres per hour, and English miles per hour.

10. The best form for the receiver of the rain-gauge is a circular one with the area of one-tenth of a square metre, that is, having a diameter of about 14 in. The receiver of the rain-gauge should be placed at a height of not less than 1, and better, of 1½ metres above the ground, or at a height of from 3 to 4½ ft. In the published results the height above the ground should be stated. Where it can be done, the measurement of the rainfall should be at the end of the fall; in other cases the first observing hour of the day is recommended, in which case the amount is to be put down to the previous day. It is recommended that the duration of the fall be stated in hours.

11. It was agreed to introduce symbols for the character of the precipitation in the "Remarks" column, and to give in the monthly *résumé* the sum of the days of rain and snow separately; to have two columns, one for the quantity fallen, and one for the depth of the unmelted snow; and to give, in the yearly *résumé*, the maximum fall in twenty-four hours for each month. It was further recommended to state the number of days when the fall is less than 0·04 in. and 0·01 in.

12. Hail is defined to be as a precipitation of frozen water, in which the stones attain such a size that they may be expected to do damage to agricultural products.

13. (*a*) In order to obtain data regarding thunderstorms which admit better of comparison, it is recommended only to count the days of thunderstorms, but this is not intended to prevent individual observers from inserting in the column of "remarks," in addition, the number of the storms, the time of their commencement, their duration, direction of motion, &c.

(*b*) As days of thunderstorm, only those are to be noted on which both lightning and thunder have been observed. If only lightning without thunder has been noticed, the entry for the day should be sheet lightning.

14. As regards evaporation, the evaporating dish should not be less than seven inches in diameter, and it is indispensable that it be absolutely identical as regards diameter and depth at

* "Report of the Proceedings of the Meteorological Congress at Vienna." Protocols and Appendices. Translated from the Official Report. Published by the authority of the Meteorological Committee. London, 1874.
† NATURE, vol. viii. p. 468.

all stations, if comparability is aimed at. The level of the water in the dish must remain constant, for the obvious reason that the evaporation is less the deeper the surface of the water stands under the edge of the vessel. Provision must be made for reading off the quantity evaporated with accuracy. The measurement of evaporation by means of floating apparatus on large surfaces of water should be introduced wherever possible.

15. (*a*) The degree of cloudiness is to be given by the figures 0—10, in which 0 represents a sky quite free from cloud, and 10 an entirely overcast sky. These figures refer only to the extension and not to the thickness of the cloud, the latter being indicated by accompanying expressions, such as "slight," "great," &c.

(*b*) Arbitrary symbols representing rain, snow, fog, &c., were adopted.

16. It was resolved that the Institution of observations on atmospheric electricity be recommended only for head observatories. As regards ozone, the existing methods of determining its amount in the atmosphere are insufficient, and the Congress therefore recommended investigations for the discovery of better methods.

17. It was agreed that for observations as well as for publications, the use of the same units of measure is desirable; that among all existing systems of measure the metric has the best prospect of universal adoption; that it is most desirable, if it be not possible to introduce uniform measures at present, to use henceforth only metric and English measures (with Celsius and Fahrenheit scales), and that all action is to be supported which tends to the introduction of the uniform metric system. It was also agreed that the results of observations, or the means, should be published in the metric scale as well as in the original scales.

18. The hours of observation should be chosen which give a close approximation to the true mean temperature of the day. The following are the suitable combinations:—

h.	h.	h.	h.	h.	h.		h.	h.
6	2	1	8	2	8	with min. temp.	8	8
7	2	1	9	3	9		9	9
7	1	9	10	4	10		10	10
7	2	9						

Observations should be set on foot at a number of normal stations, especially in Turkey, East Indies, Australia, Southern States, and Brazil, in order to ascertain the corrections for the most important meteorological elements, such as temperature, pressure, and humidity.

19. As units of time should be chosen (1) the mean solar day of the place of observation, reckoned from midnight to midnight; (2) the civil year; (3) the civil months everywhere, the calculation of the monthly means being simply arithmetical; and (4) Dove's 5-day means (73 in the year) for a selected number of stations of each country. It is proposed to count the first 12 hours of the day, from 1 to 12, as forenoon; and the following 12 hours, from 1 to 12, as afternoon; thus counting 12 o'clock midnight as the end of the day, and 12 o'clock noon as the close of the forenoon.

20. It is resolved to choose, as the periods for calculation of normal values, intervals of five years to be called *Lustra*, so that the next Lustrum will begin with January 1, 1876; and that as regards the more important data, old observations should be calculated in accordance with this proposal.

21. The existence of a system of weather telegraphy is, for all countries, considered to be a necessity; in addition to the direction and force of the wind, the barometric gradients at the time of observation should also be added. For purposes of storm warnings, the reduction of the barometer readings to mean sea-level for places not above 1,000 feet in height is admissible. For greater heights, the gradients are to be referred to the mean normal heights of the barometer at the stations. The relations of temperature, moisture, rain, cloud, and state of the sea and tides to storms, are recommended for investigation. As regards storm warnings, each director should give his opinion on the probable course of atmospheric disturbances which are expected, or have already commenced, not as prophecies, but as *probabilities*. Only wind-force of 8, and upwards, of Beaufort's scale should be announced.

22. As regards maritime meteorology, it is desirable that each country should, if possible, collect all its meteorological observations at one place, and that the Institute for Maritime Meteorology should be established as near as possible to the sea, and that this institute might best be placed under the general management of the chief institute of the country. The convening of a maritime meteorological conference was declared to be desirable, and the preparation for this conference is entrusted to the permanent committee appointed by the Congress.

23. It is necessary that in every country, at least one but in case of necessity several central institutions should be established for the management, collection, and publication of meteorological observations.

24. The verification of all instruments supplied to meteorological stations, and the inspection of stations yearly, but at least once in the course of every five years, is necessary. With regard to instrumental errors detected on verification, or inspection, corrected results only should be published. It is intended that the Permanent Committee prepare, in conjunction with the other members of Congress, instructions for the institution and discussion of meteorological observations.

25. As regards standard barometers and thermometers, each central office is recommended to adopt a real standard barometer, *i.e.* an instrument which allows of the determination of atmospheric pressure according to its definition in absolute measure, and to prepare a standard thermometer on scientific principles.

26. The publication of observations at stations of the first order should be entirely separated from those of stations of the second order. It is handed over to the Permanent Committee to prepare, in conjunction with members of Congress, a form of publication suited for international purposes.

27. It is desirable to organise, on the model of the Smithsonian Institution at Washington and the Central Bureau at Haarlem, a similar office for the exchange of publications in every country.

28. A Permanent Committee of seven, with the right of increasing their number to nine, was appointed, with Dr. Buys Ballot as president. The duty of this committee is to care for the carrying out of the decision of the Congress, and arrange for convening a future Congress; and it shall place the delegates of the Congress in cognisance with its action and proceedings.

For the extension of meteorological knowledge it was recommended that stations provided with self-registering instruments be established on high mountain-tops; that experiments on the possibility of continuous meteorological observations with captive balloons be instituted; that stations be established in the North Polar regions, and also in the high southern latitudes; on the north coast of Africa; that the organisation of the stations in Turkey be made more complete, especially the Central Observatory at Constantinople, and that the meteorological station at Athens be maintained.

29. The establishment of an International Institution for the Advancement of Meteorology was declared to be really useful and desirable, and it was remitted to the Permanent Committee to prepare a detailed scheme for this purpose for the consideration of a future Meteorological Congress.

(To be continued.)

SCIENTIFIC SERIALS

Poggendorff's Annalen der Physik und Chemie, No. 1, 1874.—In this number M. Holz communicates an account of experiments on bar-magnetism which he made in Prof. Helmholz's laboratory. They had reference to the effect produced on magnetic moment of bars, when these were subjected to the corrosive action of dilute muriatic acid for twenty-four hours. He finds (among other things) that the amount of magnetic moment of a steel bar, with regard to quality, depends on the structure of the iron, and the carburet of iron (*Karboneisen*) united with it; that it increases per unit of weight, through abstraction of magnetised iron, and decreases through abstraction of magnetised carburet of iron; also, that particles of carburet of iron remaining after solution of the iron are magnetisable, and receive permanent magnetism.—M. Lehnebach gives a determination of the emissive power of dark bodies, by the ice-calorimetric method. The principle is briefly this: Suppose a thin glass sphere filled with ice, and placed within a larger sphere, whose temperature is above 0°, and constant; also that the former has an arrangement for showing the amount of ice melted in a given time, and a vacuum can be made within the spheres; then the increase of heat received by the inner globe may be measured calorimetrically. The apparatus is said to prove very serviceable for measuring emissive power.—M. Braun investigates some points connected with elastic vibrations, the amplitudes of which are not infinitely small; and M. Meyer studies the theory of elastic effects.—A method of graphic representation of absorption-spectra is described by M. Vierordt, and the curves are given for

some ten different substances. The curves are very regular and characteristic, and he considers that with those spectra, in which the absorption continuously increases from one end to the other, a measurement of the light intensity at six or eight parts of the spectrum is quite sufficient, in order to construction of the whole absorption curve, and determining the relation of absorption to the wave-length of the light.—Attention is directed to some new physical phenomena: thus M. Kundt has observed a well-marked dichroism in certain substances (such as caoutchouc and gutta-percha) on stretching. Examined with a dichroscopic lens a thin strip gave two images, one dark brown, the other nearly straw-yellow; the ray whose vibrations are in the direction of stretching is the most absorbed.—M. Antolik studies what he calls the "gliding" of electric sparks; a phenomenon which is had, if *e.g.* a spark be made to strike a soot-smeared glass ball. The path-trace left by the spark shows two light parallel lines, and a dark one between; the former are due to thrusting aside of the soot, and, in the dark band, the soot seems compressed, for, on washing the globe, the soot remains there after the rest has gone. The outer edge of the light band shows, in the microscope, a number of dark and light triangles, apparently produced by induction.—M. Obermayer describes phenomena presented by the dispersion of some solutions of aniline colours in water.—M. Edlund rejects, as inadequate, a recent experimental investigation, by Prof. Roiti, of the question: Is the galvanic current an ether current? and M. Reye replies to M. Zöllner on the subject of sun-spots and protuberances.—A Japanese toy-bird is the topic of a note by M. Erdmann. The bird is placed with its back on a board, by means of which it is thrown forward; and after rising 8 ft. or 9 ft. in a parabolic curve, it returns, head foremost, to the thrower.—M. Nordenskjold furnishes some particulars as to the nature of cosmic dust which had been observed to fall, with atmospheric precipitates, in the neighbourhood of Stockholm.—Among the matter selected from other serials we may note an account of M. Wiedemann's researches on the elliptical polarisation of light, and its relation to the surface colours of substances; and remarks on the arrangement of a *dispersiometer*, by M. Mousson.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, April 23.—Note On the minute anatomy of the alimentary canal, by Herbert Watney, M.A., Cantab. Communicated by Dr. Sanderson, F.R.S., Professor of Practical Physiology, University College.

Zoological Society (anniversary), April 29.—Viscount Walden, F.R.S., president, in the chair.—The report of the council, which was read by the secretary, Mr. P. L. Sclater, F.R.S., stated that the number of ordinary members of the Society on January 1 last was 3,173, of foreign members 25, and of corresponding members 196.—The total income of the Society in 1873 was 28,099*l*., being 1,371*l*. more than that of 1872, and exceeding the income of any previous year, even those of the years 1851 and 1862, when the Great and International Exhibitions were held, which have hitherto been regarded as exceptional years. The total ordinary expenditure of 1873 had been 22,721*l*., and 4,945*l*. had been likewise devoted to extraordinary expenditure, leaving a balance of 1,384*l*. to be carried forward for the benefit of the current year. The assets of the Society on December 31, 1873, were calculated at 10,530*l*., while the liabilities were reckoned at 5,490*l*. The reserve fund consisted at the close of the year of a sum of 8,000*l*. reduced three per cents., but it had been resolved to increase this fund by investing the interest of it from time to time, and by purchasing a further sum of like stock to the amount of 500*l*. every year. The scientific publications of the Society for 1873 had consisted of the usual octavo volume of "Proceedings," and of three parts of quarto "Transactions." The most important work undertaken in the Society's gardens in 1873 had been the rebuilding of the main refreshment-room in the South Gardens at a total cost of 2,096*l*. The total number of visitors to the Society's Gardens in 1873 had been 713,046 being 64,958 more than the corresponding number in 1872, and exceeding that of any previous year since the Gardens had been open to the public. The number of animals in the menagerie on December 31, 1873, was 2,187. Many of the accessions during the year had consisted of specimens of rare or little-known animals, of which full particulars were given. The report concluded with a long list of donors and their several donations to the menagerie. The adoption of the report was moved by Mr. J. Stewart Hardy, M.P., seconded by Prof. Tennant, and carried unanimously. The meeting then proceeded to elect the new members of council and the officers for the ensuing year, and, a ballot having been taken, it was found that Viscount Walden, F.R.S., had been elected president, Mr. Robert Drummond, treasurer, and Mr. P. L. Sclater, F.R.S., secretary to the Society. The new members of council elected were Robert Hudson, F.R.S., the Marquis of Ripon, K.G., Lord Arthur Russell, Osbert Salvin, F.R.S., and Lord Walsingham.

Anthropological Institute, April 28.—Prof. Busk, F.R.S., president, in the chair.—Mr. H. H. Howorth read a paper, entitled Strictures on Darwinism; part 3, on Gradual Variation. The paper was in continuation of a series in which the author endeavoured to show that Mr. Darwin's main conclusion is not supported by the evidence of the changes of type that can be examined. Mr. Darwin differed from the older naturalists in assigning, as the cause of variation, a struggle between the individuals of a class for existence by which a favoured individual and its progeny eventually survive. They, on the contrary, argued that variation is induced by a change in the external conditions of climate, food, &c., which operate upon the whole class together and make it change, as a whole, in a certain definite manner and direction, that is in one which can be actually predicted. So that if any individual of a class or any number of individuals of a class be subjected to a certain alteration of conditions, a certain definite and uniform change will be produced in the individual or the class. Again if the new conditions were annihilated, the object of the experiment is reverted to its original surroundings. The author supported that argument by a large number of facts, and in doing so was constrained to conclude that the operating cause of variation in man, as in the case of plants and animals, is the working of external causes; and that an individual with its progeny is not so much better fitted for enduring the new conditions that it eventually supplants the rest, but rather that the whole class is moulded together into a new shape, which is called a new variety. Some facts were drawn from the experience of history showing that where the conditions have been uniform, as in Egypt, although there has been a considerable mutual pressure among the individuals of a class for food, &c., yet there has been no variation, while a transplanting of similar individuals, as in the case of European emigration to America, has been followed by almost immediate change. The illustrations that might be drawn from the cases of man, as in the changes that have ensued in both the Aryan and the black emigrants to North America, of the Dutch to the Cape, of the Portuguese to South America, &c., were notable and telling instances of the operation of the law argued for by the author, inasmuch as changes of type of a marked character have occurred where there has been neither time nor opportunity for the creation of a fresh type by the successive amelioration or change in the idiosyncrasies of the descendants of a common ancestor, but where the change has undoubtedly occurred in the whole class together over a very wide area.

DUBLIN

Royal Irish Academy, March 16.—Rev. J. H. Jellett, B.D., president, in the chair.—The minutes of the previous meeting having been read and confirmed, Dr. Ingram, secretary to the council, read the annual report, which referred to the work done by the Academy during the previous session, the state of the museum, &c. Seven members were lost by death during the year.—At the conclusion of the report, a ballot took place for the election of president and council. Dr. Stokes, F.R.S., was declared duly elected president, and the following officers were elected:—J. R. Garstin, LL.B., treasurer; E. Perceval Wright, M.D, secretary; J. T. Gilbert, librarian, and Dr. R. M'Donnell, F.R.S., secretary of foreign correspondence.

April 13.—Dr. Stokes, president, in the chair.—A paper was read by M. Donovan On some Improvements of a Comparable Self-acting Hygrometer.—John Casey LL.D., read a paper On a new method of finding the Equation of the Squares of the differences of the roots of a Biquadratic, given by its general equation.—Mr. H. W. Mackintosh read a paper On the Anatomy of the Coatimondis and Marten. During the summer of last year two species of the coatimondi (*Nasua narica* and *N. fusca*), and two specimens of the common species of marten (*Martes foyna*), which formed part of the collection in the Dublin Zoological Gardens, having died, were obtained for the Dublin Uni-

versity Museum, and through the kindness of Dr. Macallster I had the opportunity of assisting him in dissecting them. *Nasua narica*, as doubtless many are aware, has a very long and flexible snout, and hence we found the facial muscles correspondingly better developed in it than in the others. Trapezius, which is tripartite in all, is remarkable in *N. fusca* for sending from its clavicular portion a slip to the humerus and also for being joined to brachialis anticus. Omohyoid was completely absent in the Coatis, but represented by a fine muscular band in Martes. Teres major is remarkable in Martes for being inserted into the humerus free from the tendon of the latissimus dorsi. Pectoralis major has the usual band from the presternum to the humerus; in *N. fusca*, besides the two laminæ from the whole sternum, and from the mesosternum respectively to the pectoral ridge, and greater tuberosity of the humerus, there was a third portion arising from the abdominal parietes and inserted below the humeral tuberosity. The clavicle being rudimentary, the subclavius, as is generally the case amongst carnivores, had disappeared. Acromial deltoid in *N. narica* has some of its fibres continuous with those of brachialis anticus. There was a perfectly separate prescapular slip of subscapularis in *N. fusca*, but not in the other two pronater radii teres passes in all to be inserted below the distal half of the radius. The extensor of the little finger sends tendons to the third and fourth, as well in *N. fusca* and Martes; but in *N. narica* there is a separate extensor *quarti et tertii digiti*. In the hind limb, sartorius has a double insertion into the tibia and into the patella and femoral condyle, the former segment being fused with gracilis. *N. narica* has a distinct agitator caudæ, which is represented in the marten by the caudal origin of the biceps femoris. Bicipiti accessorius is distinct in the Coatis, but inseparable from triceps in Martes, in which also gastrocnemius externus and plantaris are fused. Tibialis anticus is double in Martes, one part arising anterior to the other and being inserted beside and separate from it.—Dr. Collins read a paper On accessory Lobes of the Human Lung. The specimen exhibited presented an accessory lobe of the right lung, lying above the root, and invested by a pleural duplicature, which contained in its lower free margin the azygos vein, and in its external border the superior intercostal. Reference having been made in detail to seven similar cases noticed in different parts of Europe, special stress was laid upon a unique case detailed by Wrisberg of a lobe having similar relations upon the left side, as conclusively establishing the mode of origin of the lobe in connection with the development of the azygos, and superior intercostal venous systems. The author regarded these as the only true accessory lobes yet described in man. Mention was made of other so-called accessory lobes, particularly one described by M. Pozzi, below the right bronchus, from its apparent homology to the mammalian lobus impar, and a similar one upon the left side, described by Prof. Recktorzik. These, however, the author regarded as merely higher developments of pulmonary notches, which in not a few instances are normally to be found. The paper, which was illustrated by the recent specimen and by drawings, concluded with an allusion to accessory bronchi in their connection with the subject.

PARIS

Academy of Sciences, April 27.—M. Bertrand in the chair.—The following communications were read:—Fourth memoir on chemical dynamics, by M. Becquerel, a continuation of the author's electro-chemical researches.—On freezing mixtures, by M. Berthelot. The author concluded, from his researches, that by application of the resources indicated by theory, a much lower temperature ought to be obtained than has hitherto been reached.—Study and experiments upon sulphides: alkaline sulphides, by M. Berthelot, a continuation of the author's thermo-chemical researches.—M. Kronecker contributed an algebraical paper on quadratic and bilinear forms.—Note on the decomposition of the work done by forces, M. A. Ledieu. The author gave a rigorous enunciation of Luca's theorem relating to the division of the work done by forces in a material vibrating system.—The production of gum in fruit trees considered as a pathological phenomenon, by M. E. Prillieux. Trees affected by this malady were stated to be cured by making longitudinal incisions in the branches.—On unicursal curves, a geometrical memoir by M. Painvin.—Orbit of the double star γ Virginis, by M. C. Flammarion. This system offers the unique case of an elliptical orbit facing us in a plane exactly perpendicular to the line of sight, so that no distortion of the ellipse due to perspective is perceived.—On the conclusions to be drawn from the application of thermo-chemical theorems to explosive bodies in general and to gunpowder in particular, by M. F. Castan.—On the thermal conductivity of rocks and of bodies in general, by M. E. Jannettaz. The law which regulates the propagation of heat in crystals appears to the author a particular case of the general law that heat is propagated most easily in the direction of least cohesion.—Determination of the age of the human embryo by the examination of the evolution of the dental system, by M. E. Magitot. The results are likely to be of great service in medico-legal cases.—M. E. Combescure presented a note on a theorem concerning simultaneous partial differential equations.—Direct construction of the radius of curvature of the curve of apparent contour of a surface projected orthogonally on a plane, by M. A. Mannheim.—On the limit of the degree of the primitive groups which contain a given substitution, a mathematical note by M. C. Jordan.—Elements and ephemerides of the planet (127), by H. Renan.—On the elementary law of electrodynamic actions, by M. J. Moutier.—Observations on Tyndall's experiments on the acoustic transparency and opacity of the atmosphere, by M. Baudriment. The author stated that the given explanation of the phenomenon of acoustic extinction might be true, but did not seem sufficiently demonstrated to be admitted without submission to a special inquiry, and concluded by stating that the observations were made to be considered by Prof. Tyndall only as means offered to him for the verification of facts of such great importance.—Study of the properties of explosive bodies, by F. A. Abel.—On the employment of oxygen mixed with atmospheric air in respiration, by M. A. Gaudin. The author confirmed the results obtained by MM. Crocé-Spinelli and Sivel in their last balloon ascent.—On a burying-place of the ancient Troglodytes of the Pyrenees superposed upon a (funeral) hearth containing human remains associated with sculptured teeth of the lion and bear, by MM. L. Lartet and Chaplain-Duparc.

BOOKS RECEIVED

BRITISH.—Physiology for Practical Use. 2 vols. Edited by James Hinton (H. S. King & Co.).—A Treatise on Food and Dietetics: Dr. Parry (Churchill).—Sanitary Arrangements for Dwellings: W. Eassie (Smith, Elder & Co.).—Thorpe's Qualitative Chemical Analysis (Longmans).—Principles of Mechanics: Goodeve (Longmans).—Year Book of Facts: Timbs (Longmans).—Surface Zones of the Globe: Keith Johnston (W. & A. K. Johnston).—Lectures on Experimental Chemistry: Prof. Reynolds (Hodges, Foster & Co.).—Mechanics: Willson (Thacker).—Pickering's Physical Manipulation (Macmillan).—Physiology: F. de Gros. Clark (S.P.C.K.).—Geology: T. G. Bonney (S.P.C.K.).—Africa: A. Gruar Forbes (Low & Co.).—Proceedings of the Royal Society of Edinburgh.

AMERICAN.—The Constants of Nature. Part I. (Smithsonian Institute). Compiled by F. W. Clarke, S.B.—A History of American Birds: S. F. Baird, T. M. Brewer, and R. Ridgway (Little, Brown & Co.).—The Unity of Creation: F. K. Kingston (Trübner).

COLONIAL.—General Report of the Great Trigonometrical Survey of India during 1873: Col. J. T. Walker (Dehra Doon).—Geological Survey of Canada. Report for 1873: (Dawson).—Report of the Secretary for Agriculture, Victoria.—Transactions of the Royal Society of Victoria.

FOREIGN.—Statique des Liquides. 2 vols. J. Plateau (Gauthier Villars).—Association Française. 1st session. Comptes Rendus.—Histoire de la Creation: E. Haeckel (Reinwald, Paris).—Schriften der Naturforschenden Gesellschaft in Danzig. 1873.—Les Explorations Sous-Marines.—Elements de Geologie et de Palæontologie: Ch Contejean (Baillière).—Principes de Geologie: Gustave Dollfas (Savigi, Paris).—Verhandlungen Zoologisch Botanishen Gesellschaft in Wien, Band xxiii.

CONTENTS

THURSDAY, MAY 14, 1874

THE SCIENCE COMMISSION

IT would be difficult, we think, to overestimate the value of the evidence brought together in the second volume published by the Science Commission. The first volume dealt mainly with the diffusion of knowledge; the second is concerned mainly with the advancement of Science. The Commission has done good service in bringing before Parliament and the country the carefully weighed opinions of men of the highest mark in all departments of Science on subjects of the first importance, not only in their bearing on the advancement of Science but also on some of the best interests of this country. We propose to show the general bearing of the evidence contained in the volume on some of the questions on which the Commission sought information, omitting all opinions of our own.

The unanimity of opinion among the witnesses examined—and their number is large—as to the duty of the State in the matter of Abstract Science is striking; without exception, so far as we have been able to examine the evidence, the opinion is unanimous that it is the duty of the State to encourage original research in Abstract Science. As might naturally be expected opinions vary as to the method which the State should adopt in carrying out this duty, but that some action ought to be taken by the State in this direction is the all but unanimous conviction of the best men in all departments of Science. We need only mention in this connection such names as those of Lord Derby, Lord Salisbury, Sir Stafford Northcote, as statesmen, Sir Wm. Thomson, Dr. Joule, Dr. Sanderson, Col. Strange, Mr. George Gore, Dr. Carpenter, Mr. T. H. Farrer, Prof. A. W. Williamson, Dr. Frankland, Mr. E. J. Reed, General Sir Edward Sabine, Prof. Balfour Stewart, Prof. Owen, Admiral Richards, Dr. C. W. Siemens, Mr. P. L. Sclater, Dr. Hooker, Dr. De la Rue, &c., to show the weight and comprehensiveness of opinion on this point, and that it is held not only by men concerned solely with Abstract Science but also by those concerned with some of the most important practical applications of Science.

Of course the principal way in which the State can aid scientific research is by granting money for the purpose; as to how such a grant ought to be applied various opinions are offered by the witnesses, each witness, as a rule, naturally looking at the matter from the point of view of his own branch of Science, but all are decidedly of opinion that a very large sum should be put on the estimates annually for the promotion of Science. Nearly all the witnesses who have been examined on this point are of opinion that Government, under judicious advice, ought to make grants to existing scientific institutions, to university laboratories, and to private individuals, to enable them to carry on research that is likely to lead to valuable scientific results. In addition to this, however, such men as Sir Wm. Thomson, Dr. Frankland, General Strachey, Prof. Owen, Dr. Joule, Dr. De la Rue, Dr. Carpenter, Col. Strange, Mr. Gore, and others, express a most decided conviction that one of the most efficient methods by which Government could further research in this country is by the establishment of public laboratories for the pursuit of scientific research in connection with the various and ever-multiplying departments of Physics, Chemistry, and Biology, adequate research in connection with which is admittedly quite beyond the means of private individuals. The evidence in favour of institutions of this kind is very strong indeed whether we consider the number and position of the witnesses or the earnestness and decision with which they express their convictions. It is clearly stated that in this country we are very far behind continental states and America in this respect, and that not only is Science a loser from want of assistance from the State, but the general welfare of the country is seriously impeded. The evidence in favour of the establishment of State institutions for the prosecution of scientific research is so voluminous and strong that it is difficult to select any particular part for quotation. As an example of its nature, however, we may quote what Dr. De la Rue says on the subject of chemical laboratories:—

"I hold it to be so important that chemistry should be extensively cultivated in England, that I would strongly advocate that there should be a State laboratory. That State laboratory should undertake all the chemical work which the Government might require; but at the same time, according to the views which I hold, it ought to be such an establishment as could afford facilities to men who have completed their scientific education, and who might be desirous of continuing original investigations, in which space for working and instruments should be afforded them, and, moreover, if men were not in a position of fortune to continue their researches, in some cases materials and even money might be granted to them on the recommendation of the Council. I may state that of my own knowledge I know that chemical science at present is not progressing in England in a satisfactory manner, that we do not make so many original researches as our continental neighbours, particularly the Germans, do. In Germany very great patronage is given to Science, magnificent laboratories have been built, and the students, who after they are sufficiently advanced are encouraged to make original investigations, contribute at present most largely to scientific chemistry."

On the question of establishing a Public Physical Laboratory, Col. Strange says:—

"I think it is an absolute necessity on the ground of my second postulate, in which I say that all science should be cultivated, even branches of Science which do not appear to promise immediate advantage. It is one of the most important parts of Science, and cannot be omitted without detriment to all the other parts. . . . . Investigations connected with almost the whole of our material economy are required. There is no question connected with sanitary improvement, with water supply, or sewage, or telegraphy, or the enormous number of the requirements of the army and navy, which would not derive advantage more or less from investigations of a physical nature such as would be conducted in a physical laboratory. I think that the whole of our naval and military and social economy is dependent upon investigations such as would be carried on in a physical laboratory."

A similar tone pervades the evidence of the witnesses who were questioned on the subjects of physiological and biological laboratories, metallurgical laboratories, botanical laboratories, and observatories for astronomical physics. Of those in favour of an observatory of the last-mentioned kind, we might mention the names of Lord

Salisbury, Lord Derby, Sir William Thomson, Prof. Balfour-Stewart, Admiral Richards, Dr. Siemens, Dr. Joule, General Strachey, Dr. Frankland, besides many others.

This may suffice to show the nature of the evidence as regards the duty of the State in the matter of Abstract Science and the method by which this duty should be performed. In minor details, of course, there are differences of opinion, but the weight of evidence is without doubt in favour of the establishment of scientific laboratories by the State, in addition to the encouragement of suitable private individuals and the subsidising of existing institutions. Most seem to be of opinion that at first central laboratories should be established in London only, to be afterwards extended to the provinces, and most of those examined on the subject expressed their decided conviction that the men who gave up their time to the service of Science and the State in these laboratories or elsewhere should be adequately remunerated, indeed be regarded as a superior class of Civil servants. For example, Lord Salisbury, on the question of income, suggests that men who might be appointed to pursue original research by the State ought to have an income of about 1,000*l.* or 1,500*l.*, with a provision for retirement. Other witnesses who spoke in favour of paying public researchers were Lord Derby, Dr. Joule, Sir William Thomson, Sir E. Sabine, Sir Stafford Northcote, Dr. Siemens, Mr. Gore, the late Prof. Rankine, &c.

In order that the State may look after the interests of Science and the scientific interests of the country, it would of course be necessary that some well-organised system should be adopted by which the intentions of the State should be carried out. The great majority of those examined on this point agree that this would be best accomplished by the establishment of a State Council of Science presided over by a Minister of Science, who, however, some are of opinion might also be Minister of Education. But that a special department, or at the least, a sub-department of the State should take the promotion of Abstract Science and Science in its practical bearings on the interests of the country under its wing, seems to be the opinion of the great majority of those whose opinion was asked by the Commission on this question; and they include many of the men most eminent in Abstract as well as Applied Science. This State Council of Science, as we have indicated, is not meant solely to look after the interests of abstract scientific research in the country; its time would be much, if not a great deal more, occupied in bringing to a scientific test and advising Government upon all Government projects in which scientific principles are more or less involved. All are agreed that the cost to the country of such a Council would be nothing compared to the losses which are being continually sustained through the haphazard projection and carrying out of schemes that fail wholly or partially from not being founded on strictly scientific principles. Several of the witnesses, for example, refer to the unfortunate *Captain*, whose blundering construction would have been impossible had the Government had such a Council to consult. As to the size and composition of such a Council, opinions of course differ, though many of the witnesses referred with more or less approval to the long-thought-over and well-matured scheme of Col. Strange.

As to some of the duties which would devolve upon such a Council, we cannot do better than quote from Sir William Thomson's evidence, merely reminding the reader that his statement is typical of the opinions held by most of the other witnesses who spoke to the question:—

"The main object of such a Council would, in my opinion, be to advise the Government on all scientific questions which might come under the attention of the Government, and on all scientific works actually undertaken. With a vast amount of mechanical work which is necessarily undertaken by the Government, and which is continually in hand, questions involving scientific difficulties of a novel character frequently occur: questions requiring accurate knowledge of scientific truth hitherto undeveloped are occurring every day. In both respects Government is at present insufficiently advised, and the result is undoubtedly that mechanical works are sometimes not done as well as they might be done, that great mistakes are sometimes made: and, again, a very serious and perhaps even a more serious evil of the present system, in which there is not sufficient scientific advice for the Government, is the undertaking of works which ought never to be undertaken. . . . One great mistake undoubtedly was the construction of the *Captain*, and I believe that a permanent scientific Council advising the Government would have made it impossible to commit such a mistake. They would, in the very beginning, have relieved the Government from all that pressure of ignorant public opinion which the Government could not possibly, in the present state of things, withstand."

On the question as to whether such a Council would command sufficient public confidence among men of Science, the answer of Mr. P. L. Sclater, F.R.S., may be taken as embodying the opinion of most of the other witnesses. He says:—"I have no misgivings at all upon that subject. I should say that they would meet with general support from men of Science. Most men of Science, I think, see that something of the sort is imperatively required. All lament the piecemeal way in which scientific subjects are dealt with by Government, in consequence of their being subdivided amongst all these different offices, and of there being nobody to appeal to upon a question of Science, and, therefore, I think the proposal to establish such a Council would meet with universal acceptation amongst scientific men."

Into the questions of the size of the Council, whether the members should or should not be appointed for life, &c., we need not enter here; the great point is that the mass of evidence is in favour of establishing such a Council, presided over by a Minister of Science.

The question of the institution of a State Minister of Science has been so often discussed in these pages that we need not go into the voluminous evidence in its behalf which is published by the Commission. While some of the witnesses think that such a Minister's functions ought also to include the department of Education, most of them point out that Britain is the only country in which the interests of Science have no representative in the Government of the country.

It will thus be seen that the Commission has been the means of eliciting from the various eminent men who have come before it a complete and comprehensive scheme for the promotion of Science by the State, and for giving Government the means of obtaining trustworthy counsel in all matters in which scientific principles are in any way in-

volved. In the main features of the scheme nearly all the witnesses who were examined on the subject are at one; many of the details in which they differ are of such a nature as can be settled only by actual trial.

On the many other subjects touched upon in the volume we cannot enter here. Much of the evidence bearing on the Universities tends to prove that the interests of Science are inadequately attended to in these institutions, and that the scientific teachers in some of them have to contend with very great difficulties. With respect to what Universities should do to advance the interests of Science, not to speak of the utilisation of the enormous funds at the disposal of Oxford and Cambridge, such men as Dr. Siemens, Dr Frankland, Dr. Sanderson, and others are of opinion that for the highest degrees in Science original research should be required; Prof. Balfour-Stewart thinks that Universities ought to afford facility for the prosecution of original research, and Dr. Carpenter that University Fellowships should be given to men employed in original research.

Many of the most eminent witnesses—as Sir B. Brodie, Lord Salisbury, Dr. Frankland, Prof. Williamson, Colonel Strange, Sir William Thomson, &c.—are of opinion that research ought to be endowed quite apart from teaching in the ordinary acceptation of the term.

Most of the witnesses who spoke to the condition of Science in this country contrasted it with the great encouragement given to research in nearly every other European country, and in America. In this relation we cannot help quoting a very striking statement made by Sir William Thomson in respect to France, in answer to the question as to how many institutions for research he would recommend.

"There should be five," he says. "One at present exists, namely, the Royal Observatory at Greenwich. Another in my opinion is very much wanted, an observatory for astronomical physics; then again a physical laboratory, and a laboratory for chemical research, and a physiological laboratory are necessary. In respect of such institutions, I believe, we might with great advantage obtain information, with a view to following example, in Paris. The strong feeling of the necessity to promote scientific research which was evinced shortly after the recent sad disasters which came upon France illustrates very strongly the national value of such institutions. In the depths of their misfortunes, one of the first strong feelings shown by the most intelligent part of the French nation was the want of rigorous and accurate scientific research. Competitive examinations seemed in France to have swallowed up scientific energy, and there was a strong feeling of the insufficiency of the national institutions for promoting the advancement of Science."

In conclusion, we cannot do better than quote the forcible and noble language of Sir William Thomson, on the much-discussed question of the "utility" of abstract scientific research. To the question as to some of the objects to be gained by the establishment of a Council of Science, Sir William Thomson replies:—

"The immediate utility of the work is undoubtedly a very important object, and perhaps may be considered to be the first duty of the Government; but yet there is another duty which, although we cannot call it the first duty, is certainly not an inferior duty, and that is, to promote the honour of this country. There can be no doubt but that the inhabitants of this country do get benefit from the feeling of satisfaction that naturally results from any great scientific discoveries or great advances in Science made by their own countrymen, and especially by the assistance of their own Government. The Royal Observatory at Greenwich is an honour and a glory to this country, and I am quite sure that the money paid for it is very well spent, in the satisfaction that the country feels in the honour of having one of the greatest and best, if not *the* greatest and best, of scientific astronomical observatories in the world. This country undoubtedly has a great permanent possession in the name of Newton and in the name of Faraday. The promotion of scientific research in a regular way cannot make Newtons and Faradays, but it can obtain great scientific results by systematic business-like action, carried out through well-instructed and able men. It seems to me to be a duty of the Government to make the national honour in scientific investigation a subject of its solicitude and an occasion (with due safeguards against abuse) for spending the public money." J. S. K.

OUR BOOK SHELF

Proceedings of the London Mathematical Society. vol. iv. Nos. 41-66. (Messrs. Hodgson, Gough Square.)

THE volume before us contains the papers which have been read during the eighth and ninth sessions of the Society. We notice a favourable sign in the much greater number of contributions which have been made in the later session—36 against 15. A large number of the members have been led to take an interest in the meetings, and the papers without losing their former high character are in some cases less "caviare to the general" than in previous volumes. The Society's first president himself thus wrote, "Not a drop of liquor is seen at our meetings, except a decanter of water; all our 'heavy' is a fermentation of symbols, and we do not draw it mild. There is no penny fine for reticence or occult science; and as to a song! not the ghost of a chance." The Society, however, as we see, has reached its tenth year; and though some of the members drop off for reasons which perhaps may be gathered from our quotation, yet the number of members recorded in this volume is fairly satisfactory: the present number of members of the Mathematical Society is about 117. In Paris the new Society (la société mathématique de France) started with almost double this number of members. So far as we have seen, however, the papers of the volume under notice and of previous volumes will not lose by a comparison with the opening numbers of the younger society's *Bulletin*. Of course no volume would fairly represent English mathematics without having contributions from Prof. Cayley's fertile pen; here we have no less than ten papers, some of considerable length, principally on curves and surfaces, and constructions for mechanically describing the former.—Dr. Sylvester furnishes only short notes on the properties of numbers.—Prof. H. J. S. Smith contributes an arithmetical demonstration of a theorem in the integral calculus, and two other papers bearing upon linear congruences and determinants.—Prof. W. K. Clifford writes, among other things, upon geometry, on an ellipsoid, and a new form of Biquaternion.—Mr. Samuel Roberts rivals Prof. Cayley in the extent and nature of his communications upon parallel surfaces, and also upon epi- and hypo-trochoids.—Prof. Clerk-Maxwell takes us to another sphere, and treats of the transformation of solids, of the equations of motion, of a system of electrified conductors, and of the focal lines of a refracted pencil.—Lord Rayleigh too takes us into the domain of physical science, in his vibrations in a sphere, the investigation of the disturbance produced by a spherical obstacle on the waves of sound, general theorems relating to vibrations.—A presidential address by Mr. Spottiswoode treats of some recent generalisations of algebra.—Mr. J. W. L. Glaisher writes on

Bernoulli's numbers, and on points connected with definite integrals.—Prof. Wolstenholme's papers are concerned with series and loci, and treat also of epicycloids and hypocloids.—Mr. T. Cotterill gives a short paper on an algebraical form and the geometry of its dual connection with a polygon, plane or spherical.—An analogous theorem relating to polyhedra is discussed by Prof. Clifford in this same volume.—M. Hermite contributes two short notes, one on circular functions, the other on unicursal curves.—Mr. J. J. Walker writes on the invariant conditions of multiple-concurrence of two conics, and Mr. R. B. Hayward on an extension of the term *Area* to any closed circuit in space.—From this analysis it will be seen that there is considerable variety in the contents of the volume. It is not necessary here to give any detailed account of the papers, as notices of them have appeared from time to time in our columns.

LETTERS TO THE EDITOR

The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.]

Flowers of the Primrose destroyed by Birds

I HOPE that you will permit me to make a few final remarks on the destruction of primrose flowers by birds. But first I must return my best thanks to your correspondents, as well as to some gentlemen who have written direct to me, and to whom I have not had time to send separate answers. Secondly, I must plead guilty to the high crime of inaccuracy. As the stalks from which the flowers had been cut were shrivelled, I mistook, in a manner now inexplicable to me, the base of the ruptured or removed ovarium for the summit; a remnant of the shrivelled placenta being mistaken for the base of the pistil. I have now looked more carefully, and find that on twelve stalks only three had any remnant of the ovarium left. I have also examined sixteen bits of the calyx which had been cut off by a caged bullfinch, presently to be noticed, and in fifteen of these not only had the ovarium been torn into fragments or quite destroyed, but all the ovules had been devoured, excepting sometimes one or two. In several cases the calyx had been split open longitudinally. The ovarium was in the same state in thirteen small portions of the calyx lying on the ground near a wild cowslip plant. It is therefore clear that the ovules are the chief attraction; but the birds in removing by pressure the ovules could not fail to squeeze out the nectar at the open end, as occurred when I squeezed similar bits between my fingers. The birds thus get a dainty morsel, namely, young ovules with sweet sauce. I still think that the nectar is, in part, the attraction, as caged bullfinches and canary birds much like sugar; but more especially because Mr. C. J. Monro has sent me some flowers from a cherry-tree near Barnet, which during several years has been attacked; and he finds many of the flowers, both those on the tree and on the ground, with rather large ragged holes in the calyx, like, but much larger than, those often made by humble bees when they rob flowers in an illegitimate manner. Now the inside of the flower of the cherry, round the ovarium, is bedewed (if protected from the visits of insects) with drops of nectar, which sometimes collect so as almost to fill up the bottom of the flower. In the case of the cherry I cannot doubt that this is the attraction, for I examined the ovarium of ten flowers, and although they had all been scored by the bird's beak, and in four instances punctured, the ovule had in no case been devoured.

To return to the primroses: from the accounts received, it seems that the flowers are cut off in the manner described by me, near Preston in Lancashire, in North Hampshire, Devonshire, and Ireland, as well as in Kent. In several other places, not worth specifying, where primroses are abundant, they have not been thus attacked; and this may possibly be due to the proper enemy, namely, as I now suspect, the bullfinch, not being a common bird. In my former letter I remarked that if the habit of cutting off the flowers proved to be a widely extended one, we should have to consider it as inherited or instinctive; as it is not likely that each bird should discover during its individual lifetime the exact spot where the nectar, and, as I must now add, the ovules, lie concealed, or should learn to bite off the flower so skilfully at the proper point. That the habit is instinctive, Prof. Frankland has given me interesting evidence. When he read my letter he happened to have in the room a bunch of cowslip flowers and a caged bullfinch, to whom he immediately gave some of the flowers, and afterwards many primrose flowers. The latter were cut off in exactly the same manner, and quite as neatly, as by the wild birds near here. I know that this is the case by having examined the cut-off portions. The bird worked so quickly that he easily destroyed twenty flowers in three minutes; a single wild pair would therefore cause great havoc. Prof. Frankland informs me that his bird pressed the cut-off portions of the calyx in its beak, and gradually worked them out on one side, and then dropped them. Thus the ovules were removed, and the nectar necessarily squeezed out. A canary bird to whom some cowslip and primrose flowers were given attacked all parts indiscriminately, and ate up the corolla, calyx, and stalks. A lady also informs me that her canary and siskin always attack primrose and cowslip flowers, if kept in the same room. They generally first make a ragged hole through the calyx opposite the ovarium, and remove the ovules, as I found to be the case with flowers which were sent to me; but the ovules had not been so well removed as by the bullfinch, and the nectar could not be obtained by this method of attack.

But now comes the interesting point: the caged bullfinch just referred to was caught in 1872 near Ventnor, in the Isle of Wight, soon after it had left the nest, by which time the primroses would have been out of flower, and since then, as I hear from Prof. Frankland, it had never seen a primrose or cowslip flower. Nevertheless, as soon as this bird, now nearly two years old, saw these flowers, some machinery in its brain was set into action, which instantly told it in an unerring manner how and where to bite off and press the flowers, so as to gain the hidden prize. We are reminded by this little fact of Mr. Spalding's admirable observations on the instinctive actions of chickens when their eyes were uncovered, after having been blind-folded from the moment of being hatched.

Prof. Frankland seems to have been much struck with the behaviour of his bullfinch, and remarks in his letter that "it had all the precision of a chemical reaction; the result of putting a primrose within its reach can be almost as certainly predicted as that of putting a plate of iron into a solution of sulphate of copper." CHARLES DARWIN

Down, Beckenham, Kent, May 7

P.S.—This letter was printed before I saw your last number, and I am glad to find that some of my statements are confirmed, more especially with respect to bullfinches. During the last fortnight not one primrose has been attacked in the little wood where shortly before there was such havoc. I imagined that the pair of bullfinches, which I saw there earlier in the season, had wandered away; but yesterday evening (May 10) it occurred to me that the flowers produced late in the season might fail to secrete nectar, or that the recent cold weather might have produced this effect. Accordingly, in the afternoon I gathered fifteen flowers from as many distinct plants, and kept them in water in my room for seventeen hours. Earlier in the season I treated some flowers in this same manner, and found the tube of the corolla full of nectar; but now only one of the flowers contained a very small quantity of nectar, another showing a

mere trace of it. And the flowers being no longer cut off by the birds supports my belief that the nectar is one chief attraction to them; the ovules without the sauce not being worth the gathering. I may add that as the primrose is a dimorphic plant, these non-nectariferous flowers would be sterile, for they would not be visited by insects.—C. D.

Mr. Spencer and *à priori* Axioms

I QUITE agree with Mr. Spencer that argument between us will not be to much purpose; but it should be noted that my principal "exemplification of unconsciously-formed preconceptions" was of Mr. Spencer's own choosing, namely, Newton's "Second Law of Motion," which, if I understand him aright, may now be described as "a consciously-formed hypothesis concerning the relation between weight (force?) and motion." Only demurring to the word "hypothesis," and leaving it to Mr. Spencer to reconcile this with his former declaration that the law in question is an "immediate corollary" of one of these unconsciously-formed preconceptions, it seems to me there is little left to argue about.

ROBT. B. HAYWARD

Harrow, May 8

MR. SPENCER does not state his arithmetical illustration very exactly. He implies that there is a certain truth which the savage is incapable of understanding concerning which the schoolboy makes a mistake, but that there is present in the civilised adult a consciousness of its logical necessity. It does not appear distinctly what that truth is.

The most obvious interpretation of what is printed is, that Mr. Spencer refers to the local value of figures in the Arabic system of notation: this is probably not what is meant.

Two other interpretations suggest themselves. The sum of seven and five is the same number whatever be the things to which the seven and five refer; or else the more particular statement that the sum of seven and five is the same as the sum of ten and two. It is not apparent that either of these is intended.

To say that seven and five make twelve without implying something about twelve other than the statement that it is seven and five, seems a proposition so purely verbal that it is difficult to see how the recognition or non-recognition of it illustrates the grounds of belief in physical laws.

NOT A METAPHYSICIAN

The Glacial Period

IN the many kind and favourable reviews of my book, "The Naturalist in Nicaragua," exception has been generally taken to my speculations on the extent and effects of the ice of the glacial period. The subject is a large one, and too little of my time can be given to scientific inquiry to allow me to hope that I can deal with it in detail for some years to come; but as it appears that I have not expressed my views with sufficient clearness and have been misunderstood by some of my critics, I shall be glad of an opportunity to state them with distinctness and brevity.

1. At the present sea-level, the ice extended, in the northern hemisphere, from the Pole to lat. 39° in America, to about the valley of the Thames in England, to lat. 50° in central Europe, and to lat. 52° in north-western Asia. Along the high lands of America it reached to the tropics, and in Central America all the land lying over 2,000 ft. above the sea supported glaciers. I do not contend that the present low lands of tropical America were ever covered with ice, and it is on the mountain chains of that continent alone that I believe it nearly reached to the equator.

2. The ice was thickest over the American continent, not because it was coldest there, but because the great evaporating area of the Pacific lay to the south-west of it and the counter tradewind swept across it and precipitated the moisture with which it was laden. Siberia was equally cold, but the upper moisture-bearing currents of air were intercepted by the Himalayas, the Kuen Lun, and the Altai Mountains. It was thickest in America for the same reason that it is thicker on the summits of the Pyrenees than on similar heights on the Caucasus, and thicker on the southern than on the northern slope of the Himalayas, not because of greater cold, but of greater precipitation.

3. The immense accumulation of ice in the extreme north of America and Europe must have overflown and filled the polar basin even if it had not independently collected there; but the precipitated moisture would not have frozen on the continents if the climate had not been much colder then than now; and the surface of the Arctic Ocean must have been frozen over, and as capable of sustaining accumulations of snow as the solid land itself, even if that ocean was not displaced by the ice flowing into it from the northern extremities of the continents.

4. Probably the ice was not thickest at the Pole, but formed a ridge of varying height at unequal distances from it; for, as we have seen, it would not be thickest where it was coldest, but where there was most precipitation, and the south-west winds would part with their moisture long before they reached the Pole.

5. Whilst we can follow on the land the marks left by the ice of the glacial period, and map out its former boundaries, we can only speculate on its extent over the areas now covered by the sea. We have, however, some evidence. The Hebrides and the extreme north-east of Scotland were overflown by ice that came from the north-west, and the bed of the North Atlantic must have been filled so far at least, or to about lat. 59°; and taking into account the much greater quantity of ice lying on America than on Europe, it is not an extreme supposition that on the western side of the Atlantic the bed of the ocean was occupied by ice to lat. 45°.

6. One of the principal effects of this great advance and accumulation of ice, not yet taken into consideration by geologists, was an interruption to the drainage of all countries whose rivers flowed northwards. The great plain of Siberia was, I believe, occupied by an immense lake caused by the blocking up of the whole of the watershed to the north. In western Europe this interference with the drainage of the land took place, even if we do not accept the theory of an ice-cap, but hold with some geologists that the ice descended only from existing chains of mountains. All the rivers of northern Germany must have been dammed back by the ice descending from the Scandinavian mountains. One of the most important changes was effected in the German Ocean. Its northern half was filled with ice, from the mountains of Norway and Sweden, from Scotland and northern England. As we know that at this time the Straits of Dover did not exist, it is evident that the southern portion of the bed of the German Ocean must have been filled by a great freshwater lake, varying in extent during the advance and retreat of the ice, into which flowed all the water of the melting ice, and all the rivers that now run into the same area.

7. There is no satisfactory evidence of the intercalation of a warm period between two glacial ones, though doubtless there was more than one retreat of the ice, during which a temperate climate prevailed in regions glaciated before and afterwards. The intermingling of the remains of northern and southern mammalia in the gravels of south-eastern England arose, probably, as explained by Sir Charles Lyell, by a northern and a southern fauna having migrated to the district at different seasons of the year.

When the German Ocean was blocked up to the north by ice, a great river must have run to the south through what are now the Straits of Dover and the English Channel, receiving into one stream the waters of the Rhine, the Thames, the Humber, and the Somme. How far that river ran southward would depend upon the relative heights of the land and the sea. It must have run into a comparatively warm ocean, for the effects of the warm currents of water coming from the tropics, instead of as at the present time entering the polar basin, would be confined to and intensified in more southern latitudes, and they would then, as now, be deflected upon the western coast of Europe. Up this river the hippopotamus and the southern species of rhinoceros and elephant may have come in summer and autumn, whilst the mammoth, the woolly rhinoceros, and the musk ox came from the north in winter.

8. The theory of the damming-up of many rivers throws much light on the difficult question of the formation of the high and low level gravels and the loess. The lake occupying the area of the German Ocean must have stood much higher in spring and early summer than it did later on in the year and in winter; and the levels of the lower parts of the rivers running into it must have been affected by its rise and fall. If we can suppose that the hippopotamus only came up the river when it was low in the latter part of summer, or in the autumn, we can understand how its remains are only found in the low-level gravels of the Thames and the Somme; though it is also possible that they may belong to a later and milder period when the ice had retired so far back that the great lake partly drained to the north around Scotland.

9. The glacial period probably existed in both hemispheres at the same time. First, because we can trace the evidence of the existence of ice along the high lands of America into the northern tropics until it nearly inosculates with that coming down

from the south, and there is no difference in the character or appearance of the moraines left on both sides of the equator. Second, because, excepting on the supposition that the ice extended, at least along some meridians, both from the south and the north nearly to the equator, at the same time, we cannot explain the distribution of those animals and plants that are found in the temperate zones of both hemispheres, separated by the whole width of the tropics, over which they cannot now pass. For example, there are more than forty flowering plants of North America and Europe which are also found in Terra del Fuego. Darwin's theory that these plants were driven to the high lands of the tropics during the glacial period, and followed the retreating ice in its retrocession, must fall to the ground if the ice did not exist in both hemispheres at the same time. (See "Origin of Species," p. 405, &c.)

10. The piling-up of water around the poles in the form of ice could not fail to affect the level of the ocean. Mr. Alfred Tylor has calculated that the accumulation of the ice in the northern hemisphere alone would abstract so much water as to lower the level of the sea 600 feet; and if, as I believe, the glacial period occurred at the same time in both hemispheres, the level of the ocean must have been lowered at least 1,000 feet.

11 The theory of the lowering of the level of the sea during the glacial period is directly opposed to the generally accepted one of a great submergence of part of England and Scotland to a depth of about 2,000 feet, when the marine shells of Moel Tryfaen and Macclesfield were deposited. The facts on which this theory of submergence is based can be otherwise explained. The shells are broken or worn, and generally mixed amongst other transparent materials. They are just where they ought to be found on the supposition that an immense body of ice coming down from northern Ireland, from Scotland, and from Cumberland and Westmoreland, filled the basin of the Irish sea, scooped out the sand with the shells that had lived and died there, and thrust them far up amongst the Welsh hills that opposed its course southward and around the great bight of which Liverpool forms the apex. Excepting some raised beaches around our coast, which were probably formed after the glacial period, and in no case reach more than 100 feet above the present level, I believe there is no evidence of the submergence of Great Britain either during or since the glacial period. THOMAS BELT

Lakes with two Outfalls

THE subject of double outfalls is of some interest, if only as showing the necessity of accurate observation, and the difficulty of ascertaining the truth in matters apparently of simple fact. In NATURE, vol. ix. p. 485, Mr. W. B. Thelwall brings forward two instances of lakes with double outfalls, and states that he has passed two or three more. Now, as regards that upon the Fille Fjeld, which he describes from personal observation, I beg entirely to call in question his accuracy. I passed the locality during each of the two last summers, and my attention was drawn to the position and nature of the watershed, especially during my visit of last summer, when I had carefully inquired into the asserted existence of a natural double outfall at the Lesjeskaagen Vand. (See NATURE, vol. viii. p. 304; also Colonel Greenwood's and Mr. R. B. Hayward's letters, NATURE, vol. viii. p. 382.)

Mr. W. B. Thelwall says:—"Between Nystuen and Skogstad is a chain of lakes crossing the watershed, the highest of which (not the one marked on the Vei-cart over Norge, I think), sends its waters to the west, past Nystuen to the Sogne Fjord, at Lærdalsören, and on the east by the Lille Mjösen, and Aadalen to the Tyrifjord, and so past Drammen to the Christiania Fjord. This lake is a small one, and the double outflow is close to the high road."

Now this statement is inaccurate in all the essential details. The division of the waters is *not* between Nystuen and Skogstad, but on the other side of Nystuen between it and Maristuen. The water which passes Nystuen does *not* flow towards the west to the Sogne Fjord, but to the east towards the Lille Mjösen, as I carefully ascertained when I was staying at Nystuen. This is rendered certain, too, by the fact that the land rises to the west of Nystuen, the actual division of the waters being about 100 or 105 feet, by my aneroid barometer, above Nystuen. Moreover, having scrambled up a steep mountain close behind Nystuen, whence the view on a clear day is of the wildest character, I had a bird's-eye view of the whole district in debate, and examined it carefully with a good field-glass, with a view to detecting any evidence of a double outflow. I came to the conclusion that the division of the waters took place in the boggy bottom of the valley to the west of Nystuen, and that it would be impossible to say exactly where it was. To the westward of this boggy place is indeed another lake, of which the waters flow to the Sogne Fjord; but this lake is several miles to the west of Nystuen, and separated from it by dry land, rising 100 feet or more above the levels of the water in the two lakes.

Whether lakes with two outflows exist or not, it is difficult to avoid feeling that Colonel Greenwood was warranted in his former incredulity upon the subject. W. STANLEY JEVONS

Trees Pierced by other Trees

UNDER this heading your correspondents discuss two distinct questions as if they were the same, namely the piercing of the stem of a tree by the head of another, as supposed by Mr. Murphy, and the growth of the *root* of a plant in or on another tree. Nothing can be more common than this last. Wherever soil aggregates the roots of seeds will grow as a matter of course. More than this, trees will strike roots into soil collected in their own forks, as I can show here, or down the rotten wood of their own trunks. A remarkable case of this may be seen in a yew tree in West Tisted churchyard near here. But nothing can be more opposite than the growth of the root and that of the head. The root grows to darkness; the head to the light.

Alresford, May 11 GEORGE GREENWOOD

[This correspondence must now end.—ED.]

The supposed Antipathy of Spiders to Chesnut Wood

SOME years back, while walking in the cloisters of New College, I remember a resident Fellow (since deceased) telling me that spiders were never known to occur in the woodwork of the roof, and attributing their absence to the chesnut timber, of which it was framed.

It has been asserted that this wood, which was formerly supposed to be that of the chesnut, really belongs to *Quercus sessiliflora*, but I do not know if that is still held to be the case.

The roof of Westminster Hall was at one time considered to have been constructed of chesnut; has any such story been heard of in connection with it? R. A. PRYOR

13 Bury Street, S.W.

*AN EXPERIMENTAL OBSERVATION ON HAY FEVER**

"THE accompanying brief but most interesting paper was received a day or two ago. Believing that it may bring relief to those who during the coming warm weather may be attacked with hay fever, Prof. Tyndall forwards it, with his compliments, to the editor of NATURE."

From what I have observed (says Prof. Binz) of recent English publications on the subject of hay fever, I am led to suppose that English authorities are inaccurately acquainted with the discovery of Prof. Helmholtz, as far back as 1868, of the existence of uncommon low organisms in the nasal secretions in this complaint, and of the possibility of arresting their action by the local employment of quinine. I therefore purpose to republish the letter in which he originally announced these facts to myself, and to add some further observations on this topic. The letter is as follows† :—

"I have suffered, as well as I can remember, since the year 1847, from the peculiar catarrh called by the English 'hay fever,' the speciality of which consists in its attacking its victims regularly in the hay season (myself between May 20 and the end of June), that it ceases in the cooler weather, but on the other hand quickly reaches a great intensity if the patients expose themselves to heat and sunshine. An extraordinarily violent sneezing then sets

* By Prof. Binz, of Bonn.
† Cf. Virchow's *Archiv*, vol. xlvi. p. 100.

in, and a strongly corrosive thin discharge, with which much epithelium is thrown off. This increases, after a few hours, to a painful inflammation of the mucous membrane and of the outside of the nose, and excites fever with severe headache and great depression, if the patient cannot withdraw himself from the heat and the sunshine. In a cool room, however, these symptoms vanish as quickly as they come on, and there then only remains for a few days a lessened discharge and soreness, as if caused by the loss of epithelium. I remark, by the way, that in all my other years I had very little tendency to catarrh or catching cold, while the hay fever has never failed during the twenty-one years of which I have spoken, and has never attacked me earlier or later in the year than the times named. The condition is extremely troublesome, and increases, if one is obliged to be much exposed to the sun, to an excessively severe malady.

"The curious dependence of the disease on the season of the year suggested to me the thought that organisms might be the origin of the mischief. In examining the secretions I regularly found, in the last five years, certain vibrio-like bodies in it, which *at other times I could not observe* in my nasal secretion. . . . They are very small, and can only be recognised with the immersion-lens of a very good Hartnack's microscope. It is characteristic of the common isolated single joints that they contain four nuclei in a row, of which two pairs are more closely united. The length of the joints is 0·004 millimetre. Upon the warm objective-stage they move with moderate activity, partly in mere vibration, partly shooting backwards and forwards in the direction of their long axis; in lower temperatures they are very inactive. Occasionally one finds them arranged in rows upon each other, or in branching series. Observed some days in the moist chamber, they vegetated again, and appeared somewhat larger and more conspicuous than immediately after their excretion. It is to be noted that only that kind of secretion contains them which is expelled by violent sneezings; that which drops slowly does not contain any. They stick tenaciously enough in the lower cavities and recesses of the nose.

"When I saw your first notice respecting the poisonous action of quinine upon infusoria, I determined at once to make an experiment with that substance, thinking that these vibrionic bodies, even if they did not cause the whole illness, still could render it much more unpleasant through their movements and the decompositions caused by them. For that reason I made a neutral solution of sulphate of quinine, which did not contain much of the salt (1:800), but still was effective enough, and caused moderate irritation on the mucous membrane of the nose. I then lay flat on my back, keeping my head very low, and poured with a pipette about four cubic centimetres into both nostrils. Then I turned my head about in order to let the liquid flow in all directions.

"The desired effect was obtained immediately, and remained for some hours; I could expose myself to the sun without fits of sneezing and the other disagreeable symptoms coming on. It was sufficient to repeat the treatment three times a day, even under the most unfavourable circumstances, in order to keep myself quite free.* There were then no such vibrios in the secretion. If I only go out in the evening, it suffices to inject the quinine once a day, just before going. After continuing this treatment for some days the symptoms disappear completely, but if I leave off they return till towards the end of June.

"My first experiments with quinine date from the summer of 1867; this year (1868) I began at once as soon as the first traces of the illness appeared, and I have thus been able to stop its development completely.

* There is no foundation for the objection that syringing the nose could not cure the asthma which accompanies hay fever; for this asthma is only the reflex effect arising from the irritation of the nose.—*B.*

"I have hesitated as yet in publishing the matter, because I have found no other patient* on whom I could try the experiment. There is, it seems to me, no doubt considering the extraordinary regularity in the recurrence and course of the illness, that quinine had here a most quick and decided effect. And this again makes my hypothesis very probable, that the vibrios, even if being no specific form but a very frequent one, are at least the cause of the rapid increase of the symptoms in warm air, as heat excites them to lively action."

I should be very glad if the above lines would induce medical men in England—the haunt of hay fever—to test the observation of Helmholtz. To most patients the application with the pipette may be too difficult or impossible; I have therefore already suggested the use of Weber's very simple but effective nose-douche. Also it will be advisable to apply the solution of quinine *tepid*. It can, further, not be repeated often enough that quinine is frequently adulterated, especially with cinchonia, the action of which is much less to be depended upon.

Dr. Frickhöfer, of Schwalbach, has communicated to me a second case in which hay fever was cured by local application of quinine (Cf. Virchow's *Archiv* (1870), vol. li. p. 176). Prof. Busch, of Bonn, authorises me to say that he succeeded in two cases of "catarrhus æstivus" by the same method: a third patient was obliged to abstain from the use of quinine, as it produced an unbearable irritation of the sensible nerves of the nose. In the autumn of 1872 Helmholtz told me that his fever was quite cured, and that in the meantime two other patients had, by his advice, tried this method, and with the same success.

THE COMING TRANSIT OF VENUS †

IV.

It has already been pointed out how unsatisfactory in some respects were the results of the observations made in 1761. Those of the year 1769 were more successful, but the discrepancies of different observers still threw a doubt on the result. After Encke had discussed with all possible care the observations made upon these two occasions,‡ doubts were still raised as to the correctness of the value thus found for the solar parallax. The reasons of these doubts were manifold. In the first place in order to get any value whatever of the solar parallax, Encke had been forced to assume that enormous errors had been committed by some of the observers; and again, all the other methods of which we have spoken were found to give a tolerably accordant value of the solar parallax, but values that differed considerably from Encke's determination.

It was with no small satisfaction then, that astronomers learnt that M. Powalky in 1864 had deduced a sensibly greater value for the solar parallax, by using more accurate values for the longitudes of the places of observation.

But Mr. C. J. Stone, now her Majesty's astronomer at the Cape of Good Hope, has lately re-discussed these observations. § He finds that when the remarks of the observers are rightly interpreted, all the observations agree without any extravagant errors of observations; and moreover, the value of the solar parallax thus deduced agrees with the values found by other means. Mr. Stone deserves the thanks of the scientific world for having convinced them that this method, which at one time was falling into disrepute, may really be rendered very trustworthy.

The result of Encke's determination was that the mean

* Helmholtz, now Professor of Physics at the University of Berlin, is although M.D., no medical practitioner.—*B.*
† Continued from p. 14.
‡ *Berlin Abhandlungen*, 1835, pp. 295-310.
§ Monthly Notices of the R.A.S., xxviii., p. 155.

distance of the sun from the earth is about 95 millions of miles. It now appears that the true distance is somewhere about $91\frac{1}{2}$ millions of miles. The annexed table gives the values of the sun's parallax and distance as determined by different methods.

Method.	Parallax.	Dist. of sun in miles.	Computer.
Transit of Venus * . .	8″·91	91,580,000	Stone
Opposition of Mars † .	8″·943	91,240,000	Stone
Lunar Theory ‡ . . .	8″·916	91,520,000	Hansen
Lunar Theory § . . .	8″·850	92,200,000	Stone
Planetary Theory ‖ . .	8″·859	92,110,000	Leverrier
Jupiter's Satellites and velocity of light ¶ .	8″·86	92,100,000	Foucault
Constant of Aberration and velocity of light **	8″·86	92,100,000	Cornu

The uncertainty of observation which Mr. Stone aimed at clearing away is one of a very curious optical character. It is found that Venus at the time when she has almost completely entered within the sun's disc does not retain her round aspect, but becomes pear-shaped, or at least connected with the sun's limb by a "black drop" or "ligament." This ligament sometimes appears simply as a fine black thread connecting the planet with the limb of the sun. One observer in 1769 saw a number of black cones shooting out to the sun's edge in a fluctuating manner.

Many of these phenomena were doubtless due to bad definition of the telescope employed, or to the instability of its mounting. But the existence of a "black drop" even under the most favourable circumstances cannot be doubted; it was well observed in the case of a transit of Mercury that occurred in 1868.†† If the planet be entering upon the solar disc, the first phase occurs when the edges of the sun and planet *seem* to be in contact. The second phase occurs at the instant when the "black drop" breaks off and a flood of light sweeps in between the planet and the sun. This occurs very suddenly, and has been supposed to indicate the true time of actual contact.

By referring to the *Philosophical Transactions* of 1769-70, a large number of descriptions of the phenomenon may be read. Some of the appearances are shown in Fig. 14, they are copied from the originals by Bevis, Hirst, Bayley, and Mayer, respectively—Prof. Grant states that the last one bears a resemblance to the appearance of Mercury as seen during its transit in 1868 from the Glasgow Observatory, the sun being near the horizon.

In the case of that transit of Mercury, studied by six experienced observers at Greenwich Observatory, two curious facts appear. Firstly, the times of contact as determined by different observers vary to the extent of $13\frac{1}{2}$ seconds. And secondly, the shape of the planet varied considerably with different observers.

Mr. Stone having noticed a confusion in the language of the astronomers of the last century as to which of the two phases was observed, carefully re-studied their words; and by supposing the two phases to be separated by a constant interval of time, he utilised both kinds of observation. This constant interval of time was deduced from all the observations, and found to be about 17 seconds. In this manner he arrived at the more accurate value of the sun's parallax.

It has been asserted that astronomers claim undue credit for the accuracy of their measurements, since Encke made an error of three or four millions of miles in the calculation of the sun's distance. This is not so. A chemist may be able to weigh many substances with an error of $\frac{1}{100}$ per cent. or less; but if the substance to be weighed be only $\frac{1}{100}$ of a milligramme, he might have a larger percentage error. When we consider how extremely small an angle the solar parallax is, it is astonishing to find so great a concordance between the results of different methods.

As to the cause of the phenomenon of the "black drop," Lalande ascribed it to irradiation. Irradiation is that curious phenomenon in virtue of which a star, or any bright object, appears larger than it really is. If a thin platinum wire be intensely heated by the passage of an electric current, it seems, to a person distant about fifty feet, to be as thick as a pencil. In this way the sun's diameter seems to be increased. The sun's light also encroaches upon the disc of the planet and makes it seem to be smaller than it really is. But when Venus and the sun have their edges almost in contact, as shown by the dotted line in Fig. 15, then there is no light at that point which can encroach; hence we see at this point the "black drop" to which allusion has been made.

Father Hell, one of the observers in 1769, ascribed the phenomenon of the "black drop" to the sensible size which an illuminated surface must have before it can be visible. There is probably some truth in each of these suppositions.

As to the cause of irradiation, it is difficult to speak with certainty. It is probably caused in part by the telescope and in part by the eye. Great confusion has been introduced by persons neglecting to separate two perfectly distinct phenomena. True irradiation is only observed with a powerful light. With less illumination similar results may be seen, but they are of a different nature, and are produced between the formation of an image on the retina and its reception by the brain. In accordance with the customary nomenclature, this error of vision may be called the *mental aberration* of the eye. It is a perfectly definite phenomenon capable of accurate investigation, and M. Plateau has made measurements of the mental aberration of his own and his friends' eyes.* True irradiation may be caused either wholly or in part, by the spherical aberration or the chromatic aberration of the eye, or by diffraction, or by a spreading of the excitement of the nerves of the retina, which gives rise to the sensation of vision over a sensible space. In a telescope it is probably chiefly due to diffraction.

The success or failure of all observations of contact in the coming transit will to a great extent depend upon our knowledge of the nature of this appearance. For this reason numerous experiments have been made with the object of gaining information upon the question. The Russians, Germans, Americans, and English have all mounted artificial transits of Venus for the practice of observers. The arrangement adopted by the Astronomer Royal consists essentially of a metal disc with two arcs of circles drawn upon it to represent the sun's edge with the metal between them cut away. Behind these there passes a glass plate with a circle of metal to represent Venus let into it flush with its surface. The glass plate is moved by clock-work so that the different phenomena are observed in succession exactly as they will be seen in the true transit. As the artificial planet passes in succession the two arcs representing the sun's edge, the phenomena of ingress and egress are successively observed. Before contact takes place, the sun has two cusps at the point of contact where Venus is touching the edge of the sun. The distance between the points of these cusps rapidly diminishes, the space between them being intensely black. They suddenly meet. But between the planet and the sun's edge a light shade is still seen which lasts several seconds before the planet appears completely detached. If instead of watching the meeting of the cusps, the part between them be studied, a sudden diminution of intensity of the blackness is seen

* Monthly Notices, xxviii., 255.
† *Ibid.* xxiii., 183.
‡ *Ibid.* xxiv., 8
§ *Ibid.* xxvii., 271.
‖ *Comptes Rendus*, July 22, 1872.
¶ *Ibid.* 1862, p. 502.
** *Ibid*, 1873. p. 341.
†† Monthly Notices, xxix., p 17, &c.

* Nouv Mém. de l'Acad. Royal de Bruxelles, t. xi. p. 1, &c.

about a second before the meeting of the cusps. The diminution of brightness is very sudden, and this is the phenomenon to be chiefly attended to in the actual observation. It occurs almost exactly at the moment of true contact, though the "black drop" does not disappear until some seconds later. It is of the utmost importance that the nature of these different phenomena should be carefully studied by all the observers. And at the present time experiments are being made with a view of determining the personal equation of each of the observers on the British expeditions.

But the actual observation will be rendered more difficult for various reasons. Firstly, the enormous extent of atmosphere which the rays of light must penetrate before reaching the telescope will destroy the definition to a large extent. Secondly, the existence of an atmosphere around the planet Venus may materially affect the nature of the phenomenon.

In any case there is little doubt that as many of the observers as possible of all countries should describe, as accurately as can be done, the exact appearances which are noticed at successive stages of the ingress and egress respectively. Comparisons being also made between different observers and between different telescopes, it will be possible to reduce the observation of any phase which may chance to be caught in the actual observation to the true time of contact. From observations with the Model Transit of Venus made at Greenwich, the following facts appear :—

1. It requires considerable experience for an observer to appreciate all the definite changes of appearance which occur.

2. When two observers describe a particular phase which they see, and determine to observe this phase together, the times recorded by each are generally accordant within a fraction of a second.

3. The successive phases of an ingress or egress appear to follow each other sometimes rapidly, at other times gradually; so that in some cases all the phenomena are observed within three seconds, on other occasions the same series of phases is completed in ten seconds.

4. The time at which any particular phase is observed varies very slightly with the aperture of the telescope. When a telescope of good definition is employed, the time of any phase at ingress is earlier than with an instrument of less perfect definition.

In the case of the observations of last century, it is easy to see how observers quite unprepared by previous observations as to the nature of the appearances they were about to witness were sometimes inconsistent with each other. In fact, without preliminary practice, and with bad definition, observers might vary even with a Model Transit of Venus by as much as 15 seconds. But, knowing what they are to observe, they would differ under no circumstances by more than about 2 seconds. Hence it is probable that in the actual transit, if the definition be good, the observation *may* be accurate to within one second; but if the circumstances be not very favourable, they may differ to an extent of fully three seconds, even after considerable practice with the model. These estimates serve to give us some idea of the accuracy with which we may hope to have the observations made; and it is probable, from the care which has been taken to multiply the number of observers at each station, that each pair of observations of contact will give us a determination of the parallax of the sun true to about $\frac{1}{3}$ per cent.

In the observations of contact, however, a great deal depends upon the experience of the observer; and it is fortunate that the idea originally thrown out by M. Janssen, and the mechanical execution of which has since been so ably carried out, will indelibly record the progress of the phenomenon and serve as a check to the observers.

By the aid of this method photographs of particular sun-spots have already been taken with great success at intervals of one second during one minute of time. Each of these sixty photographs is perfect in itself, and would admit of very perfect measurements. Hence there is every reason to believe that in this manner an independent and very valuable observation of the true time of contact will be made at each station where a photo-heliograph is situated.

The observations by means of photography during the progress of the transit have few difficulties to contend with. Their value will be largely increased by the fact that the actual measurements will be made afterwards when the observer cannot be carried away by the excitement of the moment. But even in this class of observation there are difficulties which must be carefully considered. It is found that if a sensitised plate be over-exposed, the image of the sun is considerably enlarged. This is due to *photographic irradiation*. It has been found by Lord Lindsay and Mr. A. C. Ranyard to be mainly due to the reflection of light from the back of the glass plate.* It can be almost entirely avoided by wetting the back of the plate, and placing black paper against it. There will still be probably a slight enlargement of the sun's diameter. This will not affect the relative positions of the centres of the sun and Venus; but it will render it extremely difficult to determine the unit of measurement.

There are two ways of applying the photographic method. The first is the same as the heliometric method. For this purpose it is necessary to have one station in the north and another in the south. By the other method we do not determine the least distance between the sun and planet, but the actual position of the planet at each observation. In other words, we determine the distance of Venus's centre from the sun's centre, and also the angular distance measured from the north point of the sun. To do this we must have in the focus of the photo-heliograph a fine thread to indicate the direction of the meridian in the photograph; or in the American method we must have a thread suspended vertically which shall indicate the vertical direction in the solar photograph. The arrangements of the American method, as set up by Lord Lindsay at Dunn Echt, are shown in Fig. 16. The siderostat, lens, and hut, are all shown in position.

The value of the different methods has been well discussed by De la Rue,† Tennant,‡ and Proctor.§ The method which takes into account the *actual* position of the planet on the sun is the more accurate, but it requires that the fiducial lines, or lines of reference, shall be exactly represented in the photographs. Mr. De la Rue says that this can be done to within one minute of space.

Besides photographic irradiation, however, there is a very important difficulty which enters into both the photographic and heliometric methods. This is due to the refraction of our atmosphere. Everyone knows the distorted forms which the sun assumes at the time of sunset. In our own climate these appearances are seldom seen on account of clouds and the haziness of the atmosphere. But even from a high mountain, or from any position which allows the form of the sun to be accurately seen up to the time of sunset, its shape may be noticed to be either square, elliptical, or pear-shaped, according to the circumstances of the atmosphere. Now at the most favourable points of observation the sun will be comparatively near to the horizon. Consequently its form will vary with the temperature of the air and with atmospheric disturbances. With our feeble knowledge of the laws of refraction it will be a matter of some difficulty to determine with accuracy the distance at different times between the centres of the sun and Venus.

* Monthly Notices of the R.A.S 1872, p. 313.
† *Ibid.* xxix., 48 and 282. ‡ *Ibid.* 283.
§ *Ibid.* xxx., 62.

The same remarks apply to the heliometric method. But with stations chosen where the sun is not too low, we

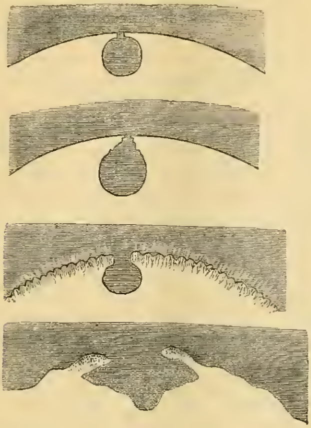


Fig. 14.—The "black drop" as observed in 1769.

may expect accurate results. The value of a heliometer over other instruments designed for measuring small angles consists in this, that by it we can measure angles as large as the sun's diameter. It is expected by observers with this method that an observation will be made each time with an accuracy comparable with that of an observation of the time of contact. In this case the heliometric method will give valuable results. For the

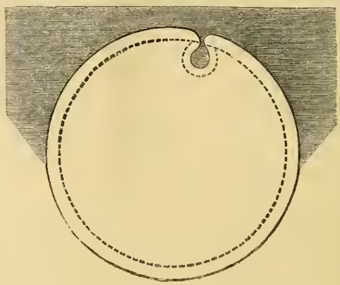


Fig. 15.

same reasons observations made by means of a double-image micrometer of the distance between the limbs of the sun and Venus near the time of contact will be as accurate as an observation of the contact itself.

The last difficulty which we shall mention in connection with this kind of observation is due to atmospheric

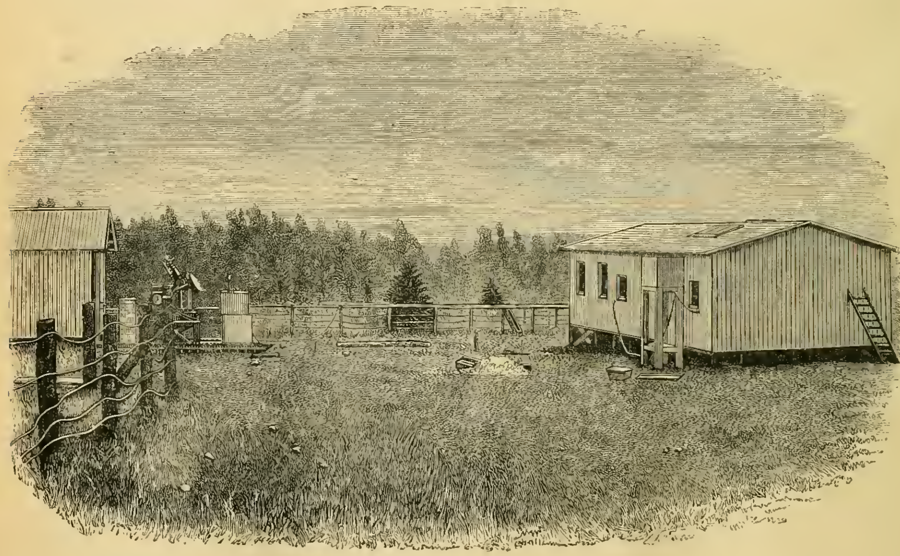


Fig. 16.—Lord Lindsay's Photographic Arrangements as set up at Dunn Echt.

conditions as affecting the apparent time of contact. With regard to the British expedition, great care has been taken to choose stations where the weather can be depended upon. But in cases where the method of duration is applied, the observations will be useless if there be not a very clear atmosphere both at ingress and at egress. De l'Isle's method, on the other hand, requires a perfect observation only at the time of one of these phases. Hence the nations which have adopted this method are less likely to be disappointed than others.

George Forbes

(*To be continued.*)

LARVÆ OF MEMBRACIS SERVING AS MILK-CATTLE TO A BRAZILIAN SPECIES OF BEE

MY letter in NATURE, vol. viii. p. 201, was incomplete so far as the names of the Brazilian insects alluded to are concerned, but I am now enabled accurately to name both the supposed milk-cow and the supposed milker. With regard to the former, Mr. Rogenhofer, of Vienna, has had the kindness to compare my specimens of Membracis with the collection in the museum of that metropolis, and informs me that my Membracis belongs to the genus *Potnia* of Stäl (*Umbonia* of Fair-

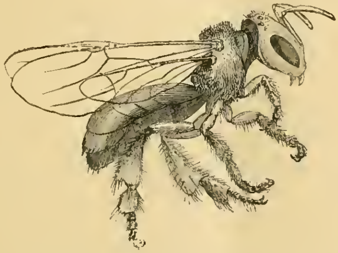


FIG 1.—Cacafogo, worker (side view).

maire), the species most probably being *indicator* Fairm. As to the Trigona species referred to in the above letter, I have in the meantime received numerous good specimens, not only a number of workers, but also some males, and even one queen. Mr. Frederick Smith has been good enough to compare my specimens with the collection in the British Museum and has found that they belong to an undescribed species. Having worked through the literature on Trigona and Melipona as completely as possible, and after perusing the descriptions of about one hundred species, not having found a single one of which all three kinds of individuals are known, I think it will

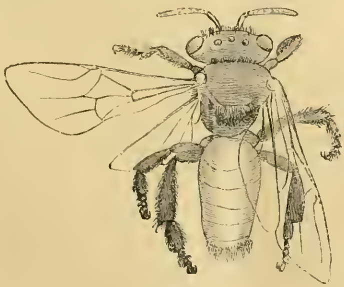


FIG. 2.—Cacafogo, male.

be welcome to the readers of this journal who are interested in entomology, if I do not restrict myself to merely mentioning the name and diagnostics of my new Trigona species, but give a description of its workers, male and queen, adding a brief account of its peculiar habits and economy from my brother's (Fritz Müller) observations.

*Trigona cagafogo**

Length of the workers and males 5—5½, of the queen 6—7 mm. Males and workers are almost alike in size, colour, and outline of the body, and are distinguished from most other species of the same genus by the breadth of their head and the narrowness of their abdomen, which, in the workers, scarcely exceeds half the breadth of the head. In the males the abdomen is equally slender, but the head somewhat less broad; in the queen the head is of the same size and form as in the workers, but the abdomen is so much dilated as to reach one and a half times the breadth of the head.

The head, tegulæ, scutellum, and abdomen, in all three kinds of individuals, are ferruginous, smooth and shining, the posterior margins of the vertex, of the scutellum and of the last segments of the abdomen have a

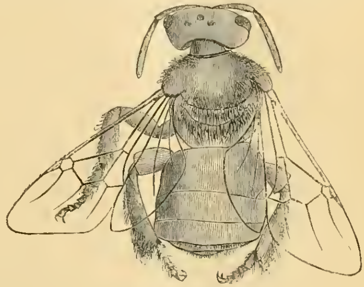


FIG. 3.—Cacafogo, queen.

black pubescence; the rest of the thorax, together with the legs, is black with black pubescence; the antennæ black, the greatest part (☿) or the whole (♂) of the scape rufo-piceous, the flagellum fuscous beneath. The wings by far exceed the abdomen; the basal portion and radical cell of the anterior wings dark fuscous; their apical portion and the posterior wings subhyaline; the stronger nervures brown, the feeblest ones pale ferruginous; no cubital cell at all. The mandibles with two teeth at their apex. The tibiæ triangular, their outside pubescent from the base to the middle, towards the apex slightly exca-

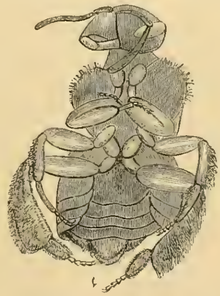


FIG. 4.—Cacafogo, queen (from beneath).

vated, smooth, shining, and naked. The whole body destitute of feather-like hairs. The unguiculæ of the males are, in this as in other Trigona and Melipona species, two-cleft; whilst those of the workers and females are simple. The queen, besides her larger size and the much dilated abdomen, differs from the workers by the colour of the head being somewhat paler, the antennæ longer, the thorax stronger, its anterior and lateral margins and two longitudinal streaks rufo fuscous, the anterior wings provided with a completely closed cubital cell, the legs larger and more robust, especially the anterior and middle tibiæ much thicker, the outside of the posterior tibiæ slightly convex and pubescent nearly

* I call the species Cagafogo, using the vernacular name for the specific one.

as far as the apex, the apex of the posterior tibiæ bordered with partly feather-like hairs.*

The nests of *T. cagafogo*, like those of many other species, are built in hollow trees. One of two nests which my brother had the opportunity of observing was found in a tree cut down a long time before; but its combs, lying in confusion, probably in consequence of the direction of the trunk having been altered by felling the tree, showed that the nest had probably been built before the tree was felled. In this nest, the inhabitants of which partly perished by having been plastered over with the honey which flowed from the damaged honey-pots during the transport, partly, as is to be supposed, flew away afterwards; besides a great number of workers and a small number of males, only a single queen was found, viz. that illustrated in Figs. 3 and 4. The honey-pots, of the size of large hazel-nuts, were closely aggregated together. The honey was of a very viscous consistence, partly as clear as water, partly lighter or darker yellow; its flavour appeared to my brother insipid, pituitous, and somewhat disagreeable (the latter perhaps, as he supposes himself, because he was conscious of the cagafogos feeding upon carrion). The brood-combs, as with other Trigonas, were simple layers of hexagonal upright cells. The wax, of which both the honey-pots and the brood-combs were built, was nearly of a pure white colour, but it was mixed with such an enormous quantity of heterogeneous ingredients (perhaps 90 per cent.) that the building appeared of a dirty brown or blackish colour.

Another nest, found by my brother in a trunk of *Canella pimenta*, about five meters above the ground, was brought safety home after cutting down the tree; but a week afterwards all the inhabitants had flown away.

The most striking feature in the natural history of this stingless bee is its fondness for oily matters, and its singular means of defence, connected with a great irritability. As I have already stated (vol. viii. p. 201) it feeds upon carrion; and is also fond of old stinking cheese. When visiting flowers, it seems to be also guided by its particular taste; it visits in swarms the flowers of a bean with glandular calyx; also a white-flowered Abutilon and *Sicyos angulata*, the flowers of which are glandular and secrete an oil. It was also observed fertilising the flowers of *Asclepias curassavica*, milking the larvæ of Membracis, repeatedly sucking the juice flowing out of trees, and devouring the sugar spread to be dried. Its singular means of defence are indicated by the vernacular name Cagafogo (spit-fire), for although stingless, like all other Trigonas and Meliponas, it possesses a very intense venom, which causes a most lively irritation in the skin. Whilst the defenceless species are for the most part very peaceable, the Cagafogos, on the contrary, are so irritable that the observation of their nests proves impossible, unless cold weather or strong breezes from the land keep them quiet.

Lippstadt HERMANN MÜLLER

THE MAMMALS OF MOUPIN

"WHERE is Moupin?" our readers will say, when they see the heading of this article. To this it may be replied that, if not already well known to zoologists, Moupin bids fair to become so very quickly, as it possesses one of the most strange and interesting faunas which have become known to us of late years. Moupin is the name of one of the small independent principalities lying on the extreme west of the great Chinese province of Setchuan. It does not appear to be marked on any of our charts, but if our readers will turn to the map of China and find Ching-tou, the capital of Setchuan, they will see still farther to the west a range of mountains designated the "Yungling Mountains," which separate China proper from Thibet. Amongst these the district called Moupin is situated.

The first and only European who has penetrated to this remote corner of the earth is the celebrated French traveller, Armand David, a missionary priest of the congregation of Lazarists, who has for many years, by permission of his superiors, devoted himself to the exploration of the Chinese flora and fauna. Père David left his mission in Pekin in May 1868, and travelled by the Yangze-kiang —the great high road into the interior of China—to Chong-kin. Hence he proceeded by land, leaving his baggage to follow by water, and after twelve days' journey reached Chong-tong, the capital of the great province of Setchuan, where there is a large Catholic mission, presided over by an Apostolic vicar. Hence to Moupin was eight days' journey farther westward, during the latter portion of which a mountain range nearly 10,000 ft. high was traversed. Père David's ordinary residence in Moupin was in one of the high valleys at an elevation of about 7,000 ft. above the sea-level, above which rose one of the principal mountains of the district to the height of 15,000 ft. Up to about 10,000 ft. dense woods of pines and cedars varied with rhododendrons, laurels, and magnolias prevail. During a ten months' residence in this locality, Père David formed extensive collections in every branch of Natural History, which were transmitted to the museum of the Jardin des Plantes at Paris. In a report* addressed to the professors of that establishment, which has been lately published in the 7th volume of the "Nouvelles Archives," Père David has given a complete list of the mammals of his collection, which embraces no less than 110 species. The novelties are shortly described by M. Alphonse Milne-Edwards, one of the naturalists of the Jardin des Plantes, who, however, is now giving a much more complete account of them in a large work on which he is engaged, entitled "Récherches sur l'histoire naturelle des mammifères." The following are some of Père David's most remarkable discoveries in Moupin in the class of Mammals.

Under the name *Rhinopithecus roxellanæ* is described a very singular new form of monkey, clothed with dense hair, and with a turned-up nose, which inhabits the highest forests adjoining the snow. A second monkey from the same mountains is described as *Macacus thibetanus*; and a third was ascertained to exist in the rocks of the more eastern part of the district, but was, unfortunately, not obtained.

Amongst the Insectivora, Père David's discoveries are also remarkable. Besides several species of shrew, of the known genera *Sorex* and *Crocidura*, a new form, allied to *Diplomesodon*, was discovered, which M. Milne-Edwards names *Anourosorex squamipes*. Still more curious is an entirely new aquatic form, allied to *Mygale*, which M. Milne-Edwards names *Nectogale elegans*. The moles are also represented in Moupin by two entirely new genera, *Uropsilus* and *Scaptonyx*, besides a new species of true *Talpa*.

The rodents of Moupin embrace several new species of *Mus*, *Rhizomys*, *Siphneus*, and *Lagomys*, besides squirrels of different genera: examples of thirty-six species in all were obtained. The carnivores also furnished some important novelties, three new polecats (*Putorius*), two new species of the badger-like form *Arctonyx*, and a new cat (*Felis*). But in this group the most industrious discovery was that of the *Ælurus fulgens*—hitherto regarded as a type peculiar for the higher Himalayas, and of its allied but larger brother *Æluropus melanoleucus*—one of the most wonderful of recent additions to the class of mammals. These two genera constitute a special family of carnivores, representing, in the Palæarctic region, the

* A more full and detailed description of this and some other new species will be given in a separate treatise on Trigona and Melipona, to be published by my brother and myself.

* Rapport addressé a MM. les Professeurs-Administrateurs du Muséum d'Histoire naturelle par M. l'Abbé Armand David. Nouv. Arch. d. Mus. vii. Bull. p. 75.

Procyonidæ of the New World. The *Ælurops* is a large bear-like animal clad in snow-white fur. It inhabits the highest forests, and is called by the Chinese hunters "*Pae-shioung*" or "white bear." Its food is said to be of a vegetable character.

Proceeding to the Ungulates, we find other very remarkable discoveries recorded. The singular form *Budorcas*, hitherto only known from the Mishmee Hills of Assam, a large antilopine-looking creature with a pair of in-curved horns, is also met with in Moupin. Three new *Nemorhedi*, or goat-like antelopes, are also in the list. But perhaps the most interesting of all Père David's discoveries in this order of mammals is a new form belonging to the family *Cervidæ*, which M. Milne-Edwards has termed *Elaphodus cephalophus*. It is intermediate between the muntjacks and the true deer, having the highly developed upper canines of the former, but possessing a minute pair of horns about an inch in length, covered by a long tuft of frontal hairs as in the antelopes of the genus *Cephalophus*.

Altogether, out of the 110 species of mammals obtained by Père David in Moupin, no less than forty turned out to be new to Science, amongst which, as will be seen from what we have said above, were many of the most remarkable characters. There can be little question therefore, we think, that Moupin presents one of the most extraordinary faunas as regards its mammals that has become known to us for many years. It must be conceded that the land is difficult of access, and that perhaps no living European, except Père David, clad in Chinese garments, and speaking the ordinary vernacular of the country, could have found his way there. It has been lately stated in a scientific periodical that zoology is at a discount in France, and that their recent contributions to this science have been of the most meagre description. The splendid discoveries of Père David, and the works of Alphonse Milne-Edwards in which they are described, are of themselves sufficient to refute such a baseless charge.

THE TRANSIT EXPEDITIONS TO RODRIGUEZ AND KERGUELEN'S LAND

SOME four years ago (NATURE, vol. i. p. 527), we directed attention to the desirable opportunity, presented by the Transit expeditions to several little-known spots in the Pacific, of sending out qualified Natural-History observers to the same islands, in order to obtain a knowledge of their flora and fauna. The astronomical stations selected as being especially worthy of this kind of research were the Sandwich Islands, Kerguelen's Land, and the Island of Rodriguez. This subject having been brought before the Council of the Royal Society last year, and thus to the notice of the Treasury, we are glad to be able to announce that, after certain little difficulties on account of the change of Government, the present ministry were induced to grant a sum of money sufficient to send out naturalists to two of these stations, and that arrangements are now being made for their speedy departure along with their astronomical brethren.

Three naturalists will proceed to Rodriguez, the most remote and least known of the Mascarene group of islands. Dr. T. B. Balfour, son of the well-known Professor of Botany of the University of Edinburgh, will devote himself to an examination of the general geological structure of this island, which presents features of the greatest interest, inasmuch as it forms one of the few exceptions to the general rule that all oceanic islands of the deep sea are of volcanic origin. Dr. Balfour will also collect the plants of Rodriguez so as to increase our acquaintance with the flora of the island, which has hitherto, we believe, been scarcely touched.

Mr. George Gulliver, of the University of Oxford, has undertaken the zoological department, and will form as complete a series as possible of the recent animals of the island of every kind. The fauna of Rodriguez, as is well known, is excessively meagre, but it is very desirable that what little endemic life there is left on it should be investigated and collected at once, as being the relics of a very peculiar phase of life which is now passing away very rapidly.

To Mr. Henry H. Slater, of the University of Cambridge, who has had good experience of cave-digging in the north of England, has been entrusted the task of the complete exploration of the limestone caverns of Rodriguez, which has been so ably commenced by Mr. Edward Newton, the Colonial Secretary of Mauritius, with successful results well known to the majority of our readers. We trust also that Mr. Edward Newton may himself be able to accompany the party to Rodriguez, in order to give them the benefit of his advice and assistance. If this can be arranged, there remains no doubt that the Rodriguez expedition will attain most successful results.

For the expedition to Kerguelen's Land, the second point to which it has been agreed that natural history investigaton shall be directed, one naturalist has been considered to be sufficient, regard being had to the well-known poverty of its flora and fauna, and to the fact that the *Challenger* expedition has paid, or will shortly pay, a visit to the island. For this post the Committee of the Royal Society has selected the Rev. A. E. Eaton, who has already distinguished himself by making excellent collections, both zoological and botanical, in Spitzbergen. Spitzbergen, as observed by Dr. Hooker, lies under somewhat similar conditions as regards climate in the northern hemisphere, to Kerguelen's Land in the southern, and there can be no doubt that a naturalist who has worked well in the former will have gained experience likely to assist him in the latter locality.

As regards the exact time of the departure of these two expeditions, we believe that nothing is yet finally settled; but it is probable that the naturalists will in each case depart in company with the astronomers, who are under orders to leave England in the course of the ensuing month.

NOTES

AT a meeting of Convocation of the University of London held on Tuesday evening last, a motion "That in the opinion of Convocation it is desirable that women should be permitted to take degrees in the University of London," was carried by a majority of 83 against 65. The subject will, it is said, shortly be brought before the Senate, with whom originates all fresh legislation, Convocation having only a power of veto.

AT the same meeting a motion urging the Senate not to permit the practice of vivisection to be carried on in the physiological laboratory of the Brown Institution under any circumstances except for medical or curative purposes, was lost by a majority of 59 against 16.

WE have, on more than one occasion, spoken of the disgraceful way in which the Natural History Collections belonging to the defunct East India Company have been treated. They have been "boxed up" several years and deposited in the cellars of the India Office, so that they cannot be got at even when access to a particular type-specimen is requisite to enable a naturalist to determine a *vexata quæstio*. On the 5th inst. Sir John Lubbock endeavoured to ascertain from the Under-Secretary for India whether there is any prospect of the grievance being remedied, but did not succeed in getting much more than the cautious reply that the subject was "under consideration." We believe, however, that there is really a negociation for the transfer of the whole of the collection to South Kensington, in accordance with the suggestion put forward in our article on this

subject in NATURE, vol. vii. p. 457, and are glad to recognise that the present Government show some symptoms of paying attention to the just claims of scientific men.

THE Senate of the University of Cambridge last week conferred a great boon on students of Natural Science who intend going to the University, by deciding to accept the certificate of the Leaving Schools Examination in lieu of the Previous Examination. The student who obtains this certificate, passing the examination with distinction, will be able to enter uninterruptedly upon the pursuits of Natural Science as soon as he goes up to the University, and will therefore be able to attain greater proficiency than has hitherto been the case. The examination is, we believe, likely to be a very thorough one, but the particulars can be obtained through the "Regulations of the Oxford and Cambridge Schools Examination Board," which may be obtained for a shilling at any bookseller's.

TRINITY COLLEGE, Cambridge, offers one or more foundation scholarships of the value of 100*l*. per annum. The examination will be open to all undergraduates of Cambridge who have passed the Previous Examination. Also an exhibition of the value of 50*l*. per annum. This examination to be open to all persons under 20 who have not commenced residence at the University. The examination will commence on March 30, 1875. Candidates must send certificates of age and moral character to one of the Tutors of Trinity before March 13.

THE use of a lecture-room in the New Museums, Cambridge, has been granted to Dr. Carpenter for the purpose of giving a lecture on some of the results of the voyage of the *Challenger*.

THE visit of the *Challenger* to Melbourne has been exceedingly pleasant. Free passes have been granted by the railway companies in the most liberal fashion, and excursions have been the order of the day. Letters will reach the *Challenger* if directed to Sydney, by the mails leaving London *via* Brindisi, May 15, *via* San Francisco, June 3. They will find the ship at Somerset, Cape York, on August 16. Letters to Singapore should be sent *via* Southampton, June 18, and July 16; *via* Brindisi, June 26, and July 24.

THE Council of the Society of Arts has fixed Wednesday, May 20, for a general meeting on the subject of Public Museums and Galleries. To it will be invited the Mayors of Corporations, Chairmen of Art and Science Schools, and others interested in the question. The object of the meeting will be to name a deputation to wait upon the Prime Minister, and urge upon him the importance of bringing all National Museums and Galleries under the authority of a Minister of the Crown, with direct responsibility to Parliament; and also of causing all such museums to be made conducive to the advancement of education and technical instruction. The chair will be taken by the Right Hon. Lord Hampton, at 12 o'clock.

THE annual meeting of the Iron and Steel Institute was held on the 6th, 7th, and 8th inst., under the presidency of Mr. J. Lowthian Bell, M.P. The president's address as well as the papers read were almost entirely of a technical nature. The Bessemer medal founded by Mr. Bessemer since the last meeting of the Institute, was awarded to Mr. Lowthian Bell. According to the Report of the Council, the number of members was 644, showing an increase of 122 since the last annual meeting. In Friday's sitting Mr. G. W. Maynard read a paper On the iron ores of the Lake Champlain region. The author gave a topographical and geographical description of the district, and placed before the meeting a large amount of information respecting the minerals existing throughout the whole of the United States.

WE regret to learn the death of Dr. Meissner, the eminent botanist, which took place on the 2nd inst. at Bâle, in the 64th year of his age, "après de longues souffrances." He was a foreign member of the Linnean Society.

MR. EDWARD BARTLETT has been appointed Curator of the Maidstone Museum, which contains so many objects of interest collected by the late Mr. Julius Brenchley in his numerous and extended travels.

IN reply to a question on Monday in the House of Commons Mr. Disraeli said that the claims of the late Dr. Livingstone' family "will be considered by her Majesty's Government, and, if they think they ought to be provided for, we shall not hesitate to ask the House to grant such a vote as they think would be proper under the circumstances." The ways of "her Majesty's Government" are mysterious. Chumah and Susi, Dr. Livingstone's two faithful servants, are expected to arrive at Southampton in the next homeward-bound Indian mail steamer.

THE Rev. Charles New has just left England for the scene of his former labours in Eastern Africa. After investigating some of the less-known portions of the coast he purposes to press forward into the interior in the direction of the sources of the Nile.

A sharp frost set in in many parts of France on May 4-6, and destroyed a quantity of young plants, especially in vineyards. The occurrence had been predicted by M. Sainte Claire-Deville, who is now in Algeria for the purpose of organising meteorological observations in the remotest French desert stations. The disasters are serious, although they do not endanger the future crops and vintage. Several agricultural papers propose to protect young plants against cold spring nights by covering them with canvas or burning substances which produce much smoke, in order to create artificial clouds over the fields. It remains to be seen with what success such schemes, which appear rather rash, may be followed.

WE have received a few additional letters on the destruction of flowers by birds, which we have forwarded to Mr. Darwin.

AT a meeting of the Alpine Club on the 5th inst., Mr. W. S. Watts spoke of a proposed exploration of the Vatna Jökull, Iceland. An exploration devoted to this purpose would, he observed, possess peculiar interest, since the vast area known as the Vatna Jökull, situated on the south-eastern side of the island, is at present wholly unexplored. Mr. Watts visited Vatna Jökull and spent some time upon it in 1871, in company with his friend Mr. John Milne, F.G.S. So far as they could determine, Vatna Jökull, with its surrounding jökulls, was an aggregation of volcanoes and glaciers, encompassed on all sides by a desert formed by the action of the sea, huge lava streams, and fragmentary ejectments and detritus brought down by the flooded rivers incidental to volcanic eruptions. The object of the proposed expedition is to cross and explore Vatna Jökull, to reach, if possible, the seat of present volcanic activity, and to determine the character and position of any other phenomena it might contain. In order to accomplish this it is essential that his party should not be less than six in number. Three gentlemen have already promised to accompany him, and he hopes that from the club, or others who might hear of his undertaking, he may get four more to join him. He proposes to start on May 31, and remain away about three months, and that should his party consist of eight the expenses would not exceed 50*l*. per man.

A NEW drug from Brazil has appeared in France, under the name of Jaborandi. It consists of the leaves and small branches of a shrub growing in the interior of some of the northern provinces of Brazil, and from specimens which have come into the hands of Prof. Baillon, it seems that the plant is the *Pilo-*

carpus pinnatus Lem., belonging to the Rutaceæ. It is stated that this drug has been used with great success in France, and that it is looked upon "as an incomparable diaphoretic and sialogogue." Dr. Gubler expresses himself in the belief that it "will be the first indisputable example of a diaphoretic truly worthy of the name; that is to say, a medicine having the power of provoking directly by an electric action the secretion of perspiration."

In the same manner as the lichen dyes have been superseded by those derived from coal tar, so the demand for madder roots seems to be rapidly falling off, owing to the discovery of alazarine. In a report on the trade of Beyrout, it is stated that heavy losses have been incurred in the article, owing to its great fall in value in the English markets from the cause above stated; indeed it is said that so far as England is concerned, the trade in this article with Beyrout has almost, if not quite, ceased. Its cultivation, however, in this neighbourhood, has never been on a very extensive scale, being confined to a few outlying districts; it is, moreover, very exhaustive to the soil. Nevertheless, in the early part of the year 1872, 2,300 cwt. of the value of 5,728*l.* were shipped from Beyrout to English ports.

We have just received the publications of the "Bataviaasch genootschap van Kunsten en Watenschappen" for 1873. In the "Tijdschrift" is a short paper on Rotti, by Mr. Jackstein, a missionary in the island, followed by another paper by him on the Rotti words in use by the Malay-speaking people in the district of Koepang. Several papers are devoted to the accounts of the suppression of piracy, which has so long been a characteristic of the Malay race. Dr. Adolf Meijer has also communicated a paper On the Language spoken in Mendanoa, Solog, &c.

Prof. William M. Gabb, of Philadelphia, who is at present engaged in an exhaustive geological exploration of Costa Rica, has lately made a very important discovery in reference to the sedimentary rock on the Atlantic slope of Costa Rica, namely, that even such portions as are auriferous are not earlier than the Tertiary. Indeed, in Prof. Gabb's opinion, they are of Miocene age, which is, of course, strongly in contradiction of the hypothesis of Sir Roderick Murchison, that gold is of Silurian origin.

The last part of the Transactions issued by the Geological Society of Manchester contains a paper by Mr. S. Aitken, On the Discovery of the new Fish of the Genus *Acrolepis* Ag. in the millstone grit near Habden Bridge, Yorkshire. There is also a paper On the Economic Value of Heat Fuels, by Mr. Plant.

A curious phenomenon happened at Belfast recently while some men were sinking a well. A light having been let fall, a flash overspread the bottom of the well; and a pipe about 60 ft. long having been conveyed from the bottom of the well to the second storey of a building, the gas was ignited, and continued burning all day. The strata passed through in digging the well were esturine, clay, gravel, boulder clay, and New Red sandstone. The gas has been proved to be marsh gas (carburetted hydrogen) probably generated in the decomposed vegetable matter, which abounds in the lower stratum of the esturine clay, in which were also vast numbers of fossil shells.

One of the most elaborate mineralogical papers that has appeared for some time in the United States, with the exception of Dr. Genth's on corundum, is that by Prof. Josiah P. Cooke, jun., upon the vermiculites, and their crystallographic and chemical relations to the micas, together with a consideration of the variation of the optical angle in these minerals. This appears in the Proceedings of the American Academy of Arts and Sciences, and is to be considered as a very valuable contribution to the science of mineralogy.

We have received a very interesting map of Victoria showing the distribution of forest trees in that colony by an ingenious arrangement of different colours. It is compiled by Mr. Arthur Everett from the Record Maps in the Office of the Surveyor-General, under the direction of Mr. R. Brough Smith. The map is accompanied by notes on the various trees by Dr. F. von Mueller, Government Botanist.

A Madeira correspondent writes us concerning the damage caused to objects of natural history from cedar-wood cases. A naturalist in Madeira, to do his collection of the remarkable land shells of the island more honour, had made for them a case of this wood. Unobserved for a month, the shells were found drenched with the turpentiny resin exhaling from the wood. Shells covered with a rough epidermis seemed to have attracted the oil less. *Craspedopoma*, and the smooth fresh-water shells had specially suffered; semi-fossils full of sand had escaped; all others, whether recent or semi-fossil, had suffered to such an extent that the cardboard to which they were attached was in many cases soaked. This occurred, however, only when the affixed shells offered the needful point of attraction and condensation.

We have received an appendix to the Annual Report for 1873 upon the Survey of the (U.S.) Northern and North-western Lakes in charge of Major C. B. Comstock. Notwithstanding much unfavourable weather, a great deal of work has been done. It was expected that a continuous chain of triangulation, reaching from St. Ignace Island, on the north shore of Lake Superior to the southern end of Lake Michigan, a distance of 500 miles, would be completed during 1873. It has been measured with sufficient precision to give an arc of the meridian 7° in length. This is the longest arc measured on the American continent, and it is hoped to extend it further south.

The additions to the Zoological Society's Gardens during the last week include a Capybara (*Hyrochœrus capybara*) and a Coypu (*Myopotamus coypus*) from S. America, presented by Dr. H. Young; a Garnett's Galago (*Galago garnetti*) from E. Africa, presented by Mr. R. H. Cusack; an African Civet Cat (*Viverra civetta*) from the Gold Coast, presented by Mr. W. B. Ramsay; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Mr. H. Humphry; a Sun Bittern (*Eurypyga helias*) and seven Upland Geese (*Chloëphaga magellanica*) hatched in the gardens; a Black Saki (*Pithecia satanas*) and a Red-backed Saki (*P. chiropotes*) from S. America, deposited; a Blue-faced Green Amazon (*Chrysotis bouqueti*) from Honduras, purchased. Of this last-named bird Dr. Finsch, in his monograph on the parrots, remarks that he has never been able to find a skin in any of the many museums to which he has had access.

SCIENTIFIC SERIALS

The *Journal of the Chemical Society* for March contains the following papers read before the Society:—On the preparation of standard trial plates to be used in verifying the composition of coinage, by W. Chandler Roberts, chemist of the Mint. The author had been instructed by the Lords of the Treasury to prepare new plates of gold and silver for comparing annually with the coinage being issued, in order to guarantee the fineness of the latter. The gold plate consists of an alloy of copper and gold ranging in composition in its different parts from 916·5 to 916·7 parts of fine gold in 1,000 (the standard is 916·66). This plate did not present much difficulty in its preparation, since the two metals were obtained in a state of perfectly homogeneous mixture after repeated meltings. The silver plate presented much greater difficulty owing to the tendency of the silver to concentrate itself in the centre of the mass. The difficulty was overcome by casting the alloy into a plate, which was then planed down on both surfaces and afterwards greatly extended by roll-

ing; a portion cut out from the side of this plate served for the new trial plate. Its composition ranges from 924·6 to 925·1 parts of pure silver per 1,000 (925 being the standard). The author has also constructed supplementary plates of pure silver and gold. An interesting table of assays of trial plates from 1477 down to the present time is given.—Mr. J. Hannay contributes a description of a sp. gr. apparatus for temperatures other than atmospheric.—Dr. Gladstone and Mr. Tribe give the fourth part of their researches on the action of the copper-zinc couple on organic substances. They have now turned their attention to the series containing the $C_nH2_n-_1$ radicals, the first body acted upon being iodide of allyl, which yields with the dry couple a resinous body of the formula $n(C_3H_4)$, but when mixed with ether rapid decomposition sets in at ordinary temperatures, and the ethereal solution gives zinc oxide on mixing with water. All attempts to isolate zinc-allyl have, however, failed. Allyl iodide and water acted upon by the couple give propylene $C_3H_5I + H_2O + Zn = ZnI.HO + C_3H_6$. The iodide mixed with alcohol is acted upon violently by zinc alone yielding propylene $C_3H_5I + C_2H_6O + Zn = Zn \left\{ \begin{matrix} C_2H_5O \\ I \end{matrix} \right. + C_3H_6$.—On ferrous anhydro-sulphate, by T. Bolas. A mixture of 10 per cent. of a saturated aqueous solution of ferrous-sulphate with oil of vitriol deposits, on cooling, small white prismatic crystals having the formula FeS_2O_7. When exposed to moist air the anhydrosulphate yields granular crystals of the formula $FeSO_4.6H_2O$.—On tetranickelous phosphide, by Dr. R. Schenk. This substance (Ni_4P_2) was obtained by adding a sufficient quantity of tartaric acid to a solution of nickelous chloride, to prevent precipitation by potash, boiling the potash solution with phosphorus and then drying the precipitate in a stream of hydrogen. The remainder of the journal is devoted to the usual abstracts from other journals, British and foreign.

Poggendorff's Annalen der Physik und Chemie, No. 2, 1874.—In the commencing paper, by M. Hermann Herwig, it appears demonstrated that the conducting power of mercury, for heat, is perfectly constant between 40° and 160°.—A continuation of Julius Thomsen's Thermo-chemical Researches treats of several agents of oxidation and reduction; and in the next paper, Dr. Röntgen discusses several points connected with M. Kundt's dust-figures (produced when a metallic plate, strewn with lycopodium, receives an electric spark): the dependence of the size of the dust-circle on the nature of the gas in which the discharge occurs; on the thickness of the lycopodium layer; on the distance of wire-point from plate; and on the kind of electricity that is in the plate. He also studies the mode of production of the figure, the nature of the discharge, and the phenomena to which Prof. Guthrie lately called attention.—The concluding portion of M. Braun's paper on elastic vibrations whose amplitudes are not infinitely small, is given. Various experiments were made with steel rods, and it is shown that the pitch of tone decreases if the amplitude increases, and that with high tones the influence of amplitude is greater than with low. The deadening is dependent on pitch of tone (being greater for higher tones), on amplitude (the influence of which is also greater the higher the tone), and on figure of vibrations (those in one direction being more deadened when there are simultaneous vibrations in the direction at right angles).—This article is followed by a translation of Prof. Roscoe's account of a self-registering instrument for meteorological measurements of light.—A paper by M. Friedrich C. G. Müller (first part) has for its subject galvanic polarisation, and the distribution of the current in electrolytes. The author's experimental plan was (1) to vary the section and length of a parallelipipedal electrolyte, and the size of the pole plates, and determine each time the resistance; (2) to insert metallic conductors of small resistance (*e.g.* thick copper-wire) in the long direction of the liquid conductor, but not touching the electrodes, and measure the increase of conduction; (3) to measure the current-density in different portions of any section by the electrolytic action taking place on a small plate brought to that part.—M. Avenarius has a paper On internal latent heat, in which he arrives at the conclusion that the temperatures (determined by direct observations) of the volatilisation of a liquid in a hermetically-closed space, perfectly agree with those calculated on the basis of empiric formulæ for internal latent heat. The experiments were made with ether, sulphide of carbon, chloride of carbon, and aceton.—Prof. Julius Kohn proposes a simplification of König's method of manometric flames, doing away with the membrane, and making the sound pass from the mouth of an organ-pipe, *e.g.* through a narrow glass tube, directly to the base of the flame (whose motions are mirrored in the revolving case, as usual)—In an article On the motion and action of glaciers, Dr. Pfaff describes some very delicate measurements he lately made on the Aletsch glacier, which seemed to prove that the progressive motion of the ice took place without any break. A minimum motion of 8 mm. per hour was observed at noon, and a maximum of 30 mm. about 5 P.M.; the latter being thus nearly four times the former. Dr. Pfaff also urges a number of considerations against certain theories of valley-formation by glaciers.—The only remaining paper is one On function of magnetisation of various iron bodies, by Prof. Stoletow, of Moscow.

Der Naturforscher, March.—In this number are described a series of experiments by M. Hansemann, who considers they demonstrate the production of a difference of temperature, in columns of air, by the attraction of the earth.—An account is given of recent observations by Dr. Boltzmann, on what he calls "dielectric action at a distance." If the hypothesis be correct (he argued), that in the molecules of an insulator, by electric forces, positive electricity is driven to one side and negative to the other, then an originally unelectrified, insulating body brought near one which is charged with electricity, must be attracted by it, simply through dielectric polarisation of the molecules, and without conduction; in fact, as a piece of soft iron is attracted to a magnet. Experiment confirmed this; and he determined, by his new method, the "dielectric constants" of several insulating substances.—We might here also call attention to M. Barthelemy's striking experiments in vibration forms, produced at the surface of liquids by means of vibrating tuning-forks. In square vessels containing mercury, systems of bright lines appear parallel to the sides, and the breadth of the waves is in inverse proportion to the number of vibrations. In this way is explained Prof. Tyndall's observation that many liquids are not set in wave-motion by vibrations. Such is the case when the breadth of the waves is greater than the breadth of the vessel; there can only then be a motion of the whole surface. The distance between two lines corresponding to the same pitch of fork is found to be independent of the density of the liquid. M. Barthelemy experimented also with round, three-cornered, and elliptical vessels, and on the rhythmical vertical flow of water from narrow orifices.—M. Spörer adduces evidence of the presence of ascending and descending currents in the atmosphere of the sun.—There are also, in the physical department, notes of Helmholtz's researches on galvanic polarisation in gasless liquids, Lockyer's on spectrum analysis of metals, Tyndall's on conduction of sound through the atmosphere, &c.—In geology, we find a summary of M. Laube's late observations as to the evidence of a much more intense Ice-period in Greenland than the present; while M. Fuchs describes the geological formation of the region about Nizza, south of the Maritime Alps.—Two curious cases of mimicry in the Articulata are discussed in a note by M. Gerstaecken, who theorises on the nature of the general phenomenon; and there is, in the same section, a paper by M. Milne-Edwards, in which the colour of birds is studied in relation to their geographical distribution.—In botany, lastly, the following topics are treated; immigration of a rust fungus, *Puccinea malvacearum* (from Chili); light and the regeneration of albuminous matter from asparagine; and the electrical phenomena in the leaves of Dionæa.

SOCIETIES AND ACADEMIES

London

Royal Society, April 30.—On Leaf arrangement, by Hubert Airy, M.A., M.D. Communicated by Charles Darwin, F.R.S. Received March 23, 1874.

The author is led to suppose: —

I. That the original form of leaf-arrangement was two-ranked.

II. That this original two-ranked form gave rise to forms with 2, 3, 4, 5, 6, 7, &c., ranks, by "sporting," as opposed to any process of accumulative modification.

III. That, of the orders so formed, those with an even number of ranks (except 2) have, as a rule, assumed a *whorled* arrangement, and those with two or an odd number of ranks have assumed an *alternate* arrangement, under the need of lateral accommodation of ranks in the bud (taken as type of close-packed forms).

IV. That all these orders have been subject to vertical condensation, under the need of vertical economy of space in the bud (taken as type of close-packed forms).

V. (*a*) That such condensation operating on a 2-ranked or 3-ranked or 5-ranked alternate order $\left(\frac{1}{2}, \frac{1}{3}, \frac{2}{5}\right)$ has produced subsequent orders of series A $\left(\frac{1}{2}, \frac{1}{3}, \frac{2}{5}, \frac{3}{8}, \frac{5}{13}, \frac{8}{21}, \frac{13}{34}, \frac{21}{55}, \frac{34}{89}, \frac{55}{144}, \text{\&c.}\right)$.

(*b*) That condensation of a 7-ranked $\left(\frac{2}{7}\right)$ or rarely of a 3- or 4-ranked $\left(\frac{1}{3}, \frac{1}{4}\right)$ alternate order has produced subsequent orders of series B $\left(\frac{1}{3}, \frac{1}{4}, \frac{2}{7}, \frac{3}{11}, \frac{5}{18}, \text{\&c.}\right)$

(*c*) That condensation of a 9-ranked $\left(\frac{2}{9}\right)$ or rarely of a 4- or 5-ranked $\left(\frac{1}{4}, \frac{1}{5}\right)$ alternate order has produced subsequent orders of series C $\left(\frac{1}{4}, \frac{1}{5}, \frac{2}{9}, \frac{3}{14}, \frac{5}{23}, \text{\&c.}\right)$.

(*d*) That condensation of a 4-ranked whorled order (whorls of two) has produced successive orders of series α, with spirals in sets of 4, 6, 10, 16, 26, 42, &c

(*e*) That condensation of a 6-ranked whorled order (whorls of three) has produced successive orders of series β, with spirals in sets of 6, 9, 15, 24, 39, &c.

(*f*) That condensation (if any) of an 8-ranked whorled order (whorls of four) would produce successive orders of series γ, with spirals in sets of 8, 12, 20, 32, &c. Higher numbers of ranks would lead to higher series.

The Structure of the Mucous Membrane of the Uterus and its Periodical Changes, by John Williams, M.D., Assistant Obstetric Physician to University College Hospital. Communicated by Dr. Sharpey.

On the Improvement of the Spectroscope, by Thomas Grubb, F.R.S.

The author refers to a statement appearing in the "Astronomical Notices" for March, viz. that the spectral lines can be rendered perfectly straight, simply by returning them (after their first passage through a series of prisms arranged for minimum deviation) by a direct reflection from a plane mirror; and further, that this has been accomplished in a spectroscope in construction for the Royal Observatory. He then shows reasons for doubting the accuracy of this statement.

The remedy, or means of producing straight spectral lines, which the author has alluded to is simply that of constructing the "slit" with curved edges instead of rectilinear. There is but little practical difficulty incurred in construction and no apparent objection to its use. It may be objected that for such variation of prism power in use there should be a special slit. It is, however, only in spectroscopes arranged for high dispersion that the curvature becomes objectionable; in such there is seldom a change required, and a single slit of medium balancing power would probably remove all practical difficulty or objectionable curvature of the lines. The author has found by trial, that when two compound prisms were in use, giving a dispersion from A to H of nearly 14°, that the spectral lines were straight in a field of one degree when the radius of curvature of the slit was made 1·25 inch.

Zoological Society, May 5.—Dr. E. Hamilton, vice-president, in the chair.—The secretary read a report on the additions that had been made to the Society's Menagerie during the month of April 1874, amongst which were a Vigne's Sheep (*Ovis vignii*), presented by Capt. Archibald; a white-cheeked flying squirrel (*Pteromys leucogenys*), presented by Mr. A. Gower; a new kangaroo (*Halmaturus luctuosus*), deposited by Sig. L. M. d'Albertis, and four bladder-nosed seals, presented by Capt. D. Gray and Capt. Alexander Gray.—Mr. Sclater made some remarks on the cassowary, living in the Society's Gardens, hitherto called Kaup's cassowary, which, it appeared, ought to bear the name *Cassuarius papuensis*.—Mr. Sclater announced that H.M. Government had consented to send a Naturalist to Kerguelen's Land to accompany the Astronomical Expedition shortly proceeding there, and that the Rev. A. E. Eaton had been selected by the Royal Society for the post.—Mr. Blandford exhibited and made remarks on a series of heads of the Ibex of Persia, which he considered to be referable to *Capra ægagrus*.—Mr. A. H. Garrod read a paper on the anatomy of the Columbæ, in which a new arrangement of that group of birds was proposed, based upon certain points not hitherto sufficiently investigated.—A communication was read from Dr. Julius Haast, containing the description of a new species of *Euphysetes* (*Euphysetes pottsi*), a remarkably small catodont whale, which had occurred on the coast of New Zealand.—A communication was read from Mr. Frederick Moore, containing a list of Diurnal Lepidoptera collected in Cashmere by Capt. R. B. Reed, 12th Regiment, with descriptions of new species.—A communication was read from Mr. A. G. Butler, containing a complete list of the known Diurnal Lepidoptera of the South Sea Islands.—Mr. Howard Saunders read a paper on the Grey-capped Gulls, in which several species hitherto confounded were distinguished.—A paper was read by Dr. A. Günther, F.R.S., entitled A contribution to the fauna of Savage Island, in which several new lizards peculiar to the island were described, and other animals found in i were mentioned.—A communication was read from Dr. J. S. Bowerbank, F.R.S., containing the sixth part of his "Contributions to a General History of the Spongiadæ."—Mr. R. B. Sharpe read a paper on a small collection of birds made in Bulama, one of the Bissagos Islands, West Africa, by Lieut. Bulger.

Chemical Society, May 7.—Prof. Odling, F.R.S., president, in the chair.—A paper On the action of ammonia on phenylic and cresylic chloracetamide, was read in French by the author, Dr. D. Tommasi.—Researches on the action of the copper-zinc couple on organic bodies; Part VII. On the chloride of ethylidene and ethylene," by J. H. Gladstone, F.R.S., and A. Tribe, F.C.S. The authors find that these two isomerides behave differently when treated with the couple, the latter splitting up into ethylene and chlorine, whilst the former gives zinc chlorethylate, $\left.\begin{matrix}C_2H_5O\\Cl\end{matrix}\right\}Zn$.—Mr. Charles E. Groves then read a note On the preparation of ethyl chloride and its homologues. He finds that when hydrochloric acid is passed into a boiling solution of zinc chloride in alcohol, the latter is completely converted into ethyl chloride; other alcohols, such as the methylic and amylic, under similar treatment yield the corresponding chlorides.—On a new mineral from NewCaledonia, by Mr. A. Liversidge.

Geological Society, April 29.—John Evans, F.R.S., president, in the chair.—The following communications were read:—On the Gault of Folkestone, by F. G. H. Price. The author divided the Gault into two great sections, Upper and Lower Gault, which he again subdivided into eleven well-defined zones, mostly named after characteristic ammonites. Each of these zones or beds is numbered, commencing with No. XI., the zone of *Ammonites interruptus*, which bed forms the base of the Gault, reposing upon the Folkestone beds of the Upper Neocomian. He found the thickness of the deposit at Copt Point to be 99 ft. 4 in.—On the Cretaceous Rocks of Beer Head and the adjacent cliff-sections; and on the relative horizons therein of the Warminster and Blackdown fossiliferous deposits, by C. J. A. Meyer. The author remarked that in advancing westward from the Isle of Wight the cretaceous rocks diminish steadily, although unequally, in thickness, and change slightly both in mineral character and fossil contents, while the base of the series rises gradually in the cliff-sections. The chalk-cliffs of Beer Head, the most westerly chalk promontory in England, owe their preservation, in his opinion, partly to a local synclinal arrangement of the strata. The cretaceous rocks of the district include the following, in descending order:—

Upper Chalk (in part)?
Medial Chalk.
Lower Chalk.
Chalk Marl.
Chloritic Marl.
Upper Greensand.
Gault.
(?)

Royal Astronomical Society, May 8.—Sir G. B. Airy, vice-president, in the chair.—Prof. Otto Struve read a paper On the irregularities in the proper motion of Procyon. He said that last year Prof. Auwers of Berlin had expressed grave doubts as to the possibility of the minute companion of Procyon being sufficiently large to account for the observed irregularities in the motion of the principal star; he had calculated that it would be

necessary to assume for Procyon a mass eighty times as great as that of our sun, and for the perturbating companion a mass at least five times as great as that of our sun. He had further calculated that if the minute companion were the perturbating body, it should, at the beginning of this year, occupy a position-angle 9° or 10° greater than that occupied by it last year, whereas if it were only a small star, situated in the neighbourhood, the observed proper motion of Procyon would carry it forward so as to diminish the position-angle of the companion by about 4°—on recently examining Procyon he had found that the companion had moved forward during the year from a position-angle of 87½° till it now occupied a position-angle of 96°. He was therefore disposed to think that there could now no longer be any doubt that the minute companion is the perturbating body, which accounts for the irregularities in the motion of the primary.—Mr. Glaisher gave an account of some MS. volumes of twelve figure-logarithms which have recently been presented to the Society by the executors of the late Mr. Thompson of Greenock, the table of logarithms of numbers extends as far as 120,000. No account has been left of the way in which Mr. Thompson obtained the logarithms of the prime numbers, but from internal evidence Mr. Glaisher was inclined to think that they had been independently calculated. He attached great value to the manuscripts. No table of twelve-figure logarithms has as yet been published. Mr. Glaisher estimated that the cost of printing these tables would be about 1,000*l*.

Royal Microscopical Society, May 6.—Charles Brooke, F.R.S., president, in the chair.—A paper by Dr. Anthony, On the suctorial organs of the blow-fly was read to the meeting. The paper suggested that the so-called pseudo-tracheæ were really sucking or pumping organs.—A paper was read by Mr. Slack On certain silica films artificially produced, in which the results of a number of interesting experiments and observations were detailed; and Mr. W. T. Read communicated to the meeting the results of similar researches, in which he had recently been employed.—A paper by Dr. Royston-Pigott was taken as read, On the use of black shadow markings, and on a black shadow illuminator.

Entomological Society, May 4.—Sir Sidney Smith Saunders, president, in the chair.—Mr. Butler exhibited an example of arrested development in a Peacock butterfly caused by the tail of the pupa having become detached during the process of emerging, the right wings being completely developed, whilst those on the left side were not developed at all, the pupa case remaining attached to the left side of the body of the butterfly.—Mr. W. C. Boyd exhibited specimens of *Solenobia inconspicuella*, taken in St. Leonard's Forest, and amongst them a specimen of a remarkably pale colour, which might possibly be an Albino variety; but it had a very different appearance from the ordinary form.—Mr. Boyd also exhibited some leaves of the common Comfrey (*Symphytum officinale*), gathered at Cheshunt, the undersides of which were found to be completely covered with specimens of *Brachycentrus sub-nubilus*. All were said to be males, but on close examination a single female specimen was discovered amongst them.—Mr. C. O. Waterhouse read a note by Dr. Lamprey, Surgeon-Major 67th Regiment, On the habits of a boring beetle, one of the *Bostrichidæ*, found in British Burma. It belonged to the genus *Sinoxylon*. Dr. Lamprey did not know the name of the tree on which it was found; but he described the insect as making a small hole in a stem that was about ½ in. in diameter; and by devouring the wood completely round, severed it with a clean cut, so that it was only kept together by the thin outer layer of bark, the first gust of wind snapping off the weakened branch. The beetle turned on its side while boring, its back being towards the bark, and in this way its form appeared to adapt itself to the circumference of the stem.

PARIS

Academy of Sciences, May 4.—M. Bertrand in the chair.—M. Jamin presented a communication on the depth of the magnetised layer in a steel bar. The author announced as the result of his experiments that in a thick steel bar there is no magnetisation in the centre, and that the elemental bars composing the magnet do not begin to appear till 3 or 4 millimetres from the surface, but become more and more numerous and contracted against the free surface.—Study of and experiments upon the metallic sulphides, by M. Berthelot, a continuation of former thermo-chemical researches.—Observations on the fecundation of the urodelous batrachians, by M. Ch. Robin. The fecundation of the oviparous urodelous batrachian (*Siredon*, *Triton*), like that of the *Anouræ*, is internal.—Observations concerning a recent communication by M. Faye relating to a calculation by Pouillet of the cooling of the solar mass, by M. A. Ledieu. The author has arrived at a result not quite in accordance with that obtained by M. Faye in his recent calculations.—M. Favre presented the continuation of his researches on hydrogen. The condition of this gas when absorbed by palladium and by platinum black is in no way comparable in these two cases. In platinum black the condensed gas is not chemically modified, but in palladium it undergoes an allotropic modification before combining with the metal. The author in concluding called attention to the importance of thermic measurements of chemical phenomena; notably of the allotropic changes of bodies.—On the action of distilled water on lead by M. Is. Pierre. Water condensed in a leaden worm was found to contain about ·000375 grms. of Pb. per litre.—Report on the apparatus intended for the operation of the transfusion of blood, presented to the Academy by MM. Moncoq and Matthieu.—On the illumination of opaque bodies by neutral or polarised light, by M. A. Lallemand.—Determination of clay in arable soil, by M. T. Schlœsing.—On gravitation, cohesion, and the distances of the centres of molecules, by M. G. West.—M. Ad. Chatin presented a continuation of his researches on "organogenesis compared with androgenesis in its relations with natural affinities." The classes treated of were Polygalaceæ and Æsculinaceæ.—Influence of vernal heat on *Phylloxera vastatrix*, by M. M. Cornu. The insect changes from brown to bright yellow and becomes larger.—On the integrals of the differential equations of curves which have an even polar surface, by M. l'Abbé Aoust.—Phenomena observed on Jupiter's satellites, by M. C. Flammarion. The author's observations lead to the hypothesis of the existence of an atmosphere surrounding the second and third of the planet's satellites.—On the reflecting power of flames, by M. J. L. Soret. Experiments have shown that carbon preserves its reflecting power at very high temperatures, thus confirming Davy's theory of the luminosity of flame, since a ray of sunlight reflected from a bright flame is polarised in precisely the same manner as when reflected from non-luminous smoke.—Study of the properties of explosive bodies, by M. F. A. Abel. Third memoir.—Note on a process for determining phosphoric acid, by M. F. Jean. Influence of the presence of nitrogen in the textile fibre on the direct fixation of the aniline colours, by M. E. Jacquemin—On the physiological phenomena observed in the high regions of the atmosphere, by M. Barral.—On the study of the fumeroles of Nisgros and of some of the products of the eruption of 1873, by M. H. Gorceix—Partial resection of the calcaneum; absolute anæsthesia produced by an intravenous injection of chloral; immediate cessation of anæsthesia after the operation by the application of electric currents, by M. Oré.—On the mechanical aptitude of horses, by M. A. Sanson.—On the occurrence of a Cycada in the Miocene deposit of Koumi (Eubée), by M. G. de Saporta. This insect (*Encephalartos gorceixianus*) is the first fossil Cycada that is capable of being referred without anomalies to a living genus. The discovery enables the author to affirm that a Cycada belonging to a genus now confined to South Africa inhabited Miocene Europe: in the same manner this region supported at a somewhat later period the African type of rhinoceros, giraffes, and antelopes, thus giving greater probability to the hypothesis of a union between Austro-oriental Europe and Africa, during the Miocene period.

CONTENTS

THURSDAY, MAY 21, 1874

ON THE ACTION OF THE HORSE

NO dynamical problem, whether physical or biological, can be considered to be based on a substantial foundation until some method has been applied to it, by which an accurate statical record can be obtained of the exact relations of all the forces which, at any given moment, operate in its production. The great preparations which are just completed for the observation of the approaching transit of Venus show how difficult it sometimes is to obtain the desired results; and the value attached to the production of photographic records of the phenomenon proves the importance of permanent registration.

The movement of the legs of quadrupeds during progression is a difficult problem, as is shown by the fact that there are still many contradictory opinions maintained by high authorities on the subject. The difficulty in this case depends on there being the four different limbs to be considered at the same time, which it is impossible to do without a considerable amount of practice. Till lately, those who have studied the point, as far as the horse is concerned, have relied on their sight or hearing, and have checked their results by the impression left on the ground by the animal's hoofs. The observational power of each individual author has therefore always been an element in the problem, and it is very difficult to estimate the magnitude of that part of it, in any given case, correctly. Within the last few years, however, a much improved method has been introduced, which, judging from the discussion that has been carried on in the *Times* with reference to the attitude of the horse in Miss Thompson's picture of the "Roll Call," is but little known by some who have very decided opinions on the movement of the legs.

In a work, published last year, entitled "La machine Animale," by the eminent French physiologist, M. E. J. Marey, of Paris, a full account will be found of an apparatus constructed by the author, by means of which the movements of each of the legs of the horse during progression are synchronously registered on a uniformly moving strip of paper, in such a way that the tracings obtained from all the four can be superposed and compared at the leisure of the experimenter, and the simultaneous positions of each leg accurately estimated. What is more, M. Marey has also introduced a beautiful writing language, as it may be termed, by means of which it is as easy as in music to transcribe the results obtained with his instrument and read them off in their proper sequence. A knowledge of this language makes it possible to refer any given position, such as that of the horse in the "Roll Call," to it; from which it may be compared with the results obtained by direct experiment. Such being the case, it is not difficult to transfer the vagueness of "opinion" into the certainty of fact, and settle a question once for all.

M. Marey's method is the following:—The record of the movement of each limb is obtained by the employment of small caoutchouc bags filled with air, similar in most respects to those with which he has obtained such valuable information on the movements of the heart. Two of these bags are connected together by an india-rubber tube; one is placed in contact with the foot, and the other with a small lever which writes on the recording paper. Each leg is provided with its pair of bags. Movements in either foot compress the bag connected with it, and this, by distending that at the other end of the tube, raises the lever. The levers write, one above the other, on a revolving drum held in the hand of the equestrian. We must refer our readers to the work itself if they desire to see the tracings obtained, mentioning that at the moment each foot touches the ground a sudden rise of the lever is the result, which is followed by an equally abrupt fall immediately it quits it.

Results even more satisfactory than those obtained by the use of the above-described air-bags might be obtained by adapting a simple electrical contact-maker and wirer to the shoes of the horses, which by acting on small electro-magnets would produce movements on levers which recorded similarly to those employed by M. Marey.

It will be necessary to give a short description of the mechanism of walking generally in order to explain that of the horse. Man in walking on level ground gives sufficient impulse to the body at each step to enable him to lift the one foot at the instant that the other touches the earth. Representing the time of contact of the right foot by a continuous line, that of the left foot by a superposed dotted line, and the exact period of the interval between the raising and lowering of either foot by the gap between the succeeding lines, the human walk on level ground would be drawn thus:—

```
          .........          .........
 ________           ________           ________
```

Whilst going uphill, however, there is a period during which both feet are on the ground together, which may be indicated thus:—

```
        .........    .........    .........
 ________     ________     ________     ________
```

Whilst, again, in running, there are periods, as we all know, during which both feet are off the ground together thus:—

```
             .........            .........
 ______                ______                ______
```

Turning to the case of the horse, and using the same method of illustration, we may employ the excellent comparison suggested by Dugès, in which he shows that any of its different steps may be imitated by two men, one behind the other. Now suppose these men, the hinder one with his hands on the shoulders of the one in front, to walk "in step," that is, with the right and left feet moving simultaneously; then, if their movements be recorded as above, with the steps of the hind man placed below those of him in front, the following would represent them:—

```
         .........         .........         .........
 ______            ______            ______
         .........         .........         .........
 ______            ______            ______
```

both would have their similar feet off and on the ground at the same time; and reverting to the horse, this formula, as it may be termed, which represents the legs of the same side off the ground together, is that of the "amble," a method of progression natural to the giraffe, but only acquired by special training in the horse.

Again, suppose that two men, instead of walking "in

step," do exactly the opposite, that is, place the *opposite* feet forward simultaneously; we then have the following formula:—

All will recognise this as the "trot" in the horse; although, as M. Marey has proved, there is always, in the true "trot," an interval between each of its two elements, during which all the feet are off the ground at once, thus:—

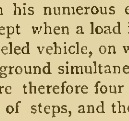
the upper of the last two formulæ, however, represents the walk of the elephant exactly.

In the amble and the trot, therefore, each complete series of steps is formed of two parts which never overlap; it follows that the sounds produced by them are double also.

The walk of the horse is a phenomenon a little more difficult to realise at first sight. Again referring to the two men, suppose that they walk quite out of step, as it may be termed, in such a way that the front one *has raised* his right leg at the same moment that the hind one is *just raising* his, although they keep to the same number of steps. Such being the case the sequence of the steps would be *right front*, *left hind*, *left front*, and *right hind*, which is the order of succession in the horse, and may be represented thus:—

In this formula it is seen that at no time are there more than two feet on the ground at the same moment, and M. Marey states that in his numerous experiments such is always the case, except when a load is being taken down an incline in a wheeled vehicle, on which occasion three feet may be on the ground simultaneously. In the walk of the horse there are therefore four sounds produced in each complete series of steps, and these four are at equal or nearly equal intervals of time.

We are now in a position to judge of the accuracy of Miss Thompson's delineation of the "Roll Call horse," which is represented walking, with the left fore-foot fully raised from the ground, whilst the others are on it. The right fore-leg is nearly perpendicular and not bent; that is, about half-way between the commencement and the end of its step. The left hind-foot is somewhat in front of the perpendicular axis of the leg; that is, has just commenced its step; and the right hind foot, though on the ground, is on the point of leaving it. As the animal is walking, the lengths of the steps and of the intervals must be represented, as shown above, as of equal duration, and the following is its expression, the thick vertical line representing the moment at which the painting figures it:—



By comparing this with the formula of the walking horse, given above, it is evident that the representation is correct, except in a very slight point, which is that the right hind leg is on the ground, though just on the point of leaving it, whereas it ought to be just off it, because in walking there are never more than two legs on the ground at the same time. The general direction of the legs is quite correct. If the animal had been "ambling," the left hind-foot would have been off the ground, as well as the left fore. It is quite impossible to mistake the "walk" for the "trot," if their formulæ are compared and the positions at any given time worked out from them.

A. H. GARROD

CARPENTER'S "MENTAL PHYSIOLOGY"

Principles of Mental Physiology. By W. B. Carpenter, M.D., F.R.S. (Henry S. King & Co.)

THE title of the volume before us shows that its author is one of those philosophers—happily, an increasing number—who refuse to treat the phenomena of mind as though they were in no way connected with the body through which they find their expression. Mental Physiology is a comparatively new science, and does not date further backward than the days of Hartley. Before his time, and to some extent since, Physiology has been treated from what—to employ a word too often pressed into the service of a somewhat hazy idea—may be called the metaphysical point of view. The phenomena of mind have been abstracted from all their surroundings, and have been analysed by themselves, and the result has naturally been that we have been left but little wiser than before. Dr. Carpenter rejects this method, and bases his Psychology on the construction and working of the nervous system. But while shunning the metaphysical treatment of the subject, he does not adopt the other extreme, the doctrine, we mean, of the thorough materialist, who regards all mental phenomena without exception as the outcome of previous physical causes, which necessarily produce certain results. He steers a middle course, inasmuch as, while he advances the theory "of the dependence of the Automatic activity of the mind upon conditions which bring it within the nexus of Physical Causation," yet he believes in "an independent power, controlling and directing that activity, which we call Will."

This doctrine of the independence of the Will is the distinguishing characteristic of Dr. Carpenter's philosophy in the book before us; it runs through the entire work as the one grand exception among a series of physical sequences, interdependent, and standing to each other in the relation of cause and effect, of antecedent and consequent. Yet, even to a mind which is not "trammelled by system," this splendid anomaly may seem strange and surprising, though the prevalence of the belief in a Free Will, even among scientific thinkers, need cause no wonder, so long as the ethical bias is not rigidly excluded from psychological speculation. It is the meritorious timidity of the moral side of human nature which says, "whatever else may be under laws of necessity, the Will at least is free and independent, for the alternative doctrine deprives all actions of their moral value, and reduces man to the level of a mere machine."

It is clear that Dr. Carpenter is not satisfied with the doctrine of the so-called necessarian school

indeed, he quotes Mr. Mill's Autobiography in his preface to show that the great necessarian himself wavered in his belief. He clearly thinks the explanation of human conduct offered by those who reject the theory of the independence, or rather the *self*-dependence, of the Will, inadequate. They would say that the unconscious operation of causes proceeds independently of the conscious conviction of the individual; that however much we may think that of two lines of conduct before us, either is equally possible for the human Will, yet, as a fact, we invariably follow the one to the exclusion of the other; the result, as it were, proves the cause, the apparent ultimate choice is the real physical consequent of antecedents engrafted in our nature, and acting in an invariable sequence, though it is true, as shown by Mr. Mill in the sixth book of his Logic, that Science is not sufficiently advanced to enable us to predict successfully the course of human action in any case, owing to the much greater complexity of the influences which operate in determining sociological phenomena when compared with other forms of activity. The necessarian philosopher would say that the operation of the Will is really nothing more than the force of the stronger motive asserting itself. Dr. Carpenter, and with him is the majority of mankind, says that the Will itself determines from within us which motive shall be the preponderating one.

But the chief merit of Dr. Carpenter's book lies, as we have said, in the explanation of the nexus which binds together the physical and the psychical elements in human nature. The well-known authority of what he says on such a subject constitutes the main value of his work. It is not too often that a great physiologist has turned his attention to mental phenomena, and we therefore welcome all the more gratefully any addition to the number of those who base their psychology on an exhaustive analysis of the functions and modes of action of the nervous system. In the first and second chapters of his book—the backbone, if we may so call it, of the work—Dr. Carpenter unravels carefully and exhaustively, step by step, all the interdependences of the nervous system and the psychical states. Without entering on all the mysteries of nervous ganglia and afferent and motor fibres, or the physiological comparison of Articulata and Vertebrata, we would say generally that Dr. Carpenter divides bodily movements in man into three classes:—(1) The primarily automatic; (2) the secondarily automatic; and (3) the volitional. Of these the first two "are performed in respondence to an internal prompting of which we may or may not be conscious, and are not dependent on any preformed intention, being executed 'mechanically'; while the last are called forth by a distinct effort of Will, and are directed to the execution of a definite purpose." But though thus clearly laying down the doctrine of the self-determining power of the Will, the author somewhat qualifies it afterwards, when he says that "even in the most purely Volitional movements the Will does not *directly* produce the result, but plays, as it were, upon the Automatic apparatus by which the requisite nervo-muscular combination is brought into action."

The conclusion at which our author arrives as to the general relations of mind and body is, in his own neatly-expressed words, "that the actions of our minds, in so far as they are carried on without any interference from our Will, may be considered as 'Functions of the Brain.'" These Functions of the Brain and of the Nervous System which supplies the brain with the materials which it works up into sensations and ideas, are lucidly and exhaustively expounded in the second and longest chapter of the work, in which the element of pure physiology preponderates, and into which we do not intend to enter, as no short summary of it can fairly represent its contents. Suffice it to say that in this part of the book Dr. Carpenter shows that the amount of intelligence (not instinct) shown by an animal is in a direct ratio to the relative size of the cerebrum and the sensorium, which latter organ in man is nearly eclipsed by the superimposed cerebral hemispheres, "the instrument of our psychical or inner life;" that the cerebrum is not concerned in the ordinary performance of our automatic movements, though in many cases it exercises control over them; its power, however, does not extend so far as to enable it to interfere with "the nervous system of organic life," or sympathetic system. The ruling monarch here at last meets with constitutional checks. It can exert no modifying influence on the "nutritive operations;" they, together with the rest of the sympathetic system, would rather seem to obey another power when they obey at all, the power, namely, of the emotions, which so often rebel against the Will, being, so to speak, the insurrectionary element which breaks in upon the dignified controlling influence of that thinking, purposeful, though sometimes eccentric monarch.

It is impossible in the short limits of a review to enter into the discussion of the part played by Attention, Sensation, Perception, and other physiological conditions in the production of mental results. These are all minutely treated of by our author, who carries us on in an easy progress from one to another with enviable clearness.

In treating of the succession of ideas Dr. Carpenter follows the doctrines of Prof. Bain in relation to the Laws of Association, and acknowledges the debt he owes to that most conscientious philosopher. All students of Prof. Bain's works on Mental Science are already familiar with the Laws of Contiguity and Similarity as explaining the principles of association of ideas, and we need not dwell further on them. The section which deals with Ideo-motor action is very interesting as leading us into the region of the marvellous. Ideo-motor action may be defined to be "the direct manifestations of ideational states, excited to a certain measure of intensity, or, in physiological language, reflex actions of the cerebrum." It is in this definition that we find the true key to the phenomena of table-turning and spirit-rapping, when practised by those who bring no dishonest arts to bear in their experiments. From this definition we should deductively infer that the revelations which reward those who take part in such experiments must be, as is in fact the case, in spite of assertions to the contrary, revelations of some matter known to at least one of the party engaged in the *séance*, whose mental activity and the play of whose ideas, apart from any exercise of Will, may influence the muscular movements *directly* and the more easily, inasmuch as the strained state of the hands on such occasions, after being stretched out for several minutes, renders them the easy and unresisting instruments of the

ideational state, intensified, as it is, by the circumstances which surround it. So independent of volition is the influence of the ideational state in these cases, that it often operates in opposition to the dictates of the Will, and the writer has himself seen, more than once, answers extorted, as it were, from a member of a *séance*, unwillingly on his part, simply in consequence of his own highly-strained ideational condition conveying a knowledge through his muscles to those who sat with him at the innocent and obedient piece of furniture. Dr. Carpenter also shows that under this head of Ideo-motor action may be ranged "all those actions performed by us in our ordinary course of life," such as the use of language to express our thoughts, which requires no separate volitional effort, at all events when once we have entered on a train of speech.

But though giving up so large a field of human life to the non-volitional activity, Dr. Carpenter still keeps the Will in view, as a sort of abstract entity, as a "supposititius," or reserve champion sitting in wait, ready to step in if occasion should call. "The dominant Idea *determines* these movements, the Will simply *permitting* them."

We can give in a few words a summary of Dr. Carpenter's theory of the relation of the Emotions to the Will. He begins by saying that "the Will has no *direct* power over the emotional sensibility," it can only operate to withdraw the attention from the emotional state and fix it determinately upon some other object. Again, the Will "can exert itself in preventing the *expression* of the exerted feelings in action" by suppressing the muscular exhibition of our emotional states; and again, "where the Emotion is not a mere *passion*, but is a state of *feeling* connected with some definite *idea*, the power of the Will is most effectually exerted in withdrawing the mind from the influence of that idea, by *fixing the attention upon some other*"—the power of self-control extends itself from our *impulses* to the habitual *succession of the thoughts*.

We had already learnt our author's views on the relation of the Will to mental and bodily action, but in the middle of his treatise we come upon a full and careful amplification of his opinions on this head, developing his theory of the influence of the Will on the formation of beliefs and on the conduct. We cannot do better than give in his own words Dr. Carpenter's doctrine on the latter head:—

"To carry into *action* the volitional determination, to give to the 'I will' its practical effect, something more is usually needed than the mere preponderance of motives. The idea of *the thing to be done* (which we have seen to be the necessary antecedent of all volitional action) may indeed be so decided and forcible, when once fully adopted, as of itself to produce a degree of nervous tension that serves to call forth respondent muscular movements, as in the purely ideo-motor form of action. But in general a distinct exertion of the Will is needed to give to the ideational state the energy requisite to call forth the action that expresses it, and this is especially the case where either some powerfully opposing motive diminishes the force of the preponderance, or a state of fatigue causes the bodily mechanism to be less easily called into action."

Hitherto we have been dealing with what the author calls "General Physiology;" we come now to the other division of the work, on "Special Physiology," and the transition is marked by a change of matter and style. We feel that, in reading this latter portion of the book we are being rewarded for the care which is necessary to the mastery of the deeper and more valuable philosophy of the earlier chapters. We have got—we do not speak disrespectfully—out of school into the playground, and we revel in the contemplation of the "morbid conditions" of the mind, illustrated as they are by numerous relevant anecdotes. Mesmerism, somnambulism, and dreaming are all subjects which attract and entertain, especially when treated of by a scientific pen. But we feel that this portion of the work does not call for special criticism so much as what we have already gone through. "Morbid conditions" are very valuable as throwing light on the operation of normal and healthy conditions, but happily the epithet "morbid" is interchangeable with the epithet "exceptional," and therefore we think that the morbid does not require such close treatment as the normal.

Dr. Carpenter winds up his work with a chapter on Mind and Will in Nature, and in it brings to a poetical conclusion what he has so carefully and exhaustively unravelled in the preceding pages.

ANDRÉ AND RAYET'S "PRACTICAL ASTRONOMY"

L'Astronomie pratique et les Observatoires en Europe et en Amerique. Par C. André et G. Rayet. 1e partie, Angleterre. (Paris: Gauthier-Villars. 1874.)

THIS little unpretending volume is of considerable importance. Not only is it the commencement of a series which is intended to include the history of practical astronomy throughout the civilised world, but independently of this, it has claims to notice which are not to be measured by its limited dimensions.

The wide outspreading in the present day of a taste for astronomical observation would lead us to regard with favour anything tending to increase our knowledge of what has been and is being done, especially when it is set before us in so pleasing a form; and we cannot but admit that our neighbours have in this respect got the start of us. Notwithstanding all our efforts to render Science generally intelligible and acceptable, we have not yet succeeded in bringing out such attractive little manuals as proceed from the presses of MM. Gauthier-Villars and Hachette. Our larger and more elaborate treatises may well bear a comparison with anything of a similar calibre produced elsewhere; but in familiar, inexpensive, tasteful manuals, the light artillery, so to speak, of the scientific campaign, we must own ourselves fairly beaten by our nearest neighbours, who have set us a worthy example. We cannot, happily, and if we could we would not, say in this instance, *fas est et ab hoste doceri.* There was a time when such a remark would have been thought appropriate, but "nous avons changé tout celà;" and if such a thoroughly ill-natured and reprehensible observation were to be attempted now, it would meet its ample refutation in this work, which adds to its other merits the charm of courteous and kindly feeling. Next to the cordial abandonment of individual hostility, or the loving, tender reconciliation of alienated friendship, what can be more pleasing than the abatement of national antipathies and the softening down of those asperities which have but too deeply marked the

intercourse of different branches of the human race? That nations should think or feel exactly in unison is no more to be expected than that individuals of the same family should possess identical tastes and habits; but as in the smaller, so in the larger groups, these distinctive characters may and ought to exist apart from every unkind jealousy or envious bitterness. There had been far too much of this in past days, and we hail with pleasure the appearance of this friendly book, which has evidently been drawn up in a truly kind and genial spirit.

If it puts us somewhat to shame, that the Assistant-Astronomers of the Paris Observatory should be telling us what goes on at our own doors, we have only ourselves to thank for the omission, and them for the way in which they have supplied it. The plan they have adopted is an excellent one; and as to its execution there is very much to praise. A history of English observatories and their work could not be otherwise than somewhat unequal in its execution; it would probably be so to some extent even in native hands; to a foreigner, who must, generally speaking, depend upon communicated information, the difficulty would be insuperable; and to this cause we may evidently refer the omission of some finely appointed private observatories, such as those of the Rev. H. C. Key, with its 18-inch silvered speculum, of Mr. Bird, the Rev. E. L. Berthon, Capt. Noble, Mr. Neison, Mr. Barnes, and many others. It is, in fact, in these private "telescope-houses" that England is so rich, as was formerly remarked in substance to the present writer by M. Léon Foucault, and it is through their work that much of the physical astronomy of the day has been advanced to its present position. But this is exactly what would escape the notice of any but ourselves, and even the generality of ourselves; and in this respect there is, of course, a good deal of deficiency in the work which cannot well be blamed. But great pains have evidently been taken to insure correctness, and to impart knowledge which to many among ourselves will have all the interest of novelty; and this has been done, for the most part, as far as we can judge, in a very satisfactory way.

The French language is now so generally understood among us that a translation is perhaps not required; but should it be undertaken, or should the authors, as we hope, be encouraged to send forth another impression, we would request permission to offer a few suggestions. The Bedford Catalogue, which has had so marked an influence on English astronomy, would well come in for a share of notice: the names of the opticians, whose work is described—which are seldom given, and perhaps not always correctly—might be supplied with advantage; several orthographical slips, and one considerable error in the little map, might be rectified. With these improvements, and some difference in the arrangement and appropriation of the very pretty illustrations, this charming little volume, even now greatly to be commended, would meet our expectations in every way. T. W. W.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Quantitative Relations of Cause and Effect

AFTER Mr. Spencer has implied that he will not himself continue the controversy further, Mr. Hayward, in his last letter, has confused the issues by misstating Mr. Spencer's position. In the circumstances, perhaps, it will not be improper for me, as one familiar with Mr. Spencer's psychological doctrines, to rectify Mr. Hayward's error and explain that which he misapprehends.

The cue may be taken from an experience described in Mr. Spencer's "Principles of Psychology" (§ 468, note), where it is shown that when with one hand we pull the other, we have in the feeling of tension produced in the limb pulled a measure of the reaction that is equivalent to the action of the other limb. Both terms of the relation of cause and effect are in this case present to consciousness as muscular tensions, which are our symbols of forces in general. While no motion is produced they are felt to be equal, so far as the sensations can serve to measure equality; and when excess of tension is felt in the one arm, motion is experienced in the other. Here, as in the examples about to be given, the relation between cause and effect, though numerically indefinite, is definite in the respect that every additional increment of cause produces an additional increment of effect; and it is out of this and similar experiences that the idea of the relation of proportionality grows and becomes organic

A child, when biting its food, discovers that the harder he bites the deeper is the indentation; in other words, that the more force applied, the greater the effect. If he tears an object with his teeth, he finds that the more he pulls the more the thing yields. Let him press against something soft, as his own person, or his clothes, or a lump of clay, and he sees that the part or object pressed yields little or much, according to the amount of the muscular strain. He can bend a stick, the more completely the more force he applies. Any elastic object, as a piece of india-rubber, or a catapult, can be stretched the farther the harder he pulls. If he tries to push a small body, there is little resistance and it is easy to move; but he finds that a big body presents greater resistance and is harder to move. The experience is precisely similar if he attempts to lift a big body and a little one; or if he raises a limb, with or without any object attached to it. He throws a stone: if it is light, little exertion propels it a considerable distance; if very heavy, great exertion only a short distance. So, also, if he jumps, a slight effort raises him to a short height, a greater effort to a greater height. By blowing with his mouth he sees that he can move small objects, or the surface of his morning's milk, gently or violently according as the blast is weak or strong. And it is the same with sounds: with a slight strain on the vocal organs he produces a murmur; with great strain he can raise a shout.

The experiences these propositions record all implicate the same consciousness—the notion of proportionality between force applied and result produced; and it is out of this latent consciousness that the axiom of the perfect quantitative equivalence of the relations between cause and effect is evolved. To shew how rigorous, how irreversible, this consciousness becomes, take a boy and suggest to him the following statements:—Can he not break a string he has, by pulling? tell him to double it, and then he will break it. He cannot bend or break a particular stick: let him make less effort and he will succeed. He is unable to raise a heavy weight: tell him he errs by using too much force. He can't push over a small chest: he will find it easier to upset a larger one. By blowing hard he cannot move a given object: if he blows lightly he will move it. By great exertion he cannot make himself audible at a distance: but he will make himself heard with less exertion at a greater distance. Tell him to do all or any of these, and of course he fails. The propositions are unthinkable, and their unthinkableness shows that the consciousness which yields them is irreversible. These, then, are preconceptions, properly so called, which have grown unconsciously out of the earliest experiences, beginning with those of the sucking infant, are perpetually confirmed by fresh experiences, and have at last become organised in the mental structure.

It is not, however, any such experiences which Mr. Hayward adduces to exemplify organic preconceptions. He asserts that his "principal 'exemplification of unconsciously-formed preconceptions' was of Mr. Spencer's own choosing, namely, Newton's 'Second Law of Motion.'" This is an error: Mr. Spencer gave *no* examples of unconsciously-formed preconceptions. If Mr. Hayward will refer to Mr. Spencer's letter in NATURE, vol. ix. p. 462, he will find that Mr. Spencer has described the unconsciously-formed notion of the relation between cause and effect in general terms, and without example or illustration. In his last letter he simply named the relation between muscular tensions and their effects. Probably he expected Mr. Hayward to seize his meaning without any specific example.

The examples given by Mr. Spencer were examples of *consciously*-formed conceptions based on this *unconsciously*-formed preconception acquired during childhood and boyhood. Mr. Spencer gave three instances into which this preconception tacitly enters: one chemical, another relating to the melting of ice, and a third to the process of weighing. The last is the only one into which the relation between force and motion can be supposed to enter. But the consciously-formed conception that double weights will balance double masses, and so on, is not one into which there really enters any relation between force and motion. The notion of weighing is that of the equal forces of equal masses at the ends of equal levers. So long as there is motion, there cannot be equilibrium. The idea of motion is excluded when weighing is complete.

When Mr. Hayward says that Mr. Spencer has taken Newton's "Second Law of Motion" as an example of unconsciously-formed preconceptions, he utterly misapprehends Mr. Spencer's meaning. The "Second Law of Motion" is one of those developed *conceptions* derived from the organic *preconceptions* above described.

Mr. Spencer's argument appears to be briefly this:—1. There are numberless experiences unconsciously acquired and unconsciously accumulated during the early life of the individual (in harmony with the acquisitions of all ancestral individuals) which yield the preconception, long anteceding anything like conscious physical experiments, that physical causes and effects vary together quantitatively. This is gained from all orders of physical experiences, and forms a universal preconception respecting them, which the physicist or other man of Science brings with him to his experiments.

2. Mr. Spencer showed in three cases—chemical, physical, and mechanical—that this preconception, so brought, was tacitly involved in the conception which the experimenter drew from the results of his experiments.

3. Having indicated this universal preconception, and illustrated its presence in these special conceptions, Mr. Spencer goes on to say that it is involved also in the special conception of the relation between force and motion, as formulated in the "Second Law of Motion." He asserts that this is simply one case out of the numberless cases in which all these conscious-reasoned conclusions rest upon the unconsciously-formed conclusions that precede reasoning. Mr. Spencer alleges that as it has become impossible for a boy to think that by a smaller effort he can jump higher, and for a shopman to think that smaller weights will outbalance greater quantities, and for the physicist to think that he will get increased effects from diminished causes, so it is impossible to think that "alteration of motion" is not "proportional to the motive force impressed." And he maintains that this is, in fact, a latent implicatiion of unconsciously organised experiences just as much as those which the experimenter necessarily postulates.

I may add that if mathematics included in its range the connection between objective phenomena and the answering subjective states, this question would be one for mathematicians; but at present it is, as it seems to me, a question pertaining to the psychological basis of inductive logic. JAMES COLLIER

Bayswater, May 18

The Glacial Period

I THINK there are but few points in Mr. Belt's letter ("The Glacial Period," NATURE, vol. x. p. 25) to which Geologists who have devoted much attention to the ice action will not take exception. May I be allowed to call attention to one or two?

1. I do not believe that there is evidence, which anyone accustomed to glacier "spoor" would admit, of an extension of the ice-cap so far south as the Thames valley.

2. It is in the highest degree improbable that the shells on Moel Tryfaen should have been scooped out of the bed of the North Sea by moving ice and transported to their present position. Apart from the difficulties of a glacier thus walking so far up-hill, and of shells having escaped utter smashing in this uncomfortable mode of transport, Mr. Belt has forgotten that Wales was a centre from which radiated glaciers, and at one time an ice-sheet, which surely would have warded off from its own hills the northern intruder. What evidence is there that the ice-sheet ever followed its path? All that I know points to local glaciation.

3. Mr. Belt forgets that the various sea-marks are often at very different heights above the present water-level—as is so well shown in Scandinavia—and that no lowering of the water will explain this. The height of even 600 ft. which he claims is one that rests on many assumptions and but little confidence can be placed on the numerical results.

It would be easy to discuss many other questions which he raises, but this would occupy far too much space. My present purpose is not so much to do this, as to utter a protest against such a portentous development of a theory which has for some time past been assuming nightmare proportions.

St. John's College, Cambridge, May 19 T. G. BONNEY

Lakes with two Outfalls

IT is quite possible that I am wrong in my memory of the Nystuen watershed; and as Prof. Stanley Jevons examined the place critically, I can have no doubt that I am so. I passed merely as a traveller, and described what I had seen, from a memory, not specially sharpened by a knowledge of the importance of the point, at the time the observation was made. I know well what tricks one's memory plays under such circumstances, particularly when one has been rambling over many similar localities; and my letter indicated that I was in doubt as to the particular lake which gave the double outfall. I passed, too, just after much heavy rain, and it is possible that the boggy bottom which Mr. Jevons describes was temporarily converted into the lake, which deceived me. I may add, that both the guide who brought me over the mountains from Aardal, and the Skydsgudt who took me to Skogstad, confirmed the double outfall.

My object, however, in writing, was chiefly to draw attention to Norway, as offering an admirable field for the settlement of the controversy, without going to the wilds of America. If there be such phenomena, and I believe there are, they may assuredly be looked for in that land of hard granite rock, mountain plateaux, and innumerable watersheds of all sizes and varieties, and if the hundreds of educated Englishmen who go there every year be only impressed with the importance of accurate observations, the point may soon be settled.

Certainly I agree that Colonel Greenwood, who has kindly favoured me with a most interesting letter of advice, has done excellent service by his quite justifiable incredulity, and I shall myself be content to have made a mistake, if by it I shall be the cause of greater accuracy in others. W. B. THELWALL

27, Burghley Road

Glass Cells with Parallel Sides

I SEND you a brief description of a method I have recently employed for rapidly fitting up glass cells with parallel sides, believing that it may be of interest to your readers.

A piece of indiarubber tubing (or of solid rubber) bent into a semicircular form is placed between two equal-sized rectangular plates of glass, the ends of the tube terminating at the upper edges of the glass plates; the plates are then held together by passing two strong indiarubber rings over their ends. If the rings are of such a size as to exert the requisite compression a semicircular water-tight cell is thus obtained, which can be taken to pieces and cleansed with the greatest ease.

A trough so made served well to exhibit with an ordinary magic-lantern the experiments described on pp. 173 and 174 in Tyndall's "Heat a Mode of Motion," and smaller cells suitably fitted with platinum wires, and held in the wooden frame of an ordinary lantern-slide, enabled the galvanic decomposition of acidulated water and of saline solutions to be thrown upon a screen and thus rendered visible to a large audience.

Queenwood College, Hants. FRANK CLOWES

Brilliant Meteor

WHEN nearing Holyhead at 0.50 A.M. on the 19th inst. the most brilliant meteor I have ever seen passed slowly across the heavens. It formed near Antares, remained stationary for two or three seconds, and then slowly moved to the northward, disappearing in the Great Bear. Throughout, the soft green light showed every portion of the hull and rigging with as much distinctness as a number of pyrotechnic fires could have done. The shape was that of an elongated ellipse, slightly contracted at one end, with the major axis of the apparent diameter of the sun. A short time before it disappeared six sparks as large as Jupiter were discharged from the southern end, and I thought a crackling sound followed.

Celtic, May 20 WM. W. KIDDLE

THE U.S. ACADEMY OF SCIENCE

Session at Washington

THE U.S. National Academy of Science held its meetings this year at the Smithsonian Institution, the venerable Prof. Henry, secretary of the Institution, presiding over the deliberations of the Academy. The session commenced on April 21 and lasted four days. By favour of the scientific editor of the *New York Tribune* we have obtained advanced reports. Our space permits us to give only the titles of the more important papers; but as Dr. Brown-Séquard's paper on the functions of the brain is of very great interest in reference to recent researches on the subject, we shall give a longish abstract of it.

Among the papers of importance were the following:—Dr. J. L. Le Conte read a paper On a classification of the *Rhynchophorous coleoptera*. Prof. Fairman Rogers described an automaton to play tit-tat-too, which he had constructed.

Prof. A. M. Mayer read three papers, one entitled "Suggestions as to the functions of the spiral scalæ of the Cochlea, leading to an hypothesis of the mechanism of audition." The second paper was headed "Abstract of a research in the determination of the law connecting the pitch of a sound with the duration of its residual sensation, and on the determination of the number of beats—throughout the range of musical sounds—which produce the most dissonant sensations; with applications of these laws to the fundamental facts of musical harmony, and to various phenomena in the physiology of audition." Prof. Mayer gave the particulars of a series of experiments by which it was ascertained what must be the frequency of successive sounds to have them blend indistinguishably together. The third described a series of experiments on the reflection of sound from flames and heated gases.

Prof. Simon Newcomb, the astronomer in charge of the Washington Observatory, gave a description of the preparations in America for the observation of the coming transit of Venus. These are most thorough and complete.

Prof. Wolcott Gibbs, of Harvard University, read a paper On metamerism in organic chemistry. Prof. Gibbs has discovered six metameric bodies, a seventh having been discovered by Prof. Erdmann.

Comparative velocity of light in air and in vacuo, by Prof. Stephen Alexander of Princeton College. This brief paper merely contained a few interesting suggestions on a small correction of the velocity of light as deduced from experiment.

In accordance with the undulatory theory the velocity of light must be less in atmospheric air than in vacuo, in the inverse ratio of the index of refraction of atmospheric air to 1; that is, as 1 to 1·000294. The velocity then as ascertained by experiment under the air should be increased by just about 0·000294 of itself to be equal to that in vacuo; *i.e.* to the extent, almost exactly, of 55 miles per second; a very small quantity indeed in comparison with the whole velocity of 185,000 miles per second; and yet, small as it is—and so small as to be below the limits of error of the experiments in question—it is yet very closely equal to three times the velocity of the earth in its orbit.

It is an outstanding excess, and no more, with which we often have to do, as, for example, in the measurement of temperature; but the scale on which those differences sometimes present themselves makes them, small as they may be in their original comparison, grand in comparison with ordinary standards. Prof. Alexander was not aware that anything has yet been put forward elsewhere on this subject.

Prof. Hayden gave a general account of the scientific explorations and survey in the West in which he has been engaged. With the results of these our readers are already pretty familiar.

In a paper On the laws of cyclones, by Prof. William Ferrel of the Coast Survey, the author gave a *résumé* of our knowledge on the subject and of some of the theories which have been advanced.

Dr. E. Bessels read a paper entitled "The History of Smith's Sound from a Geographical and Geological Point of View, and some other General Results of the *Polaris* Expedition." Dr. Bessels thinks that Smith's Sound must be regarded as the best of the three gateways to the pole. The land found between 81° and 82° seems to Dr. Bessels to be of great importance in demonstrating that Greenland has been separated from the continent in a south-north direction. Dr. Bessels stated several important facts bearing on the rising and sinking of the land on the Greenland coast.

Prof. Simon Newcomb gave a description of the great telescope at Washington; and a paper by Prof. S. Alexander of Princeton, N.J., On three of Jupiter's satellites, was read.

Prof. J. S. Newberry of Columbia College, New York, read a paper On Lower Silurian fossils. This was a memoir on the so-called land plants of the Lower Silurian in Ohio. Taking all the characters of these interesting fossils into consideration, Prof. Newberry is disposed to regard them as casts of the stems of fucoids.

The following papers were read by title only:—A memoir on the zodiacal light, by Prof. S. Alexander; On some points in Mallet's theory of vulcanicity, by Prof. E. W. Hilgard; The polarisation of the zodiacal light, by Prof. A. W. Wright. An exceedingly interesting and valuable paper on the mode of formation of the earth, its condition as to interior fluidity, and the probable limits within which it was reduced from a fluid state to its present condition, under the title of "A Criticism on the Contractional Hypothesis of the Earth's Surface Changes," was read by Capt. Clarence Dutton of the Ordnance Corps, U.S.A.

Dr. Brown-Séquard began his paper On the pretended localisation of the mental and the sensorial functions of the brain, by saying that the subject has been rendered more difficult by assumptions of physiologists upon insufficient data. Among the views which have been recently brought forward upon the localisation of nervous power in certain parts of the brain, there are two of importance: one relates to the seat of power actuating muscles, and the other is as to the seat of sensation for different nerves. In the latter particular, after noticing several exploded theories, some still pertinaciously adhered to by physicians, Dr. Brown-Séquard reviewed especially the assumption in respect to the seat of power for speech:—

"Let us consider the question of the locality of the intelligence of the brain. Most physiologists are agreed that this is the grey matter of the upper parts of the brain. But the method of communication is still open to research." (Here the lecturer went to the blackboard and drew a figure somewhat like a sheaf of wheat without a band around it; the stalks representing the nerves, the heads of wheat representing the cells.) "Now you may subtract from this, by disease or otherwise, say the upper third, and still you have the nerves and the nerve cells, and the processes can be carried on; but in the progress of such destruction downward there would eventually be reached a point where the functions of the brain could no longer exist. This view would explain the facts as we find them. But there is no case on record where the grey matter on both sides of the brain has been destroyed without the loss of intelligence, and we must regard the grey matter as the seat of the intelligence. But vast portions may be removed before the loss of intelligence becomes apparent. This I have myself tested and proved by vivisection of the lower animals.

"Now, in respect to the locality of the power of speech. It has been said that the loss of brain power to express ideas in speech was located in a certain part of the brain. This affection is called aphonia or aphasia. There are three modes of expressing ideas—by speech, by gesture, and by writing. It is with the first only that we are concerned. Some very bold theorists have tried to locate all these powers in a particular part of the brain. Let us confine ourselves to facts. Dr. Broca of Paris has advanced the view that a certain small portion of some of the convolutions of the brain holds the power of speech. I admit that facts seemed to favour this view. But we find that there is no relation between the degree of aphasia and the extent of the disease of that part, and there are cases where the destruction of those convolutions is very great, and the injury to speech very little. Secondly, we find that disease may have overtaken the anterior, the posterior, and the middle lobes of the brain, the particular convolution supposed to involve speech not being affected, and yet there is marked aphasia. Now, is some one of these lobes the locality of the power of speech? Such would be the reasoning of my opponents. We should be obliged to concede that in some persons the faculty of speech existed in one part of the brain, in some in another, in others another, and so on *ad infinitum*. This is a *reductio ad absurdum*.

"There is the case of the paralysis of the insane, where the grey matter may be diseased on both sides of the brain. In these cases the power of speech does not seem to be involved. There are cases of aphasia where the diseased person has had the power of speech restored during delirium. The speech is coherent though the sense may not be. It is evident, then, that the faculty of speech is not actually lost in such cases; and yet we find that the third frontal convolution is actually diseased in those aphasiacs who talk in their delirium. But the most decisive argument is found in the cases that I have seen, where the third frontal convolution, the alleged organ of speech, has been destroyed, and yet the patients have not lost the power of speech. Therefore the theory is itself destroyed. There are fifty cases on record to show that the question of right-handedness or left-handedness does not apply in the considerations." The lecturer here cited cases of Jacmet of Montpelier and Mr. Prescott-Hewitt of London. In the latter case the patient had suffered a destruction of that part of the brain for twenty years, and yet for twenty years had spoken.

"We shall now take up the question of the localisation of motion in certain parts of the brain. I am surprised at the avidity with which a certain series of facts has been accepted as proof of this theory in England. A very eminent man, of whom I should not like to say anything severe, my friend Prof. Carpenter, has accepted those views. I may say that all England has accepted them. Prof. Huxley, indeed, has written me, that he only accepted this view in part, but I cannot see how he can accept a part without accepting the whole, where even the part is incorrect. The famous experiments of Dr. Ferrier, of Guy's Hospital, must here be considered. As you will see, they are not, however, conclusive. By the application of galvanism to certain parts of the brain of animals, he produced certain movements. When we do not stop to think, this would seem to prove that there are in the brain certain centres of movement governing certain parts. But it is only a semblance. A part of the facts are taken for the whole. We should know all the series before we adopt the conclusions. Let us examine the other facts.

"It is perfectly well known that the cutting away of a large portion of the brain does not produce the least alteration of voluntary movement any where. Suppose that part of the brain, say the anterior lobe, being excited by galvanism, produces a movement in the anterior limb; now suppose that part of the brain is cut away, then the anterior limb should be paralysed, for its voluntary movement is gone. Admitting that the other half of the brain should supply the place of the missing part, let us take that away also; then certainly there should be a paralysis of the anterior limbs. But there is not. This should be sufficient to invalidate the conclusions of Dr. Ferrier. But there are abundant pathological facts of this nature proving the fact beyond question. And then there are the cases of recovery from paralysis. There is no such localisation of power as Dr. Ferrier has assumed. If galvanism be applied to the severed leg of the frog the leg will jump although there is no brain power in the question.

"What should have been done was to have cut the connection of parts, so that a general effect should not have been propagated throughout the brain by the application of galvanism to a part. This would be the *experimentum crucis*. My friend Dr. Dupré of Paris has made this experiment. I made it also, before he did, but he published his before mine. But there are many other facts almost equally impressive in their character which may be cited. We find many cases where the lesion of part of the brain produces paralysis on the same side of the body, and not on the opposite side, as in the majority of cases is the rule. There is a case recorded where a ball passed directly through the brain, and it produced paralysis on the right side, instead of the corresponding side." Here Dr. Brown-Séquard objected to having a certain class of brain affections named after him, stating that diseases should be named from their distinctive features, and not after physicians.

Dr. Brown-Séquard then applied a similar course of reasoning to the localisation of sensation in specific parts of the brain, concluding by stating that it is evident we cannot locate the centres of either sensation or motion in specific parts of the nervous system.

THE LONG PERUVIAN SKULL

I WISH to place before comparative anatomists and anthropologists a question which has been encumbered by some misleading inaccuracies, in a recent communication by Dr. J. Barnard Davis to the Anthropological Institute, ("On Ancient Peruvian Skulls" Journ. Anthropol. Inst., vol. iii., p. 94). So early as 1857, in communications to the British Association, and to the American Association for the Advancement of Science, I showed, in opposition to the views of Dr. Morton, and of all American ethnologists up to that date, that a dolichocephalic type of head is characteristic of certain widely diffused American races. At a later date I set forth, in "Prehistoric Man," my reasons for believing that this, which is now universally acknowledged as true in general, may be specifically asserted of the ancient Peruvians. This latter proposition Dr. Davis undertakes to refute; it is not a mere matter of personal controversy, but a question of some ethnical significance. As a Canadian, I lie outside of the charmed circles of home science and criticism, and only receive tardy news even of such communications as this, in which I have a personal interest.

Dr. Davis has not himself had an opportunity of examining the evidence on which my opinion was formed; and, in the communication above referred to, shows that he fails to appreciate its nature or true bearing. He says, Dr. Wilson's view, "which is that the dolichocephalic Peruvian skulls are of natural form, was combated in the 'Thesaurus Craniorum.' Since that book was printed, I have received ample and satisfactory evidence as to the truth of the proposition that the long skulls owe their quality to artificial means. By the politeness of Dr. J. Aitken Meigs, of Philadelphia, I have obtained two Peruvian skulls which at one period belonged to Dr. Morton's collection, as a specimen of each kind. One of

these is brachycephalic, the other is dolichocephalic, but they both present distinct traces of artficial distortion. *This fact is conclusive*." So says Dr. Davis. But conclusive of what? So far as I can see, it is simply conclusive as to the fact that both skulls have been artificially distorted. He then quotes Professor Wymann, of Boston, who, after an examination of the specimens referred to by me, settles the question thus summarily: "The upshot of the whole is, the crania do not confirm Dr. Wilson's statement. One of Dr. Wilson's points—in fact it is his chief point—is, that *skulls are natural because they are symmetrical:* and that it is next to impossible that a distorted skull should be other than unsymmetrical."

The thing I find most conclusive in all this is, that Dr. Davis and his correspondent both accredit me with inferences or opinions of their own, utterly inconsistent with my published views. So far am I from affirming "skulls are natural because they are symmetrical," that when my two critics have leisure to extend their reading to pp. 500-512 of the volume they refer to ("Prehistoric Man"), they will find many natural causes specified as tending to modify and distort the human skull. They will also find in the notes reference to papers in the *Canadian Journal*, and elsewhere, in which various aspects of this question have been repeatedly discussed. Dr. Davis has, I believe, received copies of all of those from myself; but, at any rate, there is one which can scarcely have escaped his attention—"On the Physical Characteristics of the Ancient and Modern Celt." It was published in the *Canadian Journal* in 1864, reprinted in the *Anthropological Journal* soon after, and became the subject of a good deal of reference in the famous copyright action of "Pike *v.* Nicholas." In this the explicit statement is repeated: "The normal human head may be assumed to present a perfect correspondence in its two hemispheres; but very slight investigation will suffice to convince the observer that *few living examples satisfy the requirements of such a theoretical standard.* Not only is inequality in the two sides of frequent occurrence, but *a perfectly symmetrical head is the exception rather than the rule.*" There is no possibility of mistaking the opinion thus expressed. It was published by me so long ago as 1862 (*Can. Journ.* vii. 414), and is repeated in substance in the very work from which Drs. Davis and Wymann profess to derive their absolutely contradictory dictum as "one of Dr. Wilson's points—in fact his chief point!"

But over and above all this, in the previous paper results derived from a careful study of eleven hundred and four English and French head-forms are set forth with this conclusion: "It thus appears that the tendency to unsymmetrical deformity is nearly as three to one; and that in the abnormal head the tendency towards excess of development towards the left is upwards of two to one." This tendency, it is further added, is more decidedly manifest in the brachycephalic than in the dolichocephalic head (*vid. Anthropol. Journ.* vol. iii. p. 82). The views thus repeatedly set forth, and supported by such proofs, are certainly not open to any charge of ambiguity. It is somewhat amusing, therefore, to find two such high authorities as Dr. Davis and his Boston correspondent summarising the whole, in this off-hand fashion, in a communication to a scientific body: "The upshot of the whole is," that, according to Dr. Wilson, "the skulls are natural because they are symmetrical, and that it is next to impossible that a distorted skull should be other than unsymmetrical."

By what process such opinions have been arrived at, and then accredited to me, I need not attempt to guess; but one thing unaccountably overlooked is the distinction on which I insist, between undesigned natural deformation, traceable to such simple causes as the one-sided pressure of the mother's breast, of the cradle-board, &c., and purposed modifications of the head, such as those practised at the present day among the Flatheads on the Columbia river. Three points on which I have insisted, not without evidence in their support, are: That the shape of the human head may not only be designedly altered by artificial means; but that it is much more frequently modified undesignedly, and rendered strikingly unsymmetrical, in infancy; while a third source, that of posthumous distortion, has also to be kept in view.

So far as to the general question. The specific one sought to be determined is the universality of a brachycephalic Peruvian type of head; or, as I have asserted, the occurrence of well-defined dolichocephalic heads in ancient Peruvian cemeteries. Dr. Davis informs the Anthropological Institute that my view was combated by him in his "Thesaurus Craniorum" (1867), and indeed it is with a view to the substantiation of "the criticisms of Dr. Wilson's statements in the 'Thesaurus,'" p. 246, that Dr. Wymann's "upshot of the whole" is produced. As one of the subscribers to Dr. Davis's valuable Catalogue, as well as a contributor to his collection of crania, I am familiar with the work, and with the pages specially set apart for my correction. I have had it, indeed, for years in my possession, without thinking that it needed refutation. I recommend any readers interested in the question to turn to the aforesaid p. 246, and read the curious narrative of Dr. Davis's conversion, in consequence of the receipt of a "skull next to unique in Europe," which belongs to "the long-headed race" of Peruvians, but yet is decidedly not long, or only long-headed "in a conventional sense," whatever that may mean.

I still believe it to be a fact, confirmed by my examination of examples referred to, that there is a well-defined dolichocephalic type of Peruvian cranium, although a brachycephalic type is the prevalent one. I have on three different occasions visited Philadelphia with the express object of studying the Morton collection there. One result has been to lead me to form a clear idea as to the source of Dr. Morton's later views. He had asserted the predominance of one uniform cranial type throughout the New World. "The long-headed Peruvians" were a disturbing element in this otherwise universal law. When therefore he turned to the examples in his own collection, and detected evidence of malformation by art in skulls which he had previously recognised as exceptions to his comprehensive theory, he welcomed the conclusion it suggested to his mind "that all these variously formed heads were originally of the same rounded shape." Dr. Davis informs us that he has obtained two Peruvian skulls formerly in Dr. Morton's collection, "a specimen of each kind," *i.e.* I presume, an occipitally flattened, and an elongated skull, both of the prevalent brachycephalic type. He has also the Titicaca skull already referred to, long, and yet not long, except "in a conventional sense." Possibly both Dr. Morton's and Dr. Davis's views are correct deductions from such premisses.

If a skull of the brachycephalic type, common to many American tribes (such as the Peruvian skull figured by Prof. Busk, vol. iii. pl. 7, "Journ. Anthropol. Inst."), is subjected to extreme depression of the frontal bone, with corresponding affection of the parieto-occipital region by the action of the cradle-board, such a form results as is shown in Fig. 78, p. 245, of Dr. Davis's "Thesaurus Craniorum." Examples of this are not rare. Here, if the length is measured from the projecting base of the frontal bone, immediately above the nasal suture, to the extreme posterior point, that will fall, not on the occipital bone, but nearly mid-way between the lamboidal and coronal sutures. Such a measurement is the actual extreme length of the modified skull; but if it is accepted as the true longitudinal diameter, without reference to the displacement of the points of measurement in the normal head, it is manifestly deceptive. It is, in fact, nearly equivalent to the substitution of the diagonal of a

square for a diameter drawn parallel to its two sides. Such a skull, notwithstanding its actual length by measurement, is properly classed as brachycephalic. But take such a form as that which I have designated a "Peruvian dolichocephalic skull" ("Prehist. Man," 2nd ed. Fig. 50, p. 449). It is reproduced here; Fig. 1. Compare it with the above-cited example, in Dr. Davis's collection; or again compare the Peruvian child's dolichocephalic skull ("Prehist. Man," Fig 60, p. 451), also reproduced here, Fig. 3, with another juvenile skull, from the Peruvian cemetery of Santa, but of the brachycephalic type, as shown here, Fig. 2, reduced from Morton's "Crania Americana," pl. vii. The question is

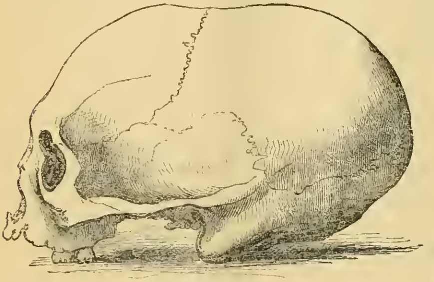


FIG. 1.—Peruvian Dolichocephalic Skull.

not, as Dr. Davis and Dr. Wymann would have it, whether the one is in its natural state, and the other artificially elongated? but whether it would be possible, by any elongation of the one, or abbreviation of the other, to reduce them to the same form? Compare the juvenile skull, Fig. 3, which is little, and probably not at all designedly, affected by art, with another of the same type, but purposely deformed by artificial means, Fig. 4. The same form is traceable in both, notwithstanding the modification of art. Both I conceive to be of the true dolichocephalic type; in contrast to the Santa skull, Fig. 2, which, whether or not affected by the parieto-occipital flattening so commonly resulting from the cradle-

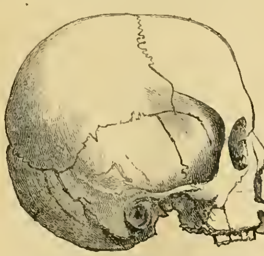


FIG. 2.—Peruvian Child's Skull, Santa.

board, is no less obviously of the brachycephalic type; and could not be transformed into the other.

The primary form of the skull, as determined, for example, by the relative proportion of the parietal bones, remains a factor to the last, however extreme may be the modifications superinduced by art. Only in the case of premature ossification of the sutures, consequent on the pressure applied in one direction, can this fail; though, no doubt in two approximate head-forms, the one only slightly dolichocephalic, and the other equally slightly brachycephalic, the original distinctive characteristics may escape observation in the modified skulls.

The question, then, turns mainly on this point—strangely ignored by Dr. Davis and his correspondent,—that a dolichocephalic and a brachycephalic skull are equally susceptible of distortion; but the same compression applied to the two types will beget different results;—will not, in any strongly marked example of either type, wholly efface the original character;—could not transform such a dolichocephalic skull as Fig. 1, into anything analogous to the elongated brachycephalic skull, Fig 78, of Dr. Davis's "Thesaurus."

I have necessarily left untouched various collateral points, for want of space; but enough has been said to show that what strikes Dr. Wymann as so "curious," and manifestly in his estimation so "conclusive" against me,

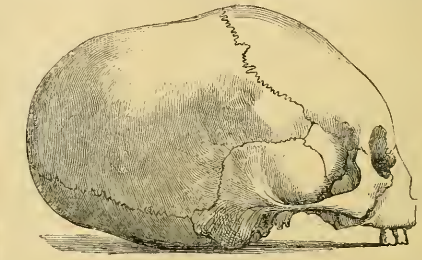


FIG. 3.—Peruvian Child's Skull, Normal.

in the projection of the occiput farther on the left than on the right side, is a feature I am very familiar with, in skulls which I should still call "natural," as distinguished from those designedly modified by art.

I shall refer only to two marked examples of this irregularity, in proof of such unsymmetrical forms existing among races in no way given to artificial cranial distortion. The first—a brachycephalic one—is "the skull of a young Greek," No. 1,354 of the Morton collection; a cast presented by Retzius. Dr. J. A. Meigs describes it minutely in his catalogue, p. 29, but takes no notice of its symmetry; although when viewed vertically it resembles some of the distorted Flathead skulls. The

FIG. 4.—Peruvian Child's Skull, Abnormal.

second—a dolichocephalic skull—Dr. Wymann will find alongside of the Peruvian skulls, No. 15 in the Warren Collection at Boston. It is that of a "Chinese," or was at any rate brought from China by Capt. Edes. It approximates in malformation to the "Hochbelaga skull," Fig. 67, "Prehist. Man," p. 501, as an example of posthumous distortion. But in this skull from China the sutures are close, with no trace of dislocation or other indications of posthumous modification of forms. Those are extreme examples; but I repeat what I have long ago asserted; that a perfectly symmetrical head is the exception, rather than the rule.

DANIEL WILSON

*THE COMING TRANSIT OF VENUS**

V.

IT is probable that the observations of contact will be very materially supported by additional observations made with the double-image micrometer. This instrument was devised many years ago by Sir George Airy.† It is the most convenient eye-piece micrometer which can be used for measuring the distance between a pair of stars, or, as in the present case, between the limbs of the sun and Venus. The peculiarity of Airy's double-image micrometer consists in this, that one of the lenses forming an ordinary terrestrial eye-piece is divided in two, like the object-glass of a heliometer. The one half can be slid past the other, and the amount of displacement accurately measured by a divided circle, concentric with the screw which gives this motion. When the halves of this lens are relatively displaced, two images of the object are seen, as in the heliometer. If the distance between a pair of stars be the subject of measurement, the line of separation of the half-lenses is made to coincide with the line joining the two stars. The screw is now turned in one direction, until the image of one star given by one half of the lens coincides with the image of the other star given by the other half of the lens. The amount of displacement is now read off. The halves of the lens are again brought to coincidence. The screw is now turned in the opposite direction, and a similar observation made. Knowing the value of the divisions on the divided circle, these two observations give us a means not only of determining the distance between the two stars, but also of fixing accurately the reading of the instrument when the half-lenses are in coincidence.

It is easy to see that after the internal contact at ingress, and before the internal contact at egress, measurements may thus be made of the distance of Venus from the sun's limb, from which the true time of contact may be deduced, just as in the Janssen photographic method.

But, besides, this double-image micrometer gives a means of estimating the true time of contact in a manner which may possibly be one of very great accuracy indeed. Consider the case of ingress two minutes before the time of true contact. From this time up to the actual contact the distance between the cusps, where the limbs of Venus

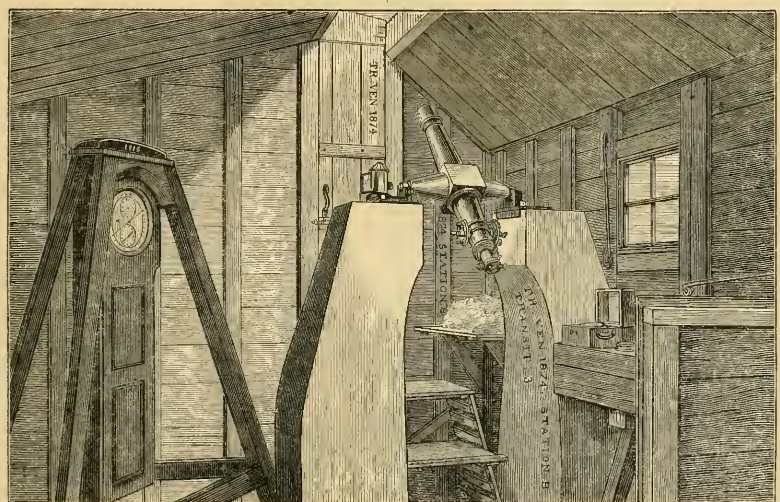


FIG. 16.—The Transit-instrument of the British Expedition.

and the sun meet, will diminish with very great rapidity. By turning the micrometer so that the line of junction of the half-lenses is in a line with the points of these two cusps, the distance between them may be very accurately measured. The observation may be repeated a number of times. The great rapidity with which these cusps approach, with a very slight motion of the planet, makes it probable that each of these observations will give the means of determining very closely the true time of contact.

There are great difficulties connected with observations of the sun at such low altitudes as are required for the application of De l'Isle's and other methods. These will materially affect the definition of the cusps, and it is not certain that the micrometer method will give results so valuable as might have been anticipated.

But even in the eye-observation of contact the low altitude of the sun will be a serious drawback. This difficulty has been fully recognised by the Astronomer Royal, and, with the assistance of Mr. Simms, he has devised an ingenious eye-piece, which is likely largely to reduce the inconvenience.* The chief difficulty is, that at such low altitudes not only are the rays of light enormously refracted by the earth's atmosphere, but the colours are actually dispersed, as with a prism. Hence the definition cannot be perfect. The principle of the new eye-piece consists in employing a hemispherical lens for the one next the eye. The surface of this lens next to the eye is plane; and the lens can be moved, by means of a screw and slight spring, in a socket which is a portion of a sphere the same radius as the lens. By turning the screw, various inclinations can be given to the plane surface next the eye. But the curvature of the other surface remains the same, though a different portion of it is used. The practical result, then, of such an inclination of the lens in its socket is simply the introduction of a prism whose angle can be so varied as to correct totally the atmospheric dispersion.

* Continued from p. 30. † Greenwich Observations, 1 .

* Monthly Notices of the R.A.S. vol. xxx. p. 58.

But in the case of photography the low altitude of the sun introduces a much more serious difficulty. The light has in this case to pass through a great length of the earth's atmosphere, in its lowest and densest regions. Much of the light is absorbed by the atmosphere, as is shown by the fact that the rising or setting sun may be gazed at with impunity. But further, it is found that of all the colours composing the sun's light, those which affect most powerfully a photographic plate are the most greedily absorbed. Hence it has been found at St. Petersburg that at mid-winter a photographic plate must be exposed to the sun 360 times as long as at the equinoxes, when the altitude of the sun is about 6° or 7°. This is a difficulty which cannot be surmounted except by exposing the plate a longer time than is desirable.

It has been already stated that considerable discrepancies in determining the times of contact might arise from observers noting different phenomena. The employment of the Model Transit of Venus ensures concordance among the observers of each nation; but all European observers will be much indebted to M. Struve, who has actually compared his own observations with those of the Russian, German, English, and French observers, so that comparisons will be possible between the observations of these different nations.

Everything being now prepared for observing as successfully as possible the actual phenomenon of contact, it remains to describe the means by which the time can be determined accurately. All clocks and watches are set and regulated by observations of the stars, or by comparison with other clocks so regulated. An astronomical clock counts the hours up to 24h. The clock is set to 0h. at the instant when a particular star passes the meridian. If then we have a means of determining the time when this happens, we can set our clock accurately to local time. But a star does not pass the meridian of Greenwich at the same time as it passes the meridian of a place having any other longitude. By the aid of a transit instrument the local time can be determined; but to determine actual Greenwich time at another place we must, as before stated, know accurately the longitude of that station. *These two things, the absolute time and the longitude, are so connected, that if we know the one, the other can be immediately deduced.*

The longitude may be determined in a variety of different ways. If the two places whose difference of longitude is to be determined be not very distant, a simple method may be employed. A rocket is sent up from some point between the two stations. An observer at each station notes the local time at which the rocket is seen to burst. The difference between these times gives the difference of longitude. A flash from a lamp or reflected sunlight may be similarly employed.

The absolute time (and consequently the longitude) can also be found by transporting chronometers from one station where it is known to another where it is not known. First-rate chronometers must be used, and a large number to check one another's errors. The main error of a chronometer is due to the influence of temperature on the momentum of the balance wheel and the strength of its spring. The Russians have of late years introduced with great success a method of secondary correction for this error. Along with the compensated chronometer at least one is sent without any compensation. The difference between this chronometer and others is a measure of the sum total of the temperatures to which they have been exposed; and by the aid of a table carefully drawn up from a number of observations, the amount of secondary correction necessary can be fairly estimated. It is said that the employment of this device is of the very greatest service. Ten well-tried chronometers, accompanied by a single uncompensated one, if carried between stations ten days apart (*e.g.* St. Petersburg and Cazan) will, in one journey, give the longitude of an intermediate station (such as Moscow) correctly within $\frac{1}{10}$ of a second of time. By the aid of this contrivance chronometers may be employed, even for very long journeys, to determine the longitude. This method is quite new, and has not been tested by any nations except the Russians. The results obtained by them are, however, perfectly satisfactory. Theoretically the idea is almost perfect; the outstanding temperature error being the main fault of chronometers, and the employment of an additional chronometer uncompensated giving us a means of determining the amount of this error, the time deduced by this means ought to give very satisfactory results. There is but one objection to the method, which is only a partial one. After a series of alternately very hot days and very cold nights, the difference between the compensated and uncompensated chronometers might be the same as after the same period, with a tolerably uniform temperature; but the correction necessary in these two cases might be very different indeed. It is easy, however, to keep chronometers at a temperature which does not vary rapidly, and the experiments made by the Russians warrant us in saying that by the aid of this method longitudes may be determined, with very great accuracy indeed, in voyages of such length that the ordinary chronometric method would be unavailing, and that in every case where longitudes are required by the use of chronometers this method should be employed.

A third way of determining the absolute time is by the use of telegraphic signals. An operator at Greenwich may arrange to telegraph a signal to another at Alexandria at a certain definite time of day. If the transmission of the current from Greenwich to Alexandria were instantaneous the person at Alexandria would at that instant receive the exact time. But a current through a submarine cable is retarded. Suppose it to be retarded two seconds; the time received at Alexandria will be *too late* by two seconds. If now an operator at Alexandria telegraphs to Greenwich he will dispatch the signal two seconds *before* it reaches Greenwich. The longitudes determined by the two currents in opposite directions will therefore differ by four seconds. The mean of these values gives the true longitude, and half the difference between the two determinations is the time of transit of the currents. It is found, however, both from theory and experiment, that if there be a leak in the cable nearer to Greenwich than to Alexandria the current will pass more slowly in going to Alexandria than in the reverse direction. This difference, however, can never be very great.

Considerable differences have been found by the Americans to exist between comparative observations of longitude by the telegraphic method and by the lunar method, which will presently be described. The Americans rushed to the conclusion that the error existed in the lunar method. This is not necessarily so. The American system of telegraphing over long distances consists in using a *relay*. A relay is an arrangement to overcome the difficulty of sending a current through a long line. It is placed at an intermediate station. It consists essentially of an electro-magnet which attracts a piece of iron when a current which has originally been sent through the primary station passes through its coils. This attraction of a piece of iron makes contact with a new electric circuit with a separate battery, and so the current is passed on to the final station, or to a second relay. The piece of iron must move through a sensible distance before the second circuit is completed. It has hitherto been supposed that the time lost in employing a number of relays could be eliminated by sending the current in alternate directions as above described. This is certainly not the case. The time elapsing before contact is made by a relay depends upon the strength of the current. The strength of the current depends upon the length of the wire through which it is passing, and also

upon the strength of the battery. Consider now the case of a relay at the junction of a long and short wire. The current passing through the long wire is weaker than the other. Hence if the current first pass through the short wire, the loss of time introduced by the relay is less than when the current is first sent through the long wire. For this reason the time taken by the current to pass in one direction is less than in the other direction. It appears then that the employment of a number of relays is injurious in longitude determinations, and if extraordinary precautions be not taken the resulting longitude will be erroneous. The same takes place with a submarine cable, with a leak near one end of it.

It must be noticed that in all the methods here described for determining the longitude, the local time must be accurately known. This is done by aid of a transit instrument as before described. One of the transit instruments of the British Expedition, in its wooden hut, is shown in Fig. 16.

Another class of method for determining the longitude depends upon the motions of the moon. It has already been stated that what we want is to know at some instant the absolute Greenwich time. If then we could get something analogous to a huge clock in the heavens which an observer at any part of the world could see we should be able to determine our longitude. The moon may be taken to represent the hand of such a clock, and the stars the hours and minutes. The moon is chosen in preference to the planets because she moves more rapidly among the stars. She moves around the earth, that is through 360°, in $27\frac{1}{2}$ days, or through 1° in two hours, or through one second of arc in two seconds of time. If then the tables in the *Nautical Almanac* predicting the place of the moon are absolutely correct, an observer by watching the instant at which she seems to come to the position of any star, and knowing from the tables the Greenwich time at which she reaches that position, receives an intimation of the absolute time from this gigantic celestial clock. Or, if there be no star, it will suffice to observe the time when the moon reaches any definite position among the stars. As a matter of fact the tables of the moon are by no means perfect; but this difficulty is overcome by the regular series of observations of the moon's place made at Greenwich on every possible occasion. Thus while the tables are sufficiently accurate to give the navigator a fair knowledge of his longitude, an observer in any country can, when convenient, compare his observations with those made at Greenwich, and so determine the longitude with great accuracy.

It is a fact of interest in connection with the present subject, that the transits of Venus will aid materially in perfecting the Lunar Tables. The motions of the moon are rendered irregular by the disturbing attraction of the sun. But we cannot determine with great accuracy either the amount or the direction of the sun's attraction upon the moon until we know accurately the sun's distance. Hence if we wish to be able to compute tables of the moon sufficiently correct for the exact determination of longitude, we must employ every means in our power to perfect our knowledge of the sun's distance.

Of the methods available for determining the moon's position, three will be employed in the coming transit. The first is by observing, with a powerful telescope, the exact time at which the moon extinguishes the light of a star in front of which it is passing. This is technically called an occultation of a star by the moon; and when the occultation is made by the non-illuminated portion of the moon the observation has great precision, and, the position of the star being known, is very valuable for determining longitude.

The second method is by observing, with a transit instrument, the exact time at which the moon passes the meridian, and by observing about the same time the transits of stars whose positions are well known.

The third method is by employing an instrument called an altitude-and-azimuth instrument, or shortly, an alt-azimuth. This instrument is shown in Fig. 17, and consists essentially of a telescope mounted upon two divided circles so arranged that the one shall give the altitude of an object towards which the telescope is pointing, while the other gives its azimuth or its angular distance from the meridian measured in a horizontal direction. An instrument of this class has long been employed at Greenwich with great success for determining the position of the moon when out of the meridian. It thus acts as a supplement to the transit-circle, of the utmost value in so cloudy a climate as our own. One disadvantage of this instrument is that the numerical reductions are extremely troublesome; but no trouble is too great in an observation of so much importance.

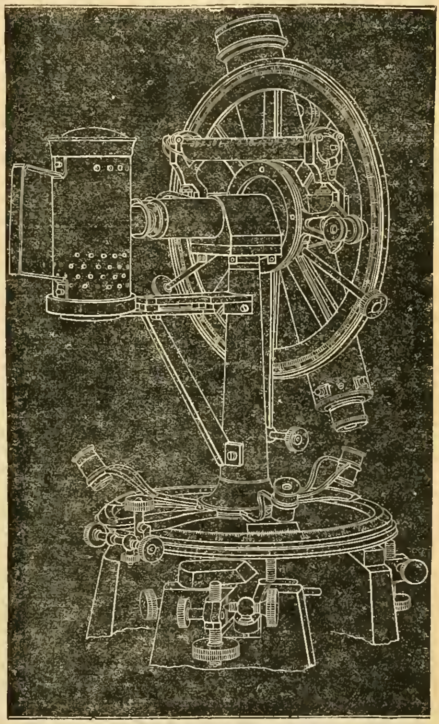


FIG. 17.—Portable Alt-azimuth Instrument.

It is not absolutely necessary that both altitude and azimuth should be observed. In equatorial regions the motion of the moon is chiefly in altitude, while in places of high latitude the motion is chiefly in azimuth. Hence among the English stations the vertical circles alone are provided for the stations within 30° of the equator, while at Rodriguez, Kerguelen's Island and New Zealand the azimuth circles are accurately divided. All these instruments have been well tested, and are found to be remarkably perfect. Not only the alt-azimuths but also most of the other instruments to be employed by the British have been constructed by Troughton and Simms; they have all been well tried, and the results have been so satisfactory that

these makers deserve great credit for the help they have thus given to the success of the expeditions.

In all observations of the moon for determining the longitude there are of course numerous corrections which must be applied. Among these none is more important than the correction for the parallax of the moon.

RECAPITULATION.—In the case of every nation depending upon De l'Isle's method and in the case of every expedition when only one contact is observed, the longitude must be determined with very great accuracy. This can be done by any of the following methods :—

1. By rockets, or flashing signals.
2. By a trigonometrical survey.
3. By the aid of chronometers, in which it would be unwise to neglect the method lately introduced of adding to the chronometers one which is uncompensated.
4. The telegraphic method, in which it is not desirable to use relays, since very long lines with a Thomson's reflecting galvanometer will give good results, while the employment of relays is objectionable.
5. By observations of the moon's position which may be made by either of the three following methods :—
   (α) By occultations of the moon.
   (β) By transit observations of the moon and moon-culminating stars.
   (γ) By aid of an alt-azimuth.

GEORGE FORBES

(*To be continued.*)

OCEAN CURRENTS

I OBSERVE that in NATURE, vol. ix. p. 423, Dr. Carpenter re-states and maintains his opinion that polar cold rather than equatorial heat is the *primum mobile* of his general oceanic circulation. In my papers in the *Philosophical Magazine* for Oct. 1871 and Feb. 1874 I have proved, I trust, to the satisfaction of any physicist who will be at the trouble to examine what I have written on the subject, that this notion is based upon a confusion of ideas in regard to the way in which difference of specific gravity produces motion. It is not my object at present to enter into any further discussion of this elementary matter ; but I wish briefly to refer to a new and somewhat plausible-looking objection advanced in Dr. Carpenter's article against the views I advocate in reference to under-currents. The following is the paragraph to which I refer :—

"According to Mr. Croll's doctrine the whole of that vast mass of water in the North Atlantic, averaging, say, 1,500 fathoms in thickness and 3,600 miles in breadth, the temperature of which (from 40° downwards), as ascertained by the *Challenger* soundings, clearly shows it to be mainly derived from a polar source, is nothing else than *the reflux of the Gulf Stream*. Now, even if we suppose that the whole of this stream, as it passes Sandy Hook, were to go on into the closed Arctic basin, it would only force out an equivalent body of water. And as, on comparing the sectional areas of the two, I find that of the Gulf Stream to be about 1-900 that of the North Atlantic underflow ; and as it is admitted that a large part of the Gulf Stream returns into the Mid-Atlantic circulation, only a branch of it going on to the north-east ; the extreme improbability (may I not say impossibility ?) that so vast a mass of water can be put in motion by what is by comparison a mere rivulet, the north-east motion of which as a distinct current has not been traced eastward of 30° W. long. seems still more obvious."

The objection seems to me to be based upon a series of misapprehensions : (1) that the mass of cold water 1,500 fathoms deep and 3,600 miles in breadth is in a state of motion towards the equator ; (2) that it cannot be the reflux of the Gulf Stream, because its sectional area is 900 times greater than that of the Gulf Stream ; (3) that the immense mass of water is, according to my views, set in motion by the Gulf Stream.

I shall consider these in their order : (1) That this immense mass of cold water came originally from the polar regions I of course admit, but that the whole is in a state of motion I certainly do not admit. There is no warrant whatever for any such assumption. According to Dr. Carpenter himself the heating power of the sun does not extend to any great depth below the surface ; consequently there is nothing whatever to heat this mass but the heat coming through the earth's crust. But the amount of heat derived from this source is so trifling that an under-current from the Arctic regions far less in volume than that of the Gulf Stream would be quite sufficient to keep the mass at an ice-cold temperature. Taking the area of the North Atlantic between the equator and the tropic of Cancer, including also the Carribean Sea and the Gulf of Mexico, to be 7,700,000 square miles, and the rate at which internal heat passes through the earth's surface to be that assigned by Sir William Thomson, we find that the total quantity of heat derived from the earth's crust by the above area is equal to about 88×10^{15} foot pounds per day. But this amount is equal to only 1-894th of that conveyed by the Gulf Stream, on the supposition that each pound of water carries 19,300 foot pounds of heat. Consequently an under-current from the polar regions of not more than $\frac{1}{35}$ the volume of the Gulf Stream would suffice to keep the entire mass of water of that area within 1° of what it would be were there no heat derived from the crust of the earth. That is to say, were the water conveyed by the under-current at 32°, internal heat would not maintain the mass of the ocean in the above area at more than 33°. The entire area of the North Atlantic from the equator to the Arctic circle is somewhere about 16,000,000 square miles. An under-current of less than $\frac{1}{17}$ that of the Gulf Stream coming from the Arctic regions would therefore suffice to keep the entire North Atlantic basin filled with ice-cold water. In short, whatever theory we adopt regarding oceanic circulation, it follows equally as a necessary consequence that the entire mass of the ocean below the stratum heated by the sun's rays must consist of cold water. For if cold water be continually coming from the polar regions either in the form of under-currents or in the form of a general underflow, as Dr. Carpenter supposes, the entire under portion of the ocean must ultimately become occupied by cold water, for there is no source from which this influx of cold water can derive heat save from the earth's crust. But the amount thus derived is so trifling as to produce no sensible effect. For example, a polar under-current one-half the size of the Gulf Stream would be sufficient to keep the entire water of the globe (below the stratum heated by the sun's rays) at an ice-cold temperature. Internal heat would not be sufficient, under such circumstances, to maintain the mass 1° F. above the temperature it possessed when it left the polar regions.

(2) But suppose that this immense mass of cold water occupying the great depths of the ocean were, as Dr. Carpenter assumes it to be, in a state of constant motion towards the equator, and that its sectional area were 900 times that of the Gulf Stream, it would not therefore follow that the quantity of water passing through this large sectional area must be greater than that flowing through a sectional area of the Gulf Stream, for the quantity of water flowing through this large sectional area depends entirely on the rate of motion.

(3) I am wholly unable to understand how it could be supposed that this underflow, according to my view, is set in motion by the Gulf Stream, seeing that I have shown that the return under-current is as much due to the impulse of the wind as the Gulf Stream itself.

I am also wholly unable to comprehend how Dr. Carpenter should imagine that because the bottom temperature of the South Atlantic should happen to be lower,

and the polar water to lie nearer to the surface in this ocean than in the North Atlantic, that therefore this proves the truth of his theory. This condition of matters is just as consistent with my theory as with his. When we consider the immense quantity of warm surface water which, as has been proved,* is being constantly transferred from the South into the North Atlantic—a quantity which to a large extent is compensated by cold currents from the Antarctic regions—we readily understand how the polar water comes nearer to the surface in the former ocean than in the latter. In fact the whole phenomena is just as easily explained upon the principle of under-currents as upon Dr. Carpenter's theory.

Dr. Carpenter lays considerable stress on the important fact established by the *Challenger* expedition, viz. that the great depths of the sea in equatorial regions are occupied by ice-cold water, while the portion heated by the sun's rays is simply a thin stratum at the surface. It seems to me that it would be difficult to find a fact more hostile to his theory than this. Were it not for this upper stratum of heated water there would be no difference between the equatorial and polar columns, and consequently nothing to produce motion. But the thinner this stratum is the less is the difference and the less there is to produce motion. I have been favoured by the Hydrographer to the Admiralty with a series of temperature soundings taken along the equator, and from these I find that to so small a depth does the super-heating extend that the surface of the ocean at the equator requires to stand only four and a half feet above that at the poles in order to the ocean being in perfect equilibrium. In this case if we suppose, in order to constant circulation, that the polar column is kept in excess of the equatorial by the weight of say two feet of water, there would then remain only a slope of two and a half feet between the equator and poles.

There is another point to which, with some reluctance, I am compelled to refer. Dr. Carpenter is continually representing that eminent physicists have adopted his theories while none of them share in my objections. I can assure Dr. Carpenter that such is not the case. Only a few weeks ago one of the most eminent mathematical physicists of the present day stated to me that no one familiar with the elements of physics and mechanics, who would be at the trouble to make himself acquainted with Dr. Carpenter's theories, could ever adopt them.

JAMES CROLL

* Phil. Mag. for March 1874, p. 170.

BIOLOGY AT CAMBRIDGE

ON the evening of Monday, 11th inst., Cambridge biologists mustered at least a hundred strong at the meeting of the Philosophical Society to hear a communication from Prof. Huxley, one of the honorary members of the Society, on the morphological conclusions to be drawn from the distribution of the cranial nerves, with especial reference to those of the seventh pair. Prof. C. B. Babington, F.R.S., president of the Society, occupied the chair. Prof. Huxley took occasion to refer in terms of the highest commendation to the researches of Stannius more than twenty years ago, on the morphological teaching to be derived from studying the distribution of nerves, and also spoke of the deductions drawn from nerve-supply by Gegenbaur, especially in his work on the "Skulls of Plagiostomous Fishes." Prof. Huxley sketched in considerable detail the distribution of the portio dura or seventh cranial nerve in man, and compared it with the homologous nerve in the frog, showing how the arrangements of branches, especially the course of the chorda tympani, which seemed anomalous in man, were a necessary consequence of perfectly obvious and natural arrangements in the lower vertebrates. He also demonstrated how the morphology of the parts might be learnt from such homologies; how a circuitous and apparently useless path taken by a nerve was full of meaning and instruction, and when studied in connection with facts of development and function would lead to an explanation which might be very much trusted. The relation of the tympano-eustachian tube to the bifurcation of the seventh nerve was dwelt upon, as leading to the identification of the comparatively small and simple auditory passage of the frog with the complex one of the mammal, and further to the homological identity of these passages with the spiracle of the Plagiostomes. The distribution of the fifth and seventh pairs of cranial nerves was held to agree with the view, suggested by development, that the trabecular arch is a pre-oral visceral arch, and that the pterygo-palatine is but an outgrowth of the mandibular arch.

The paper, which was illustrated by black-board drawing, with the professor's well-known aptitude, and which was a model of lucidity and careful reasoning, was loudly applauded. In a discussion which followed, Prof. Humphry drew attention to labours of his own having the object of showing the value of the teaching of nerve distribution. He acknowledged the strong case which was now made out in favour of the trabecular arch taking its position in the series of visceral arches, and thought that Prof. Parker's paper on the development of the pig's skull made it almost equally clear that the pterygo-palatine arch was similar in homology. It was also remarked that the same conclusions seemed deducible from Prof. Parker's paper on the development of the salmon, where the pterygo-palatine arch was distinct from the first and in all respects like the other visceral arches.

The practical class for the study of elementary biology, conducted by Dr. Michael Foster and Dr. Martin, is very successful this term. When thirty students entered last year the number was thought very large, and it was made up of men of several years who had previously had no opportunity of attending such a course. It was expected that a much smaller number would attend this year; but the large number of nearly forty have availed themselves of the course, and work proceeds in a most satisfactory and instructive fashion. Adequate superintendence is provided at all hours of the working day by the co-operation of four advanced students in addition to the lecturers. These are Messrs. P. H. Carpenter, Trinity College, A. M. Marshall, B.Sc., and Langley, St. John's College, and S. H. Vines, B. Sc., Christ's College.

G. T. BETTANY

NOTES

ON Tuesday, Sir Samuel Baker delivered the Rede lecture in the Senate House, Cambridge, before a numerous assemblage, which included all the leading men of the University in residence, and many ladies. The subject of the address was "Slavery," and Sir Samuel's narrative of his personal experiences in Africa was listened to with much interest.

IT is said to be in contemplation to confer honorary degrees at the Cambridge commencement upon Sir Bartle Frere, Sir Garnet Wolesley, Sir James Paget, and Prof. Helmholtz.

IT is stated that if the authorities of Owens College, Manchester, can show that they really require it, Government are prepared to make a considerable grant of money to the College.

THE Founder's Medal of the Royal Geographical Society has been granted to Dr. Schweinfurth, and the Victoria Medal to Col. P. E. Warburton, who recently succeeded in crossing the interior of Western Australia.

BY later advices from Australia we learn that Major Warburton accomplished exactly what he set out to do. He traversed the continent from the MacDonnell Ranges to the coast north of

Nickol Bay, passing over 800 or 900 miles of ground never before trodden by the foot of white man. The expedition has been useful only in a scientific point of view; the country for nearly the whole distance is utterly worthless. Barren, scrubby, and in the last degree wretched, the explorers had the utmost difficulty in forcing their way through. With poor food for the greater portion of their dreary journey, with water often scarce, and little game, the brave band were reduced to the utmost extremities. For three months they had nothing to live on but dried camels' flesh, and as much roots and bulbs as they were able to gather.

IT is said that the king of Sweden has conferred upon Mr. Leigh Smith, the Arctic explorer, the Order of the Polar Star. Mr. Smith succeeded last spring, at his own expense, and with much difficulty, in rescuing the Swedish expedition, which had been caught by the ice in the preceding winter.

THE Albert Gold Medal of the Society of Arts has been awarded for the present year to Dr. C. W. Siemens, F.R.S.

THE German Emperor a few days ago at Wiesbaden, received Herr Rohlfs, the German explorer, who has just returned from the Lybian desert. It was by the Emperor's special command that the well-known traveller repaired to the palace and gave his Majesty an interesting account of his latest travels. The Emperor, as a further distinction, desired Herr Rohlfs to dine that day at the imperial table.

WE are glad to learn that, in accordance with the wish expressed at the Meteorological Congress held at Vienna in 1873, a commission has been nominated by the Imperial Academy of Sciences at St. Petersburg and by the Imperial Ministry of Marine, to prepare a project for the establishment of a central office for Maritime Meteorology in Russia, including a system of meteorological telegraphy and storm warnings. Prof. H. Wild, Director of the Central Physical Observatory, and Capt. M. Rikatcheff, Assistant in the same establishment, are appointed members of the commission.

M. PRJEWALSKY, a staff-officer of the Russian army, is about to publish an account of a journey in which he has successively explored Dzungaria, Koukou Noor, and Moupin. Like Armand David (NATURE, vol. x. p. 32), he brings back with him extensive collections. Insects hold a large place in both; those of Père David, said to be exceedingly interesting, have been presented to the Musée National, at Paris, where they have remained unnoticed by the French entomologists, one of whom says, that now "they will probably always remain unknown."

M. J. LIAGRE has been elected Perpetual Secretary of the Belgian Academy of Science, in succession to the late M. A. Quetelet.

A GEOLOGICAL excursion on a somewhat extended scale has been proposed, to those localities in the Swiss Alps which have become household words amongst those who have studied the changes of the earth's surface, and the action of ice and water more especially. A gentleman whose local knowledge is undoubted has been requested to act as cicerone to the party, and to deliver discourses upon the more interesting spots. He has accepted the first task, but wishes to secure the kind offices of an indigenous geologist for the second. It is hoped to arrange for a large party of ladies and gentlemen to start early in August and be absent for a month. This is the first time the interests of Science will be added to the enjoyments of a summer's holiday, with the exception of the short excursions near home of the Geologists' Association.

THE President of the Institution of Civil Engineers and Mrs. Harrison held a reception on Tuesday evening in the western gallery of the International Exhibition, at which over two thousand guests were present. In addition to the picture galleries and rooms containing machinery in motion, the west quadrant was open, and in it were placed illustrations of recent scientific inventions specially lent for the evening. With the exception of Mr. Crook's experiments showing attraction and repulsion accompanying radiation, and Tisley and Spiller's compound pendulum apparatus, all were applications of scientific inventions to the wants of life, if wicked war may be included among our wants, for Sir W. Armstrong, and other firms, sent models of appliances for the hydraulic mounting of large guns, whereby they can be placed in position with ease. One of the most recent applications of electricity is to a self-recording "waybill" of omnibuses. An apparatus brought out by Messrs. Whitehouse and Clark counts up once every minute the number of passengers in the omnibus and prints this number and the exact time in plain figures. Each seat is separate, and the weight of the passenger on the seat brings the wire from that seat in communication with the recorder. The instrument also records the speed of the omnibus at every moment of the journey, and shows the exact time of arrival and departure from each station. The cost is said to be but a few shillings a week, but it does away with the need of a time-keeper. A sample was exhibited of bills made May 15, in Liverpool, showing that the invention is practicable as well as ingenious. Nearly all other models were of docks, lighthouses, or railway appliances.

AT a meeting of the Sedgwick Memorial Committee held at Cambridge on the 12th inst., the treasurers, Mr. Vansittart of Trinity, and Mr. Ewbank of Clare, announced that more than 10,000*l*. had been promised, of which 9,000*l*. had been received. The money is to be expended in the erection of a Geological Museum, to be called the Sedgwick Museum. After discussion it was agreed that the time had arrived when it is desirable that the University should take the subject into consideration. The chairman, Prof Humphry, was desired to communicate the resolution to the Vice-Chancellor, with a request that he would bring the subject under the consideration of the Council of the Senate.

ON Thursday last in the House of Commons Lord E. Fitzmaurice gave notice that in the event of the Royal Commission reporting on a sufficiently early day before the close of the session, he would call attention to the subject of University reform, and move a resolution.

COUNT WILCZEK, we learn from the *Geographical Magazine*, has announced his readiness to give a reward of 1,000 florins (100*l*.) to anyone who will bring home any news of the Austro-Hungarian Arctic Expedition. The *Tegethoff* steamer, with the members of the Expedition on board, was last heard of on Aug. 21, 1872, on the north-west coast of Novaya Zembya, in about 76° N. lat., when Count Wilczek himself parted company with them and sailed southward in his yacht *Isbjörn*.

A LETTER from the *Daily News* correspondent with H.M.S. *Challenger* gives some account of the work done by that ship between Simon's Bay and Melbourne. The usual sounding, dredging, and trawling operations were carried on with excellent results; many new specimens have been obtained by the dredge. The ship was at Kerguelen's Island on January 7, and stayed about the island during the month of January, making careful surveys and observations, and collecting specimens both from the sea and land. Previous to the ship's departure from Christmas Harbour, Kerguelen, a cairn was built, and papers of instruction, &c. for the Transit of Venus party left in it. On February 11 the first iceberg was seen when making for Heard Island, and from this time till the beginning of next month, ice bergs and drift-ice were met with in large quantities, the ship making one or two narrow escapes; on Feb. 24 the ship was quite close upon the so-called "Termination Island," but no sign

of land was seen at all. On March 17 the *Challenger* anchored near Melbourne, all well.

A TRAIN arrived at Algiers from Oran on the 18th inst., six hours behind time, having been delayed by a thick layer of grasshoppers which covered the rails.

THE first meeting of the Board of Governors of the Yorkshire College of Science was held in the Philosophical Hall, Leeds, on April 30. Dr. Heaton was called upon to preside. The business of the meeting was the election of the president, treasurer, council, and auditor for the ensuing year, also the appointment of six endowed grammar schools and ten institutions, each of whose governing bodies should elect a Governor of the College. Lord F. C. Cavendish, M.P. and Mr. W. B. Denison were respectively elected president and treasurer of the College. The following grammar schools were placed in Schedule A :—Leeds, Bradford, Batley, Halifax, Wakefield, and Giggleswick. The institutions placed in Schedule B were the Philosophical Societies at York, Leeds, Bradford, Halifax, Sheffield, and Huddersfield, the Clothworkers' Company of the City of London, the West Riding Coalmasters' Association, the Cutlers' Company, Sheffield, and the Trustees of Ackroyd Charity. Each of these bodies is invited to nominate a member of the Board of Governors.

THE *Times of India* states that Dr. David Wilkie has been appointed by the Government of India to conduct a scientific investigation into the nature, pathology, and causation of the fever prevailing in the Burdwan and Hoogly districts. He is to work in communication with Dr. Lewis and Dr. Cunningham, and under the direction and general superintendence of the Sanitary Commissioner with the Government of Bengal.

UNDER the direction of Mr. Liversidge, Professor of Geology and Lecturer in Practical Chemistry, the Laboratory of the Sydney University is being improved in a way to make it similar to the Laboratory of the Royal School of Mines and the University of Cambridge, and to afford appliances for the proper conduct of the exercises in practical chemistry.

MR. WILLIAM H. DALL resumed his Alaskan explorations under the U.S. Coast Survey, about April 20, at which date he expected to sail for Sitka and more northern points. It is probable that his labours during the present season will be in the neighbourhood of Cook's Inlet and the peninsula of Alaska, and the coast of the mainland as far as the islands of Nunivah and St. Michael's. His duties are to complete a coast pilot of the territory, and to make careful magnetical and other observations. Should his regular work permit, he hopes to make large collections in natural history and ethnology, in continuation of those of previous seasons, and transmitted through the Coast Survey Office to the National Museum at Washington, and which have done him and the Survey so much credit.

HEFT V. of Petermann's *Mittheilungen*, contains Contributions to the climatology and meteorology of the East Polar Sea, by Prof. Mohn ; an account of some of the results of Gerhard Rohlf's expedition into the Lybian desert, with a map ; and a German translation of the journal kept by Jacob Wainwright, while marching with Livingstone's body from Central Africa to Zanzibar. A copy of this journal was obtained by the late Richard Brenner, the African traveller and Austrian Consul at Zanzibar.

THE additions to the Zoological Society's Gardens during the last week include a Crested Curassow (*Crax alector*) from Guiana, presented by Mr. G. Bruce ; a Ring-necked Parakeet (*Palæornis torquata*) from India, presented by Mrs. A. de Normanville ; a Coati (*Nasua nasica*) from South America, presented by Miss E. Waller ; a Common Paradoxure (*Paradoxurus typus*) from India, presented by Mr. G. R. Colbeck ; two Muscovey Ducks (*Cairina moschata*) from Monte Video, presented by Mr. S. J. Oliff; a Koodoo (*Strepsiceros kudu*) from Africa, deposited.

THE METEOROLOGICAL CONGRESS AT VIENNA *

II.

WITH reference to the organisation of a system of meteorological observations on the Chinese coasts, for advice regarding which the Congress was applied to, a report was adopted setting forth the general principles of organisation suited to the circumstances of China.

In addition to the above, General Myer, as commissioned by the War Department of the United States, proposed that with a view to their exchange at least one uniform observation of such character as to be suitable for the preparation of synoptic charts be taken and recorded daily and simultaneously at as many stations as practicable throughout the world. This proposal the conference adopted, and, as the readers of NATURE are aware, is now in operation.

On these various subjects much valuable information will be found in the discussions in the Reports of the Committees, and in the communications printed in the Appendices, particularly on the subjects of weather telegraphy, sheet lightning, atmospheric electricity, ozone, clouds, atmometers, rain-gauges, and the protection of thermometers.

In the review of the Leipsig Conference (NATURE, vol. viii. p. 342) a hope was expressed with reference to the protection of the thermometers, which is really the vital question of meteorology, that the Vienna Congress would face it, seriously discuss it, and either arrive at some decision, or at least suggest some steps to be taken that might ultimately lead to the uniformity which is so imperatively called for. Unfortunately this has not been done. We say unfortunately, for scarcely two of the head observatories in the British Isles and on the Continent, where continuous or hourly observations are recorded, could be named at which there is uniformity in the protection of the thermometers as respects the box in which they are placed, height above the ground, and position with reference to walls and other surrounding objects. Now till uniformity in the position and exposure of the thermometers be obtained, there can be no comparableness in the results, and consequently the observations are of little value as data for the determination of what must be regarded as the most important fundamental facts on which the science rests, viz. the diurnal and seasonal march of the temperature and humidity of the atmosphere. It is only from the range of the temperature and the humidity of the atmosphere of different regions as ascertained by observations made on a uniform method that we are furnished with physical data for the scientific treatment of such questions as the daily fluctuations of the barometer, and the changes and movements of the atmosphere generally.

Prof. Wild's paper on the exposure of thermometers (p. 77) we recommend to the careful consideration of meteorologists. His observations, instituted at the Pulkowa Observatory at heights of 6¼ ft., 52 ft., and 86 ft., are, as far as we are aware, the best that have yet been made for the purpose of disclosing the influence which mere height, as such, has on the temperature. The thermometers were *placed on a scaffolding constructed of timber lightly put together, and standing in an open field*, being in these essential points in striking contrast with those placed for a similar object on the Chinese pagoda in the Royal Gardens at Kew, it being evident that observations made with thermometers placed like those at Kew will give results which possess little, if any, value in an inquiry touching the vital question of the position and exposure of thermometers.

From the small differences among the mean temperatures he obtained at the different heights, Wild concludes that the height of thermometers above the ground need not necessarily be the same, but may vary between 6 ft. and 33 ft. The differences he obtained as regards mean temperature, though by no means insignificant, are doubtless small ; but when we regard the maxima and minima and the observations at particular hours, which in their practical bearings are so important, the influence of height becomes well marked. Hence, if in any meteorological system uniformity as respects height be disregarded, the results so obtained fail to supply the data necessary for a satisfactory comparison of climates. This condition is all the more indispensable when the thermometers are placed at a height of 4 ft. above the ground, at which they should be placed as being the height which gives the best results as regards the application of meteorology to human mortality and other important questions affecting animal and vegetable life.

* Continued from p. 18.

We are probably yet a long way from any simple method, suited for general adoption, for observing the *true temperature of the air* at any place by means of the thermometer, so as to eliminate completely the disturbing influence of radiation as regards the thermometer and its protecting screen, or box. This is a problem which may well engage the serious attention of the chief observatories of this and other countries for some years to come. The inquiry may be conducted by ascertaining the true temperature of the air at different hours and seasons by Joule's method, described in a communication to the Philosophical Society of Manchester, November 26, 1867, and comparing the results with those simultaneously obtained by thermometers protected in boxes of different constructions and materials. On this point Wild's paper contains some very valuable observations —valuable, not because they are conclusive, but because they are suggestive, as indicating the line of inquiry which should be pursued. In the meantime all that can be secured is *uniformity*, which would be sooner attained if meteorologists recognised that the following positions of the thermometer are, on physical grounds, inadmissible in researches into the horary fluctuations of the temperature and humidity of the air, viz. the roofs of houses, close or near to walls, over bare soil, in the shadows of trees, walls, or other obstructions, or outside windows. Let it be recognised that observations made under these conditions are of less, and in most cases of no value, then the adoption of 4 ft. as the standard height would follow, and with it the question of uniformity would be almost, if not altogether, settled.

As regards *rain-gauges*, the Congress adopted as the best form for the receiver of the rain-gauge the circular one, with a diameter of 14 in., and at a height of 3 ft., or better 4½ ft., above the ground, a decision which was agreed to by all the delegates except Mr. Buchan, who lodged his protest against it. We have taken the trouble of looking over Mr. Symons' last published *British Rainfall*, and observe that there are not more than half a dozen gauges in the British Isles of this dimension. The readers of NATURE are no doubt aware of the extensive experiments and observations made on this subject in England for some years past, and published annually in the *British Rainfall*, from which it has been experimentally proved that gauges of all sizes from 3 in. to 24 in. inclusive collect amounts not differing more than 2 per cent. from each other. We have had a communication from Mr. Scott, by which we are glad to learn that the Meteorological Office has resolved to retain at its stations the 8 in. gauges hitherto in use. This decision as to the size of the gauge a future Congress will no doubt rescind. Equally in error is the decision as regards height of gauge above the ground, especially large gauges. It is certain from numerous observations made on the subject, that gauges placed at from 3 ft. to 4½ ft. above the ground will not indicate with sufficient correctness the amount of the rain which falls at the place of observation in cases where wind accompanies the rain, owing to the disturbance caused by the obstruction offered by the gauge itself, and by the eddies generated within the funnel. Now owing to the enormous dragging influence of the earth's surface of the wind, these disturbing effects are reduced several fold at the surface and at one foot above it as compared with 3 to 4½ ft. high. On these grounds we cannot recommend British Meteorologists to follow the decision of the Congress. Owing to the extreme variableness of the rainfall, particularly in such countries as Great Britain, where the surface is so uneven, the proper observation of the rainfall requires twenty times more observers than are required to observe any of the other meteorological elements. It is therefore well that a cheap gauge is also a good one, since it facilitates an adequate observation, through numerous observers, of the rainfall, which from its practical and scientific bearings it is so important to know.

In fixing the hours of observation it is essential that those hours be selected which give approximately the mean temperature of the day. The combination of hours which seems to have been most approved both at the Leipsig Conference and the Vienna Congress, and referred to by some very able meteorologists as unconditionally the best, is 6 A.M., 2 P.M. and 10 P.M. The merits of this combination consist in the equal interval of eight hours between the observations, in the close approximation to the daily mean temperature it affords, and in its suitableness for tri-daily charting of the weather. It is, however, a combination of hours which, since it all but absolutely excludes the hours of occurrence of the daily thermometric, barometric, and hygrometric extremes and means, cannot be recommended as generally suitable for meteorological observations of all countries. Indeed, its adoption in tropical and sub-tropical countries would be a blunder. As generally suitable for all latitudes, and for the observation of the principal daily atmospheric phases of temperature, pressure, &c., the best hours are 9 A.M. 3 P.M. 9 P.M., or 10 A.M. 4 P.M. 10 P.M., it being assumed that self-registering thermometers are also used.

We are glad to see that it has been proposed to convene another Meteorological Congress in three years, and hope that some of the questions that form the life-blood of the science will be seriously and adequately discussed by the members of that Congress. The more important of these questions are:—(1) The position and protection of the thermometer for the temperature of the air; (2) A more satisfactory method for observing the humidity of the air, and of making the deductions therefrom; (3) The observation of earth-temperatures, especially at and near the surface, and the depth at which fixed thermometers cease to be suitable; (4) Solar and terrestrial radiation; (5) The examination of the drying qualities of the air by atmometers, so as to secure comparable results; (6) A statement of the conditions which anemometrical stations ought to fulfil, so that the instrument shall indicate the true movement of the air over the region where it is placed, or, if this be unattainable, a means of valuing the observations so as to approximate to it;* (7) Anemometers (Wild's, &c.) for stations of the second order, with which trustworthy observations of wind-force may be made; and anemometers of velocity which admit of their errors being readily ascertained from time to time; (8) an adequate nomenclature of clouds; and (9) the question of atmospheric electricity.

Though the Vienna Congress can properly be regarded as having only concerned itself with questions lying on the outskirts of meteorology, it has done commendable work in thus paving the way for future Congresses, entering on the really important practical questions which united action on the part of meteorologists can alone settle. Until tolerable uniformity be arrived at as regards (1), (2), (5), (6), (7), and (8), in the above paragraph, meteorologists can scarcely be said to have begun to collect data of such a nature as will satisfy our best physicists, and thus lead them to undertake the investigation of the more important of the intricate and difficult problems of the science.

M. COGGIA'S COMET

THE following is an ephemeris to the comet discovered by M. Coggia. It will be seen that the comet will be vastly increased in brilliancy by the month of August.

Berlin Mean time.	R.A.	D.	Brightness (brightness at time of discovery = 1).
	h. m.	° ′	
May 19·5	6 30·9	+ 68 49·4	
28·5	34·34	53·1	
27·5	39·49	59·8	
31·5	45·55	+ 69 8·4	
June 4·5	52·57	19·2	3·8
8·5	7 0·57	31·6	4·5
12·5	10·0	45·1	5·5
16·5	20·17	58·1	6·7
20·5	31·57	+ 70 9·3	8·4
24·5	45·8	16·3	10·6
28·5	59·59	15·2	13·6
July 2·5	8 16·36	0·7	17·8
10·5	56·47	+ 68 15·0	32·3
18·5	9 35·50	+ 62 45·2	64·8
26·5	10 8·57	+ 47 10·9	146·3
Aug. 3·5	21·30	+ 8 52·7	245·0
11·5	10·55	÷ 28 17·2	130·8

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 7.—Note on some Winter Thermometric Observations in the Alps, by E. Frankland, F.R.S.

During the past winter the author spent a fortnight at the village of Davos, Canton Granbünden, Switzerland, and had thus an opportunity of experiencing some of the remarkable peculiarities of the climate of the elevated valley (the Prättigan) in which Davos is situated. The village has of late acquired considerable repute as a climatic sanitarium for persons suffering from diseases of the chest.

* NATURE, vol. viii. p. 342.

The peculiar winter climate of Davos appears to depend upon the following conditions :—

1. *Elevation above the Sea*, which causes greater rarity of the air, and consequently less abstraction of heat from the body, and also secures greater transcalency in the atmosphere by a position above the chief region of aqueous precipitation, and comparatively out of the reach of the dust and fuliginous matters which pollute the lower stratum of the air.

2. *Thick and* (*during the winter months*) *permanent snow*, which reflects the solar heat and prevents the communication of warmth to the air, and consequently the production of atmospheric currents. In still, though cold, air the skin is less chilled than in much less cold air, which impinges with considerable velocity upon the surface of the body. The effect of motion through the air upon the sensation of warmth and cold at Davos is very striking. Sitting perfectly still in the sunshine, the heat in mid-winter is sometimes almost unbearable ; on rising and walking about briskly, a delicious feeling of coolness is experienced, but on driving in a sledge the cold soon becomes painful to the unprotected face and hands.

3. *A sheltered position favourable for receiving both the direct and reflected solar rays.*—In this respect Davos-Dörfli, situated opposite to the entrance of the Dischina valley, has the advantage over Davos-Platz two miles lower down the valley, in which latter village the sun rises on December 21 1h. 9m. later, and sets about ten minutes earlier than at Dörfli.

All these conditions contribute not only to a high sun-temperature during the winter months, but also to a comparatively uniform radiant heat from sunrise to sunset.

Addition to the paper, Volcanic Energy : an attempt to develop its true Origin and Cosmical Relations,* by Robert Mallet, C.E., F.R.S., &c.

Referring to his original paper (Phil. Trans. 1873), the author remarks that from the want of necessary data he had refrained from making any calculation as to what amount in volume of the solid shell of our earth must be crushed annually, in order to admit of the shell following down after the more rapidly contracting nucleus. This calculation he now makes upon the basis of certain allowable suppositions, where the want of data requires such to be made, and for assumed thicknesses of solid shell of

100
200
400 and
800 miles respectively.

He tabulates his results for these four assumed thicknesses of shell, and shows that the amount of crushed and extruded rock necessary for the supply of heat, for the support of existing volcanic action, is supplied by that extruded from the shell of between 600 and 800 miles thick, and that the volume of material, heated or molten, annually blown out from all existing volcanic cones, as estimated in his former paper, could be supplied by the extruded matter from a shell of between 200 and 400 miles in thickness.

On data, which seem tolerably reliable, the author has further been enabled to calculate, as he believes for the first time, the actual amount of annual contraction of our globe, and to show that if that be assumed constant for the last 5,000 years, it would amount to a little more than a reduction of about 3·5 in. on the earth's mean radius. This quantity, mighty as are the effects it produces as the efficient cause of volcanic action, is thus shown to be so small as to elude all direct astronomical observation, and, when viewed in reference to the increase of density due to refrigeration of the material of the shell, to be incapable of producing, during the last 2,000 years, any sensible effect upon the length of the day. The author draws various other conclusions, showing the support given by the principal results of this entirely independent investigation, to the verisimilitude of the views contained in his previous memoir.

Linnean Society, May 7.—G. Busk, vice-president, in the chair.—Prof. Thiselton Dyer exhibited a fruit of *Telfairia occidentalis* Hook. f., the seeds of which are used parched by the natives of Calabar, and the young leaves and shoots much prized as a green vegetable. The native name is Ubōng. With reference to the fruit of the *Aristolochia*, hitherto undescribed, Dr. Thomson writes as follows :—"I have seen it, but only so far back as 1859. . . . I cannot trust myself to say more than that the fruit was of a red-brown colour, 5 or 6 in. long, and six-celled, with six well-marked ridges."—Mr. J. R. Jackson exhibited a piece of copal from Zanzibar riddled by ants. After having been some time in the Kew Museum, the living creature was found in the copal and sent to Mr. Walker, who determined it to be a species of *Termes* or white ant, *Eutermes nemoralis* Walk.—The following papers were then read, viz. :—On the discovery of *Phylica arborea*, a tree of Tristan d'Acunha, in Amsterdam Island, in the South-Indian Ocean ; with an enumeration of the Phanerogams and vascular Cryptogams of that island and of St. Paul's, by Dr. J. D. Hooker, vice-president. Labillardière stated in 1791 that the islet of Amsterdam (generally confounded with that of St. Paul), lat. 37° 52′ S., long 77° 35′ E., in the Indian Ocean, was covered with trees, while that of St. Paul, only 50 miles south of it, is destitute of even a shrub. The nature of this arborescent vegetation was unknown until H.M.S. *Pearl* touched at the island in the summer of 1873, when Commodore Goodenough brought off a specimen of what he states to be the only tree growing in the island, together with a fern in an imperfect state. The former proves to be the *Phylica arborea*, of Tristan d'Acunha, and the fern a frond of a *Lomaria*. Amsterdam Island and Tristan d'Acunha are separated by about 5,000 miles of ocean, and are nearly in the same latitude ; and Dr. Hooker discusses the various hypotheses which suggest themselves to account for the extraordinary fact of the occurrence of the same species in such widely separated localities. Near the hot springs on St. Paul's Island *Lycopodium cernuum* is found, an interesting example of the occurrence of a tropical species under special conditions beyond its normal range, a phenomenon of which other instances also occur.—Additions to the lichen flora of New Zealand, by Dr. J. Stirton. Communicated by Dr. Hooker, vice-president. The lichens here described were collected by John Buchanan, of the Colonial Museum, Wellington, N.Z., and include a large number of species now described for the first time.—Enumeratio muscorum Cap. Bonæ Spei, by J. Shaw. The general results arrived at in this paper are summed up as follows :—(1) The great majority of the Cape mosses are of northern-hemisphere types, a few being cosmopolites. (2) Some Australian and New Zealand forms are represented ; a much larger proportion than is the case with flowering plants. (3) Many forms are strictly localised to particular soils and conditions of climate. (4) The moss flora of the Cape is characterised by an almost total absence of Alpine forms.—Contributions to the botany of the *Challenger* expedition :—No. XV. Notes on Plants collected in the islands of the Tristan d'Acunha group, by H. N. Moseley. Communicated by Dr. Hooker. No. XVI. List of algæ collected by Mr. H. N. Moseley at Tristan d'Acunha, by Dr. G. Dickie. Two new species are described.—On a new Australian Sphæromoid (*Cyclura venosa*) ; and notes On *Dynamene rubra* and *D. viridis*, by the Rev. T. R. R. Stebbing. Communicated by W. W. Saunders. This form belongs apparently to a new genus. It was found in Sydney Harbour, under stones at the lowest ebb-tides.—Descriptions of five new species of *Gonyleptes*, by A. G. Butler. These are additional to the monograph of the genus already published by the writer.—Observations on the fruit of *Nitophyllum versicolor*, by Mrs. Merrifield. Communicated by the secretary. The paper contains a description of the coccidia of this species hitherto unknown, although the plant was described in 1800.—On *Hieracium silhetense* DC., by C. B. Clarke. The writer disagrees with Mr. Bentham's identification of this species with *Ainsliæa angustifolia* Hook. f. et Thoms.—Notes on Indian Gentianaceæ, by C. B. Clarke.—On some Atlantic Crustacea from the *Challenger* expedition, by R. von Willemoes-Suhm. Communicated by Prof. Wyville Thomson, F.R.S. The paper is divided into seven parts as follows :—(1) On a blind deep-sea Tanaid ; (2) On *Cystosoma neptuni* (*Thaumops pellucida*) ; (3) On a *Nebalia* from Bermudas ; (4) On some genera of Schizopoda with a free dorsal shield ; (5) On the development of a land-crab ; (6) On a blind deep-sea *Astacus* ; (7) On *Willemoesia* (Grote), a deep-sea Decapod allied to *Cryon*.

Anthropological Institute, May 12.—Prof. Busk, F.R.S., president, in the chair.—Messrs. R. and S. Garrard and Co., of the Haymarket, exhibited a very interesting collection of gold objects recently brought from Ashanti. In the discussion Col. Harley, C.B., stated that the Ashantis, and indeed all the tribes of and near the coast, could originate nothing ; they were simply copyists, and from frequent repetition of European models, as well as of natural objects, they often attained great skill in the art.—Mr. Francis Galton gave some results of school statistics which he had obtained from Marlborough and Liverpool Colleges. If his applications for co-operation from other head-masters and assistant-masters were equally successful as from these two, he would soon have sufficient material

* Read June 20, 1873 ; Phil. Trans. for 1873, p. 147.

to enable him to establish with certainty the law of growth of the English boys of the present date who are sons of professional men and clergymen and who are educated in the country and reared on the present system of diet and physical and mental work. The result so obtained would serve as a standard of comparison for future periods and for other countries and conditions of life.—A paper, also by Mr. Galton, was read, On the excess of female population in the West Indies. —A paper was read On the probability of the extinction of families, by Rev. H. W. Watson, with prefatory remarks by Mr. Francis Galton. The author remarked that it is not only the families of eminent men, or of the aristocracy, who tend to perish, but also those of municipal notabilities and others. The conclusion that was drawn was that an element of degradation must be inseparably connected with one of amelioration, and that our race is necessarily maintained chiefly through the "proletariat." The problem, which was one purely for the mathematician, was to ascertain what proportion of specified families will necessarily become extinct after a few generations. It would be easy then to measure the diminution of fertility by the frequency of extinction.—Major Godwin-Aussten contributed a paper On the rude stone monuments of the Nágás.

Geologists' Association, May 1.—Prof. Morris, vice-president, in the chair.—On some Carboniferous Polyzoa, by Robert Etheridge, jun. The author showed that, until recently, *Synocladia* was known in this country only from rocks of Permian age, being one of the characteristic corallines of the magnesian limestone. From the Carboniferous series of America, however, a species had been described under the name of *S. biserialis*, agreeing in general habit with the typical *S. virgulacea*, but in some essential characters differing widely. From the Scottish Carboniferous series the author had recently described a species of *Synocladia*, which he termed *Carbonaria*, but which he now believes to be only a well-marked variety of the American Permio-carboniferous *S. biserialis*. The author then proceeded to notice the occurrence of *Polypora* and *Thamniscus* in the Scottish Carboniferous rocks, and concluded by drawing attention to the increasing number of forms, which are gradually becoming recognised as common, in our own country, to the Carboniferous and Permian formations.—On some geological puzzles, by Ed. Charlesworth, F.G.S. Out of many hundreds of teeth of terrestrial mammals, as *Sus*, *Castor*, *Tapirus*, *Felis*, *Hipparion*, *Cervus*, *Bos*, &c., which have been discovered in the red crag of Suffolk and Essex, all, with three or four exceptions, are molars. No bones are found along with the teeth of these land animals. This we can understand, as teeth are so much the hardest parts of the animal frame. There is, however, one curious exception. The *Astragalus* of one or more species of deer is far from uncommon in the red crag. The teeth most abundant in the red crag are those of various kinds of sharks; some of these have a circular perforation, not unlike that made by South Sea islanders in the teeth of sharks at the present day. The occurrence in the red crag of certain stones of a cylindrical form, generally abruptly truncate at one extremity, and having a central cylindrical canal passing through the long axis. Though exhibiting transverse segmental division, if struck with a hammer, they do not separate at the segmental lines. That they did so once may be inferred, from the occurrence of detached segments throughout the crag. The phragmocone of the Belemnite is never found in chalk, or chalk flint, though the guard is extremely abundant. The nature of the cylindrical body, which is occasionally observed to pass in a spiral direction through the body of the Choanite. When a chalk Echinite is filled with flint, but not enveloped more or less in that substance, it is found that the calcite of the shell is partially replaced by silica. This does not occur in those parts of the shell which have flint on the outside.

GLASGOW

Geological Society, April 16.—Mr. E. A. Wüncsh, vice-president, in the chair.—Dr. Robert Brown, F.L.S., read a paper On the Noursoak Peninsula and Disco Island, North Greenland.—Mr. David Robertson, F.G.S., then read a paper On the Recent Ostracoda and Foraminifera of the Firth of Clyde, with some notes on the distribution of the Mollusca. The author said there appeared to be too much readiness to adduce climatal change as a cause of varieties in the fauna, which might only be the consequence of local circumstances. For example, *Terebratula caput-serpentis*, an arctic species, is well-grown and abundant in Loch Fyne, but dwarfed and rare at Cumbrae, in the same depth of water and on similar bottoms, which must be attributable to conditions of habitat and not of climate. With regard to the minuter organisms, Mr. Robertson mentioned a remarkable fact, that they are found in greater abundance in many places exposed to the tossings of the sea than in more sheltered bays and lochs. There can be no doubt that such circumstances as the depth of water, the force of currents, and the condition of the sea-bottom, whether it afforded a suitable habitat for certain species, supplying the food best fitted for their healthy development, as well as furnishing them with a degree of immunity from their enemies, such circumstances, often not easily cognisable, would affect the distribution of animal life in the seas of any given period, and account in a great measure for the absence or sparseness of certain species in one locality and their abundance in another.

PARIS

Academy of Sciences, May 11.—M. Bertrand in the chair. —M. J. A. Serret communicated some remarks on the note by M. l'Abbé Aoust, inserted in the *Compte rendus* of the last meeting. —M. Jamin presented a paper On the internal distribution of magnetism in a bundle composed of several laminæ.—On the carpellary theory according to the (order) Hippocastanæ, by M. A. Trécul.—General ideas on the mechanical interpretation of the physical and chemical properties of bodies, by M. A. Ledieu.—On the permanence of the intensity of the calorific radiation of the sun, by M. A. Duponchel, a defence of a previous memoir criticised by M. Faye.—Memoir on the determination of the true simple bodies by the actions of electric currents in the voltameter, by M. E. Martin. The author considers the two electricities as imponderable bodies endowed with powerful and opposite chemical affinities, and states views concerning the compound nature of the gases obtained from water by electrolysis, which differ but little in principle from the old theory of phlogiston.—On the mechanical employment of heat, by M. G. West. The author held out hopes of the possibility of utilising the waste heat of engines.—On albuminoid matters, by M. A. Commaille. The author restated the results of his researches on these bodies *àpropos* of M. Béchamp's recent note on the subject. The bodies in question are representable as amides of capronamic acid and of tyrosine, which is the amide of acetobenzoic acid ($C_{18}H_{11}O_6N$).—M. F. A. Abel presented the continuation of his third memoir on the properties of explosive bodies.—Researches on coniferine. Artificial formation of the aromatic principle of vanilla, by MM. F. Tiemann, and W. Haarmann. The formula assigned to coniferine is $C_{16}H_{22}O_8$ + 2 Aq. The substance is a glucoside decomposing in the following manner:—

$$C_{16}H_{22}O_8 + H_2O = C_6H_{12}O_6 + C_{10}H_{12}O_3.$$

This last product of fermentation ($C_{10}H_{12}O_3$) when oxidised by a mixture of sulphuric acid and potassic dichromate gives aldehyde and a crystalline substance identical with the aromatic principle of vanilla having the formula $C_8H_8O_3$. The reaction was thus represented:—

$$C_{10}H_{12}O_3 + O = C_2H_4O + C_8H_8O_3$$

—On the absolute magnetic declinations observed on the Adriatic coast, by M. Diamilla-Müller.—Observations relating to the memoir by MM. Crocé-Spinelli and Sivel on their (balloon) ascent of March 22, by MM. Lartigue. The facts observed by the aëronauts mentioned, confirm the author's view of the origin of the wind known as the "mistral" which may be generally explained by the great difference of temperature existing between the torrid zone and the temperate and glacial zones.

CONTENTS PAGE

THURSDAY, MAY 28, 1874

THE AFRICAN ECLIPSE OF 1874

IT is often said that Science is a thing of slow growth, and it must indeed be confessed that if one turns aside from the advancement of Science as a whole to the advance of any one particular branch of it, the statement is too true. Over and over again one gets instances in which crucial experiments suggested by previous work are separated by decades or even by centuries. One cause to which this slow march is undoubtedly to be attributed is the apathy of men of Science themselves. To any science in which they do not themselves excel, and especially to any newly-opened-up branch of their own technic, the attitude of many men, and especially of *official* men, of Science, is not merely one of passive resistance; it is the attitude of the Schoolmen in the time of Galileo over again. We grant that these cramped minds are fortunately in a minority, but the minority is often a powerful one, for the reason, among others, that it is composed of men as a rule advanced in years, far removed therefore from the sympathies, unselfishness, receptivity, and unbounded horizon of youth.

It is a good sign of the times, therefore, when we find a scientific official large-minded enough, and with genius enough, to help on with his whole heart new studies as well as the old; and from this point of view we are especially anxious to draw attention to the fact not only that the total eclipse of April 16 of this year has been admirably observed, but that it has been observed by the Astronomer Royal of the Cape, Mr. Stone, himself, who has thus increased the debt of gratitude which both the mechanical and the physical sides of astronomy owe to him, careless, we doubt not, of the opinion held by a very high authority here in England that the spectroscope—the instrument he employed—is not an astronomical, nay, is not even an optical, instrument!

The line of totality of the eclipse in question struck land near Port Nolloth, on the west coast of Cape Colony, somewhere about 250 miles from Cape Town, and passed over the southern extremity of Africa in a curved line with the convexity turned towards the north, ending at sunset about half way across. There were three points whence the totality might be observed: Port Nolloth on the coast, O'okiep at the opposite extreme inward, a hundred miles away; and Klipfontein, about half way between. The last-mentioned spot was very fortunately the one selected by Mr. Stone. It is known locally as the "Cottage," forming the country or picnicing residence of Mr. Hall, an engineer, and on the brow of a hill rising at least some 2,000 ft. above the level of the sea. On the day of the eclipse down at Port Nolloth there was a cloud through which, as at Port Elizabeth and Graham's Town, the phenomena of the eclipse were all but utterly invisible. Up at Klipfontein the weather and the sky were all that could be desired.

Although full particulars of Mr. Stone's observations have not been received, the *Cape Argus* of April 25, a copy of which has been forwarded to us, contains extracts from private letters received from Mr. Stone, which place us *au courant* with the main points of the observations. The most complete account is as follows:—

"I observed the eclipse from Klipfontein. The day was most favourable, not a cloud being visible. The sight with the naked eye during the few moments I could spare from my work was grand and impressive beyond conception. The eclipse, however, appeared to me to differ a good deal from those lately observed.

"The rose-coloured flames extended very nearly around the moon, although of course of unequal heights at different parts. The corona appeared much less complicated. I saw no outlying brushes, and I should without hesitation express an opinion that all the corona I saw was of the same character throughout and belonged to the sun. The less complication of the corona may, however, have been connected with the purity of the atmosphere and the absence of clouds. I used a four-inch telescope lent me by Mr. H. Solomon. My spectroscope was one of two dense flint glass of 60°. The slit was opened as wide as could allow of a clear sight of Fraunhofer's lines. This was done to insure my being able to see the spectrum of the corona, which was expected to have been very faint. During the partial eclipse I examined most carefully the spectrum near the moon's limb, and away from the limb, to see if any fresh lines could be seen near the moon's limb. None appeared, and consequently there cannot be any medium capable of producing sensible absorption of light around the moon. As the totality drew near, the portion of the sun's disc uncovered was kept half way across the slit. At the instant of the totality the whole field appeared full of bright lines. I believe that all the principal Fraunhofer lines were reversed, and seen as bright lines. One of these lines I am certain was the red line B, but no sooner had I begun to count the lines than the spectrum changed into that of hydrogen gas. This spectrum being well known as that of the rose-coloured flames, I did not care to spend the few moments available upon it; but just glancing at the eclipse to see the brightness of the corona, I turned the telescope upon a bright portion of this beyond the rose-coloured light. The spectrum was much fainter than that of the rose-coloured flames, but there was an ordinary spectrum of some brightness, and across this I feel certain Fraunhofer's lines were still visible, although seen with some difficulty on account of the faintness of the general spectrum. There was also a discontinuous spectrum near the green of one very bright line, and two very faint lines of less refrangibility. I then turned the telescope of the spectroscope over the whole spectrum, from the red to the extreme violet, but I could see no other bright lines than those near the green. My time was now nearly run out, and I turned the telescope again upon the brightest of the lines, and brought the wire of the micrometers to fix its position. The telescope remained untouched until after the totality, when the micrometer was read and the position of the line referred to the Fraunhofer's line near it. This bright line appears to agree in position with the one observed by Young. I am satisfied with the results obtained, considering the instrumental means at my disposal. I have made magnetical observations at three stations, and hope yet to reach the Orange River for the same object. Mr. Carson and Mr. Hall have been kind to an extent that I could never have expected, and have thrown all manner of facilities in our way."

It will be seen that the results obtained by Mr. Stone confirm in an important manner several observations made on the eclipses of 1869, 1870, and 1871. The position of the coronal line 1474 scarcely required confirmation, but the two less refrangible coronal lines observed by Pogson in 1868 have been again seen. The coronal atmosphere was apparently, as might have been expected at this period of minimum sun-spots, smaller than in 1871, while the dryness of the air reduced the atmospheric

corona to a minimum. The spectrum of the reversing layer was again seen, thus confirming Young's and Pye's observation of 1870, and the hydrogen lines were seen high up, as in 1870 and 1871. The most important observation, perhaps, made by Mr. Stone is that referring to visibility of the Fraunhofer lines in the spectrum of the coronal atmosphere, showing thereby that that reflects the light of the photosphere.

In a letter to Mr. Solomon, written the day after the eclipse, Mr. Stone states on this point:—"The corona presented a spectrum of a mixed character. I have a strong opinion, amounting almost to certainty, that traces of Fraunhofer's lines were visible, but very difficult to observe, on account of the faintness of the spectrum. The other part of the spectrum of the corona was discontinuous, consisting of three bright lines."

The fact that Mr. Stone has been fortunate both in his weather and in his observations, makes us regret all the more that, the observatory station being so accessible, more efforts were not made in other directions, especially in the direction of photography. A series of photographs taken during the totality, which lasted over 3½ minutes, would have been a precious boon to Science, as the coronal condition of the sun at the periods of maximum and minimum sun-spots could then have been compared. In solar physics, however, we must at present be thankful for small mercies. We willingly agree that a Transit of Venus is a phenomenon to be observed at all cost, but we also affirm that a total eclipse of the sun is, in the present state of knowledge, a phenomenon not second in importance, and we trust that our scientific leaders will not forget that there is a very favourable recurrence of the phenomenon next year.

We are sorry to see that there is a chance of Mr. Stone being left to defray, out of his own pocket, the expenses of an important series of observations, undertaken on his Eclipse journey, on terrestrial magnetism. The *Cape Argus* properly points out that they should be defrayed out of Colonial funds. They are a contribution to Colonial knowledge, and we cannot doubt that the Colonial Government will readily place on the estimates the amount required to meet the cost of transport, which is all that is asked. Mr. Stone gives his own invaluable services and scientific skill without charge; the cost of his journey, so far as the eclipse is concerned, goes to Imperial account; and all that is asked from the Colony is his expenditure on additional journeys, viz. as far as the Orange River, for the magnetic observations referred to. We were very much surprised to hear that any hesitation should have been shown by Government in giving their sanction to the application when first made, and are almost still more surprised to find that it has not been formally acceded to since then. We admire economy, but do not admire parsimony; and we are perfectly certain that no sort of vote would be passed more heartily and unanimously by Parliament than that for the paltry amount of some sixty or seventy pounds sterling required to defray the expenses of these magnetic observations.

The same number of the *Cape Argus* gives us some information also as to the effect of the eclipse upon the natives. A digger at the diamond-fields told his natives that if they did not find a big stone that day they would see something in the firmament that would frighten them. Just as the darkness was commencing a Kafir brought a 45-carat diamond that had been found a few hours previously. In Natal the Zulus stopped work when the eclipse began, and resumed when it was over, demanding two days' wages, the eclipse, in their opinion, having been a short night. The general effect on the natives at the diamond-fields is thus described in a local paper:—"The natives rushed out of their claims horror-stricken, and said that the sun was dying. The grandest living tableau ever seen was the great gathering of horror-stricken nudes on the Colesberg Kopje, watching, with fearfully rounded and glaring eyes, mouth open and fingers pointed at what they believed to be the dying moments of the Almighty luminary whose majesty is the only God they know. The effect of the eclipse on the imagination of the natives, as depicted in their countenances, is described as terrible. They grouped together upon the heights of the Kopje and on the top of Mount Ararat, silent and awe-stricken. The natives knew nothing of the meaning of the ghastly light that preceded the darkness; gloom came upon their labours silently as a thief in the night, and it was not until the whole of the mines presented a sulphureous appearance that they left their work. When they did leave it they left it with a rush, crying one to the other, 'The sun is dying.'"

FOOD AND DIETETICS

A Treatise on Food and Dietetics. By F. W. Pavy, M.D., F.R.S. (J. and A. Churchill.)

THE want of a scientific work on Food and Dietetics has been much felt for some time. Experiments in various directions, both physiological and pathological, have been long accumulating, and have much needed arrangement and satisfactory condensation. Dr. Pavy has supplied the deficiency, and in the work before us gives an excellent account of all the most important observations which have any bearing on the subjects he discusses, tempered by the results of his own extended and judicious experience.

Our knowledge of foods in the chemical, zoological, and botanical point of view, that is as far as composition and derivation are concerned, is considerably in advance of our acquaintance with the true physiological bearing of the facts; and in this section of the subject Dr. Pavy does not attempt to do more than give the well-known analyses and descriptions of previous workers. His object, in the portion of the book devoted to the alimentary principles and the principles of dietetics, is to show how the tendency of modern experiment is to modify and almost subvert the ingenious theories of Liebig as to the functions of the different constituents of our customary diets.

After some introductory remarks on the dynamical relations of food, in which a simple explanation is given of the results obtained by Grove, Mayer, and Joule, as far as they affect the physiology of alimentary principles, the constituent elements of food are discussed both theoretically and practically. Physiologically the separation of the ingesta into "food" and "drink" is shown to be unsuitable. "The two material factors of life are food and air; and food may be considered as comprising that which contributes to the growth and nutrition of the body,

and, by oxidation, to force-production." The great question of the relation of nitrogenised and non-nitrogenised matter to external body-work performed is entered into in considerable detail, and the important experiments of Fick and Wislicinus, Parkes, and Austin Flint, are described in full; to them being added others, performed by Mr. Mahomed in the author's laboratory, on the length of time required for the elimination of the products of metamorphosis of an increased amount of nitrogenised food, from which it may be inferred that urea is produced and eliminated within the three hours following the ingestion of the nitrogenised matter.

It is shown that the original theory of Liebig, in which it is assumed that muscular action involves the destruction of muscular tissue, which till lately has been so generally accepted, "although, in reality, constituting a speculative proposition, unsupported by anything of the nature of proof," is opposed to all the results of recent investigation, and that if it were true "we should have to look upon nitrogenous alimentary matter as forming, through the medium of muscular tissue, the source, and the only source, of muscular power. The renewal of muscular tissue for subsequent oxidation in its turn, and evolution of muscular force, would thus constitute one of the functions of nitrogenous alimentary matter; and on its supply would accordingly depend our capacity for the performance of muscular work." Great stress is laid on the necessity for the combination of nitrogenised with non-nitrogenised food for the sustenance of the body in a vigorous condition; and Mr. Savory's experiments on this point are shown to be quite insufficient to prove the inference which has been frequently drawn from them, namely, that nitrogenous matter, combined only with the appropriate saline principles, suffices for the maintenance of life.

The author reduces the unnecessarily extensive literature on the action of alcohol, which is so very negative in character, into a very moderate space, remarking that "from a review of the evidence as it at present stands, it may reasonably be inferred that there is sufficient before us to justify the conclusion that the main portion of the alcohol ingested becomes destroyed within the system; and if this be the case, it may be fairly assumed that the destruction is attended with oxidation and a corresponding liberation of force, unless, indeed, it should undergo metamorphosis into a principle to be temporarily retained, but nevertheless ultimately applied to force-production. The subject appears to me to be open to physiological as well as chemical investigation, and probably some additional light may be hereafter thrown upon it by an approach through the former channel."

The discussion of the sources of each of the different most important articles of diet is followed by a concise account of its practical value. In the present time of excessive tea-drinking, the following description of the action of tea is of particular interest. "To express in a few words the advantages derivable from the use of tea, it may be said that it forms an agreeable, refreshing, and wholesome beverage, and thereby constitutes a useful medium for the introduction of a portion of the fluid we require into the system. It secures that the water consumed is safe for drinking by the boiling which is necessitated as a preliminary operation in making tea. It cools the body when hot, probably by promoting the action of the skin; and warms it when cold, by virtue, it would seem, of the warm liquid consumed. In a negative way it may prove beneficial to health by taking the place of a less wholesome liquid. Through the milk and sugar usually consumed with it in England, it affords the means of applying a certain amount, and not by any means an insignificant amount, viewed in its entirety, of alimentary matter to the system. Experience shows that it often affords comfort and relief to persons suffering from nervous headache. It also tends to allay the excitement from, and counteract the state induced by, the use of alcoholic stimulants; and further, on account of its antisoporific properties, like coffee, it is useful as an antidote in poisoning by opium."

Besides the important purely physiological problems that are entered into in the work before us, there are so many which have a strictly practical bearing, and they are treated in so clear and impressive a manner, that the ordinary reader cannot but feel that he has derived great benefit from a careful study of its contents. Much stress is laid in the chapter on Practical Dietetics on the importance of a midday meal:—"A fairly substantial meal should be taken at this time, and it does not signify whether it goes under the name of luncheon or dinner." Carnivorous animals apparently thrive best when fed at long intervals; herbivorous, when they are constantly eating. Man being omnivorous, his food should be taken at intervals of much less duration than the carnivora, and therefore in diminished quantities at each, three fairly substantial meals during the day, at intervals of five or six hours being found the best in the long run. "There are many business or professional men who, after leaving home for their office or chambers in the morning, do not taste food, or, if they do, take only a minute quantity, until they return in the evening. Actively engaged all day, their system becomes exhausted, and they arrive home in a thoroughly jaded or worn-out condition. They expect that their dinner is to revive them. It may do so for a while, but it is only a question of time how long this system can be carried on before evil consequences arise." It is therefore stated as a *sine quâ non* that the interval between breakfast and late dinner should be broken by a repast about half-way between them.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Physical Axioms

MR. COLLIER's letter demands from me a reply, which I will endeavour to make as brief as possible.

Mr. Spencer, instead of answering the difficulties which I had shown his *à priori* view of the Second Law of Motion to involve, only noticed my remarks to dismiss them summarily with the lofty sentence that I "proposed to exemplify unconsciously-formed preconceptions," and had committed an absurd blunder in so doing. And now, because it did not appear to me worth while, at the expense of your space and your readers' patience, explicitly to repudiate any such lofty purpose, and so, adopting Mr. Spencer's words, I merely called attention to the fact that the example (of whatever it might be considered to be an exemplification) was of Mr. Spencer's own choosing, I am charged by Mr. Spencer's follower, Mr. Collier, with having "confused issues," which I neither raised nor accepted. If Mr. Collier will

do me the favour of reading my original note again, he will find that the object of my remarks was simply to test the truth of a definite assertion by Mr. Spencer that "the Second Law of Motion is an immediate corollary of the preconception of the exact quantitative relation between cause and effect." It was entirely beside my purpose to discuss the general psychological question of the formation of conceptions or preconceptions farther than as it is involved in the truth or otherwise of this particular assertion. Mr. Collier's note is therefore, as far as regards my remarks, entirely irrelevant and needs no other reply than to invite him, as Mr. Spencer declines to do so, to answer the simple and definite questions proposed by me as difficulties which Mr. Spencer is bound to answer, unless he is prepared to admit that he was wrong in the assertion on which I commented.

I have assumed throughout that Mr. Spencer means to assert that the Second Law of Motion is *involved in*, not merely that it *involves*, a particular preconception. And yet this latter is all that Mr. Collier asserts in the summing up of Mr. Spencer's argument, with which he concludes his note. If Mr. Collier truly represents Mr. Spencer, I can only say that, while the assertion may be admitted to be true, it certainly appears to me to be so trite as to be hardly worth formulating. The whole question turns on the distinction between "involving" and "being involved in," which I suppose Mr. Spencer and Mr. Collier would regard as an important one, though it is difficult in some cases to make out distinctly from their language and their line of argument which they mean to imply.

Passing in conclusion beyond the particular issue to which I have hitherto confined myself, I would remark that to my mind all that Mr. Spencer's and Mr. Collier's illustrations prove is that, while unconscious experiences (whether individual or inherited) may give rise to certain general, but (except in the very simplest cases) vague, preconceptions, it is only when these preconceptions are wedded to consciously-made observation or experiment that they cease to be barren generalities and give birth to the fruitful laws of Physical Science. To a mathematician, at any rate, it is almost ridiculous to observe how little either Mr. Spencer or Mr. Collier seem to realise the great gap between the indefinite observation that two things always increase and decrease simultaneously, and the definite conclusion that they are proportional to one another. For example, it is hardly a parody of Mr. Collier's remarks to say:—"A child discovers that the greater the angle between his legs the greater the distance between his feet, an experience which implicates the notion of proportionality between the angle of a triangle and its opposite side;" a preconception, as it appears to me, with just as good a basis as that whose formation Mr. Collier illustrates, but one which, as I need hardly add, is soon corrected by a conscious study of geometry or by actual measurement.

Harrow, May 25 ROBT. B. HAYWARD

MR. COLLIER'S letter, NATURE, vol. x. p. 43, is even more astonishing than anything that Mr. Spencer has written. A mathematician who reads it feels something like Alice behind the looking-glass; and perhaps behind the looking-glass it may be "a question pertaining to the psychological basis of inductive logic," with which mathematicians, as such, have nothing to do. But in this world, this side the looking-glass, in which forces are measured and effects are measured, Mr. Collier's letter is very perplexing.

For example, after giving several instances in which a greater force produces a greater effect, Mr. Collier proceeds: "The experiences these propositions record all implicate the same consciousness—the notion of proportionality between force applied and result produced: and it is out of this latent consciousness that the axiom of the perfect quantitative equivalence of the relations between cause and effect is evolved."

Does Mr. Collier know what proportionality means? Does any one of the experiments indicated prove that where effort is doubled the result is *doubled?* The child pulls his boat by a string through the water; if he pulls twice as hard does he pull it *twice* as fast?

It seems to me that the people on the other side of the looking-glass think perfect quantitative equivalence (however measured) means the same as proportionality; and are willing to raise first the general result of experience, that greater forces produce greater effects, into an axiom of exact quantitative equivalence (without troubling themselves to consider how quantity is to be estimated), and then to accept Newton's Second Law as an instance of this quantitative equivalence, without showing any connection between quantitative equivalence and direct proportionality in that instance or in any other.

A SENIOR WRANGLER

Ocean Circulation

MR. CROLL will doubtless be of opinion that as my "theories" show such an utter ignorance of "even the elements of physics and mechanics," I can employ my time much better in acquiring some knowledge of those sciences, than in continuing to discuss the subject with him.

I shall be glad to be allowed to state to the readers of NATURE, as I have to those of the *Philosophical Magazine* (May), other grounds on which I must decline to prolong this discussion.

1. Mr. Croll has charged me (Phil. Mag. for March, p. 177, note) with a serious misstatement in regard to the mean annual rate of the Gulf Stream, which he affirms to be *nearly double* what I have represented it. Now *my* statement was avowedly based on the *average of the whole year's observed rates;* whilst Mr. Croll has taken as the basis of *his* the arithmetical *mean* between the maximum and the minimum. It has been said in disparagement of statistics that "anything can be proved by figures;" and Mr. Croll, who is nothing if not a statistician, seems to me to justify the imputation, for the adoption of his method would make the *average* number of children of a marriage to be at least *ten!*

2. Mr. Croll, in asserting that I have left out of consideration "the fact that the sea is salter in intertropical than in polar regions, and that this circumstance, so far as it goes, must tend to neutralise the difference of temperature," has only exhibited his own ignorance of a very important fact of Ocean Physics—the *low* salinity of equatorial surface-water; which was ascertained in Kotzebue's voyage fifty years ago, has been confirmed by many later series of observations, has been repeatedly cited in text-books, and has been adduced by myself as an indication that polar water is continually ascending from the bottom to the surface under the equator. But further, not only has this fact been confirmed by the *Challenger* observations, but so remarkable an accordance has been shown by them to exist between the low specific gravity of equatorial *surface*-water and that of equatorial *bottom*-water, as strongly to indicate that, as the latter is certainly polar, the former is so also. It suited Mr. Croll's purpose, however, with these observations before him, completely to ignore them, and to state as fact what is the precise contrary of facts.

3. According to Mr. Croll and his anonymous authority, the Astronomer Royal must be unfamiliar with even "the elements of physics and mechanics;" for, speaking from the chair of the Royal Society in 1872, he explicitly expressed his acceptance of the doctrine I advocate, as "certain in theory and supported by observation." The eminent meteorologist, Prof. Mohn, of Christiania, also, who expressed to me in writing last year his acceptance of it, must be equally ill-informed; as, too, must be Dr. Meyer of Kiel, who has been engaged for four or five years past in the investigation of the physics of the Baltic, the North Sea, and their connecting channels, and who has satisfied himself so completely of the power of small differences of specific gravity to put large bodies of water in motion. I have *nowhere said* that no eminent physicist shares Mr. Croll's objections; though I have not myself met with such a one.

I regret to have been forced, by the personal attacks in which Mr. Croll has latterly thought fit to indulge, thus to retort upon him. Henceforth I shall not consider myself called upon to take any notice of assertions and arguments which I do not find to exert the least influence on the opinions of the eminent scientific men with whom it is my privilege to associate.

WILLIAM B. CARPENTER

Glacial Period

IN answering Mr. Bonney's letter in NATURE, vol. x. p. 44, I shall confine myself to the consideration of his second objection to my theory, as the precise southern limit of the glacial action is not of present importance, and the height of the Scandinavian sea-beaches is irrelevant to the inquiry.

Mr. Tiddemann, in an admirable paper On the glaciation of North Lancashire (Quart. Journ. Geol. Soc., vol. xxviii. p. 471), has mapped out the course of the ice as shown by scratched rocks, lines of transported boulders, carriage southwards of local

drift, and direction of overturned edges of shaly strata, and proved that it did not flow down the valleys to the westward, but passed across them and the ranges separating them, from the north to the south. On the other side of the Irish Sea the Rev. Mr. Close and others have shown that there also the ice did not move down the valleys, but flowed along the coast southwards. The ice-scratches still preserved on the rocks prove that the configuration of the land was nearly the same then as now, and no explanation has ever been offered of this southerly movement of the ice, excepting that it was prevented from flowing down the natural slope of the land by the whole of the Irish Sea having been at the time filled with ice up to a height of about 2,000 ft. above the present sea-level. The Isle of Man, that lay in the path of this great ice-stream, is glaciated from top to bottom, and it must have been completely buried in ice. It is to the action of this great agent that I ascribe the pushing up of sand and shells over south Lancashire, Cheshire, and North Wales on one side, and Wexford and around Dublin on the other, of the Irish Sea, where the course of the ice southward was obstructed by the narrowing of the channel.

So far from the movement of this great mass of ice being deflected or warded off by local glaciers, we have seen that in north Lancashire it was not affected by them; and long ago Prof. Ramsay proved that the glaciation of Anglesea and the west of Caernarvonshire had not radiated from the high land, but that the ice had come from the north and brought with it numerous boulders from the mountains of Cumberland.

As to the possibility of ice, pushed forward by higher accumulations behind it, thrusting before it loose sand and shells up to higher levels, I may remark that there are many proofs that it possesses this power. In the Isle of Man blocks of granite have been pushed up 600 feet above the level of their source. Mr. Tiddemann has also shown that as the ice moved across the valleys down one side and up the other, it thrust over the edges of the strata. On the other side of the great English watershed, Mr. Dakyns has shown that the ice when ascending the slope of a valley opposed to its course swept before it all the drift lying on the surface, pushing it over to the other side of the range.

Mr. Bonney would be more likely to damage my theory if, instead of protesting against it, he could explain some of the many difficulties that beset that of submergence. Where was the shore of that mythical sea under which England nearly to the Thames is supposed to have been submerged? How is it that not a single undisturbed bed of glacial shells has been found, that nearly all are broken to pieces, that many fragments of Cyprina exhibit glacial scratchings, and that not a single instance has been recorded of the two valves of a lamellibranch having been found together? Was there no friendly cliff or cavern able to preserve a single shell from the ruthless second advance of the ice? Mr. James Geikie finds the fragile bones of water-rats and frogs in his "inter-glacial beds," and uninjured land and fresh-water shells occur in abundance; but not one marine shell has been found in the uplands that does not show proof of having been transported, by being broken, worn, or scratched.

Since my first letter was sent to NATURE, Prof. Ramsay has drawn my attention to Mr. Croll's theory, that the glacial shells of Holderness had been pushed up by ice over the land out of the German Ocean. From other papers of the same geologist, I gather that he does not dispute the submergence of much of England and Scotland during part of the glacial period, and has indeed proposed a theory to account for it. So far as I know I stand alone at present in the opinion that neither during nor since the glacial epoch has there been any submergence of a great part of the British Isles beneath the waters of the ocean, nor can I expect that a theory so contrary to what has been taught for many years by English geologists will obtain a ready acceptance.

THOMAS BELT

Ealing, May 22

Uncompensated Chronometers

WITH reference to the employment of an uncompensated chronometer to indicate the mean temperature of an accompanying compensated chronometer during a long journey, with a view to the application of the proper correction for temperature, Prof. G. Forbes remarks (NATURE, vol. x. p. 50):—

"This method is quite new, and has not been tested by any nations except the Russians."

Permit me to direct attention to the following passage in the "Report on the Coast Survey," which I extract from p. 66 of the Proceedings of the American Association for the Advancement of Science, Springfield meeting, August 1859. The "Cambridge" referred to is Cambridge, Massachusetts.

"The difference of longitude between Cambridge and Liverpool has also been determined by means of large numbers of chronometers carried repeatedly between the two stations on the Cunard steamships. These chronometric expeditions, in the words of Mr. W. C. Bond, director of the Harvard Observatory, 'for the magnitude and completeness of their equipments, have not been equalled by any of the similar undertakings of European Governments. Even the *Expedition chronométrique* of Struve was on a scale much less extensive.' The voyages were continued through a number of successive years. The first great special expedition took place in 1849, and the most recent in 1855. In the latter the effect of temperature on the rate of the chronometers formed a subject of special investigation. For each instrument the effect of temperature on its rate was ascertained by experiment, and the average temperature during each trip was kept account of by means of a thermometric chronometer, constructed like the others, but with individual balance, so that its daily rate was affected by six seconds for a change in temperature of 1° Fahr. Fifty-two chronometers were employed in this expedition, and were transported six times between Cambridge and Liverpool."

The "Greenwich Observations" for many years past (fifteen at least) contain a record of the indications of a "chronometrical thermometer" accompanying the chronometers on trial for purchase by the Admiralty; and on p. 2 of "Rates of Chronometers" in the volume of Observations for 1871 are these words:—

"The chronometrical thermometer differs from an ordinary chronometer only in the construction of the balance, the positions of the metals forming the compensating rims being reversed. By this arrangement the effect of temperature is much magnified."

J. D. EVERETT

Malone Road, Belfast, May 22

Photographic Irradiation

IN NATURE, vol. x. p. 29, the article on the coming Transit of Venus makes mention of photographic irradiation as having "been found by Lord Lindsay and Mr. A. C. Ranyard to be mainly due to the reflection of light from the back of the glass plate. It can be almost entirely avoided," Mr. Forbes goes on to say, "by wetting the back of the plate and placing black paper against it." This subject has been investigated, explained, and the above remedy suggested years ago by practical photographers. In 1867 I used the plates of the Liverpool Dry Plate Company, then sent out with the backs painted red to prevent irradiation.

But even this is not a complete preventive. Colouring the film, as suggested by Mr. Carey Lea of Philadelphia and Henry Cooper, a well-known English amateur, is a much more effectual means, though at a loss of sensitiveness; but the most complete (where the dry emulsion process is available) is to allow the collodion to be acted on by a large excess of nitrate of silver for a considerable time and then to convert this into bromide of silver by addition of ammonium bromide. The result is that the film has a dull opaque character like unglazed porcelain, and not only stops the light more completely than an ordinary collodion film, but remedies another cause of irradiation—the molecular reflection in the film itself.

Two years ago I tested plates prepared in this way on the most difficult subjects (not astronomical) and found the halation much less than by any other means except a deep red tint in the film.

W. J. STILLMAN

Hay Fever

REFERRING to the recent article in (NATURE, vol. x. p. 26) upon hay fever, I can give my own experience as having suffered from the complaint for some years past, mainly in the months of May and June. My most severe attacks have been in the house in early morning. I am, however, near hay-fields, and a tramp, by way of experiment, through one of these has more than once satisfied me of the efficacy of the hay pollen in vastly increasing the troublesome symptoms.

The treatment I have used to myself has consisted of rather strong doses of quinine taken internally, and externally a piece of linen rag dipped in strong camphorated spirit and placed upon the nose and also partly over the nostrils.

Inhaling the vapour of a piece of camphor inclosed in a small silver tube, and carried in the mouth like a cigar, has also, I know, been used with effect. I have judged that the attacks are, to a certain extent, connected with a depressed or relaxed state of the system, partly from the time (early morning) when I have found them at their worst, and partly from the fact that in a pure bracing air like Switzerland I do not get them, even in the haying season. A French lady with whom I once travelled by train tried to satisfy me I had only influenza (*la grippe*), but our passage through a hay-field soon brought on such a succession of sneezings, &c., that I was quickly accorded the honour of a distinct disease.

I tried the homœopathic remedy of extract of hay grasses in spirit, upon the advice of a friend, but I very soon came back again to my allopathic doses of quinine and camphorated spirit, and from these alone have I found any real benefit. I have not yet tried the solution of quinine applied to the nostrils.

Guildford, May 18 J. RAND CAPRON

THE STEAMSHIP "FARADAY" AND HER APPLIANCES FOR CABLE-LAYING*

THE lecturer in his introductory remarks observed that an electric telegraph consisted essentially of three parts, viz., the electro-motor or battery, the conductor, and the receiving instrument. He demonstrated experimentally that the conductor need not necessarily be metallic, but that water or rarefied air might be used as such within moderate limits; at the same time, for long submarine lines, insulated conductors strengthened by an outer sheathing were necessary to insure perfect transmission and immunity from accident. The first attempts at insulation, which consisted in the use of pitch and resinous matters, failed completely, and in the years 1846 and 1847 the two gums india-rubber and gutta-percha were introduced, the former by Prof. Jacobi of St. Petersburg, and the latter by Dr. Werner Siemens of Berlin; this last gum soon became almost indispensable to the cable manufacturer on account of its great plasticity and ductility.

The first outer sheathing used was a tube of lead drawn tightly over the insulated wire, and this again was covered with pieces of wrought-iron tubing connected by ball and socket joints; in this way the Messrs. Siemens successfully crossed various rivers. This method was superseded later on by the spiral-wire sheathing, first proposed by Mr. Bret in 1851 for the Dover and Calais cable; since then, with few modifications and exceptions, this form has been universally adopted.

The lecturer next enumerated the casualties to which submarine cables are liable, and the precautions employed to obviate them. He showed specimens destroyed by rust and the ravages of a species of Teredo. On the Indo-European line a curious case of fracture occurred; a whale, becoming entangled in a portion of cable overhanging a ledge of rock, broke it, and in striving to get free had so wound one end round its flukes that escape became hopeless, and so had fallen an easy prey to sharks, which had half devoured it when the grappling iron brought his remains to the surface. Other enemies to be dreaded are landslips, ships' anchors, and abrading currents.

The new Atlantic cable consists, for the deep-sea portion, of copper conductors, gutta-percha insulators, and a sheathing of steel wires covered with hemp; the shallow-water part consists of similar conductors and insulators sheathed with hemp, which in turn is covered with iron wire.

In paying out, the great point to be observed is that no catenary should be formed, but that the cable should be a straight line from the ship to the sea-bottom; the retaining force should be equal to the weight of a piece of cable hanging vertically downwards to the bottom of the sea. In picking up, a catenary is formed, but a vertical position is the best.

From the peculiar nature of the service for which a telegraph-ship is required, it is evident that she must possess properties somewhat different from those of ordinary ocean-going steamers; thus speed is not so important as great manœuvring powers, which will enable her to turn easily in a small space, or by which she may be maintained in a given position for a considerable time. In the ship about to be described an attempt has been made to meet these requirements.

The *Faraday*, of 5,000 tons register, was built at Newcastle by the eminent firm of Messrs. Mitchell & Co.; she is 360 ft. long, 52 ft. beam, and 36 ft. depth of hold; there are three large water-tight cable tanks having a capacity of 110,000 cubic ft., these are each 27 ft. deep, two are 45 ft. in diameter, and one is 37 ft., they can take in 1,700 miles of cable $1\frac{1}{4}$ in. in diameter. After the cable is coiled in, the tanks are filled up with water to keep it cool, for the lecturer had found, when conducting experiments on the Malta and Alexandria cable with his electrical resistance thermometer, that heat was spontaneously generated in the cable itself, whereby its insulation was seriously endangered.

The *Faraday* has stem and stern alike, and is fitted with a rudder at each end; both are worked by steam-steering apparatus placed amidships, and are capable of being rigidly fixed when required. She is propelled by a pair of cast steel screws 12 ft. in diameter, driven by a pair of compound engines constructed with a view to great economy of fuel. The two screws converge somewhat, and the effect of this arrangement is to enable the vessel to turn in her own length when the engines are worked in opposite directions. On the voyage from Newcastle to London a cask was thrown overboard, and from this as a centre the ship turned in her own length in 8 minutes 20 seconds, touching the cask three times during the operation. This manœuvring power is of great importance in such a case as repairing a fault in the cable, as it enables the engineer to keep her head in position, and, in short, to place her just where necessary in defiance of side-winds or currents.

The testing-room of the electrician in charge is amidships, and so placed as to command the two larger tanks, while the ship's speed can be at all times noted on the index of a Berthon hydrostatic log.

The deck is fitted with machinery to be used in laying operations, which will be best described by tracing the path of the cable from the tanks to the sea. Let us begin with the bow compartment: the cable, which lies coiled round one of Newall's cones, begins to be unwound, passes up through an eye carried on a beam placed across the hatch, next over a large pulley fitted with guides, and by a second pulley is gently made to follow a straight wooden trough fitted with friction rollers, which carries it aft to near the funnels; here it passes through the "jockey," which is a device for regulating the strain, consisting of a wheel riding on the cable, which can be adjusted by a lever, and a drum fitted with a brake, thence it passes on to a "compound paying-out and picking-up machine;" this consists of a large drum provided with a friction brake, and round it the cable passes three times; it is also furnished with a steam-engine, which by means of a clutch can be geared on to the drum when required. Now in paying out, the cable causes the drum to revolve as it runs over it, and the brakes regulate the speed as the vessel moves onward; but should a fault or other accident render it necessary to recover a portion, the drum is stopped and geared on to the engine, the ship's engines are reversed, the stern-rudder fixed; and so what was formerly the bow is now the stern, while the little engine hauls in the

* Abstract of a lecture delivered at the Royal Institution on May 15.—By C. William Siemens, D.C.L., F.R.S.

cable over the same drum which before was used to pay it out; thus it is coiled back into the same tank whence it started. By this means the necessity of passing the cable astern before proceeding to haul it in is avoided. It was during this operation that an accident befell the Atlantic cable in 1865, causing its loss for the time.

The next apparatus is a dynamometer, consisting of three pulleys, one fixed, and the centre one, which rests on the cable, movable in a vertical plane; by this the strain is registered and adjusted. After passing this the cable runs into the sea over a pulley carried on girders and constructed so as to swing freely on an axis parallel to the length of the ship, so that, should the vessel make lee-way, the pulley will follow the direction of the cable, and thus friction and sharp bends are avoided. The bows are also fitted with a similar pulley, compound machine, and dynamometer. We see that by these devices the cable is kept perfectly under control, and should a fault be discovered a simple process of reversal of ship and machinery brings home the faulty portion.

Another great point is to keep the vessel trimmed and steady. For the former requirement nine separate water-tight compartments, including the cone in each tank, which also is hollow, are provided, so that water may be admitted as the tanks are emptied of cable, and thus the ship is kept trimmed. To ensure steadiness and avoid the rolling to which telegraph ships are subject, two bilge keels are set on at an angle of 45°; this was done at the suggestion of Mr. Wm. Froude, whom, said the lecturer, "I have to thank for valuable advice and assistance on several new points connected with the *Faraday*."

A steam-launch is carried on deck, whence she can be lowered into the water with steam up, ready to land shore ends and perform other useful details.

Another class of work for which the vessel is fitted is "grappling" for lost or faulty cable. In shallow seas this is a very simple operation, but in deep water it is rather a delicate matter, and requires the co-operation of two or even three vessels, so as to lift the cable without forming an acute angle, and thus to lessen the chance of fracture or strain. A special rope made of steel wire and hemp, and of great strength, is provided for this kind of work. Some specimens shown could bear strains up to 16 tons.

In conclusion, the lecturer paid a high compliment to the late Prof. Faraday, noticing the great services he had rendered to electrical science, his singleness of purpose, and the invariable kindness with which he had encouraged younger labourers in the same field. The friendly encouragement which he himself had experienced from him would ever remain a most pleasing remembrance. He had seized with delight on the present opportunity to pay a tribute to the honoured name of Faraday, and was happy to be able to do this with the full consent of the revered lady who had stood by the philosopher's side for forty years, while labouring under this very roof for the advancement of knowledge. The name of the vessel and her mission in the service of Science would combine, he thought, to create an interest in her favour in the minds of the members of the Royal Institution, and he hoped that on the morrow she would put to sea accompanied by the earnest wish, "God speed the *Faraday*."

ATMOSPHERIC CURRENTS AS OBSERVED IN THE WEST INDIES, AND PARTICULARLY IN ST. THOMAS

DURING an average period of nine months in the year the regularity of the air-currents over the Virgin group resembles clockwork. The surface, or lowest current, is formed by the trade-wind, which blows briskly from the north-north-east, with a slight variation northward during the night and early morning, and a corresponding deflection southward from noon till near sunset. Varying in strength from a light breeze to a brisk gale, it is hardly ever absent; its greatest strength is usually at or near 3-4 A.M., and about the same hours P.M. It generally bears with it light masses of cumulus, from which there fall occasionally showers, heavy, but very short in duration. This air-current, known as the trade-wind of these regions, does not appear to exceed 2,000 feet in vertical height.

Next above this current comes the south-west wind, rarely absent; it brings with it light cirrus clouds, but seldom cumulus or other indications of rain; its excess of moisture having been probably discharged while crossing the mountains of the South American continent. Very rarely, indeed, does this wind descend low enough to have effect on or even near the surface; when it does so, which generally occurs during the summer and autumn months, it is deflected to the south, and then becomes loaded with moisture, and accompanied by heavy nimbus clouds and electric phenomena.

Highest of all the west wind reigns, manifested by very light cirrus clouds, rapidly formed and as rapidly disappearing; it has at times a slight deflection to the north.

These three winds blow with scarcely any interruption from November to June inclusive; almost the only variation being then afforded by the north or north-north-east wind which sometimes prevails, but near the surface only, for a few days together during three winter months. When—a rare but much-desired event—a southerly current occurs about this time, it brings heavy clouds and abundant rain. While the wind is from the north and north-east, great dryness is indicated by the hygrometer.

But in the months of August, September, and October, and often in the latter half of July, the polar or north-east current loses its strength, and is often neutralised or even conquered by the southerly winds. These during the summer are usually light, and accompanied by a clear and serene sky, only clouded when the north-east, regaining for a time its supremacy, drives the south back, and precipitates heavy showers, amid thunder and lightning, sometimes lasting for three or even four hours; after which the wind veers round again to the south-east and south. The same phenomena, when intensified, concentrate themselves into a hurricane or cyclone—a rare occurrence in this island, not more than four of any great severity having taken place at St. Thomas in the course of the present century. Two indeed, but only of medium violence, occurred within these regions last year; neither of them however visited St. Thomas, the one keeping out to sea eastward, and not touching the coast till it reached lat. 44° in its northerly course; the other, which seems to have originated within the Caribbean Sea, did considerable damage on the coasts of St. Domingo and Cuba, passing ultimately north-east by the Florida Channel. Of both I have given details elsewhere (vol. ix. p. 468). Heavy gales, occasionally amounting to storms, sometimes blow here, particularly during the winter months, from between north and north-east, but from no other quarter of the compass. They are accompanied by cold, the thermometer sinking to 74° F., or even lower, with a dull, cloudy sky, and little rain.

Another phenomenon, peculiar to the winter and spring months, are white squalls; they take place on calm days, generally at noon, and most often at no great distance from shore; their area is very limited, and their duration does not exceed a few minutes; in some respects they resemble a miniature hurricane, and appear to be due to similar causes; but neither have I witnessed in them nor heard recorded any instance of circular motion. They are much dreaded by the small craft of these seas; a slight fall of the barometer is their only premonitory indication.

St. Thomas W. G. PALGRAVE

THE COMING TRANSIT OF VENUS *

VI.

HAVING now discussed all the methods to be employed, and the chief difficulties to be encountered, it is time to examine what has actually been done. What method or methods ought to be chosen? What stations are most suitable, taking into account the chances of good or bad weather and good or bad anchorage? What preparations have been made by the various Governments and by private individuals? And are the arrangements satisfactory?

As to the choice of method, the observation of contacts was the only kind originally contemplated. The employment of photography and heliometers is a comparatively new idea, and will be spoken of later. The observation of contacts is applicable to three methods, for each one of which different stations must be chosen; these are Halley's method, the method of durations, and De l'Isle's method. We will consider these in order.

1. Halley's method fails totally in the transit of 1874, but *may* perhaps be applied in 1882, though not under good conditions. On referring to Fig. 13 in Article III., it will be noticed that Sabrina Land is a station where in 1882 the transit will commence just before sunset, and end just before sunrise. Hence during the transit this station and another placed in America will be moving in opposite directions, thus fulfilling the conditions required by Halley in his communications to the Royal Society. By referring to Fig. 12 it will be seen that no such stations exist in 1874.

2. The method of durations may be successfully applied, so far as mere geometrical position is concerned, in either of the two transits. This method is really combined of two parts, and includes Halley's as a particular case. The lessening of the duration of the transit depends partly upon the diminished motion of one of the stations, or upon the fact that it moves in the opposite direction to the other; and partly on the fact that in one case the planet seems to trace a path on the sun farther from his centre (and therefore shorter) than in the other. The difference in this last case is greatest when the path of Venus is far from the sun's centre. But in transits like the coming ones, where this is the case, the motion of Venus towards the sun's centre at the time of contact is very much slower than when she describes a large chord upon the sun. This has been well pointed out by Mr. Stone, † and from his paper we learn that the method of durations depending upon two such observations at each of the two stations will not be so satisfactory as we might otherwise have expected. But other very serious objections present themselves to a method like this requiring four observations of contact, when we carefully consider the circumstances. In applying this method, one station must be chosen in high southern latitudes. Now diligent inquiries have been made upon this subject, and it appears very improbable that the weather at any suitable station will be such as to give much hope of observing both the ingress and egress in a satisfactory manner. Hence if we depended upon this method there would be a great probability of the expedition proving a failure. The method of De l'Isle requires the observation of only one contact at each of the two stations. For these reasons hardly any expedition will use this method except as secondary to De l'Isle's, the photographic, or the heliometric method.

3. De l'Isle's method. The accuracy with which this method can be applied depends upon the certainty of longitude operations. From what was said in the last article, it will be seen that this is no easy matter; but it is absolutely necessary that it must be done if this method is to be employed. Sir George Airy says that longitudes can be determined with an error of not more than one second by lunar observations; and observers will receive orders to remain at their stations until they have a sufficient number of observations to accomplish this. The lunar observations will be supported, where practicable, by telegraphic determinations of longitude, and also by the transport of chronometers. The Russians, whose stations lie mainly along the whole length of Siberia, will employ a telegraphic line over that region, with branch lines to the subsidiary stations. The English will probably fix the longitude of Alexandria by submarine cable. They will employ chronometers to group together all stations neighbouring each other. The station at Rodriguez will be thus connected with Lord Lindsay's station at Mauritius, and with the French station at Réunion. Lieut. Corbet, R.N., will connect by chronometers the various islands occupied by the Germans, Americans, and French in the neighbourhood of the two English stations on Kerguelen's Island. The three English stations on the Sandwich Islands will likewise be connected by chronometers; and it would be very desirable to connect these islands with San Francisco on the one hand, and Yokohama on the other. The longitudes of both these places will have been compared with Greenwich by telegraph. It would be a matter of the utmost interest to complete the chain round the world by the transport of chronometers across the Pacific. M. Struve says that with the aid of an uncompensated chronometer this might be done with great accuracy. The Germans have also made valuable suggestions for comparing the longitudes of the observing stations of all nations; and the French will also probably help in this matter. Thus it is likely that the longitudes of all the stations of different countries suitable for the application of De l'Isle's method will be very accurately known.

It will be noticed that the accuracy of De l'Isle's method depends upon two longitudes and two observations of contact; while that of durations depends upon four observations of contact. Neglecting all considerations of climate the two methods are, so nearly as the somewhat vague data at our command can tell us, very nearly equal. But the uncertain climate of southern seas renders the chance of many contact observations doubtful and throws the balance in favour of De l'Isle's method. Add to this that before long all the stations except the Kerguelen group will soon have their longitudes determined absolutely by telegraph, and recollecting that the coming observations are to serve astronomers until the next transit of Venus in 2004, by which time even the Kerguelen group may perhaps be chronometrically determined: recollecting all this, there is little doubt that astronomers have been wise in settling upon De l'Isle's method for the main observations of contacts.

It will be well, before going further, to mention the stations which have been chosen by different nations for the observation of the coming transit.

I.—The British, having selected for the reasons above mentioned the method of De l'Isle, originally fixed upon the following stations:—

Alexandria, Sandwich Islands, Rodriguez, Kerguelen's Island, and New Zealand. No alteration has been made in the choice of these stations. Supplementary ones have, however, been added. Thus at Kerguelen's Island there will be two expeditions: one at Christmas Harbour in the north, and the other in the south of the island. In the Sandwich Islands there will be three stations: one at Honolulu, a second on the island of Hawaii, and a third on the island of Kauai, sometimes called by English writers Atooi. The station at Alexandria will be supplemented by a second one at Cairo, and a private one by Col. Campbell, of Blythswood, under the Astronomer Royal's direction at Thebes. The New Zealand station

* Continued from p. 52.
† Monthly Notices of the R.A.S., vol. xxix. p. 250.

will be placed at Christchurch. Since the idea of photography has been introduced, two additional stations have been added by the Indian Government under the superintendence of Col. Tennant, R.E. These are very completely equipped, and will probably be situated the one near Peshawur, the other at Roorkee.

Besides these the observatories at Madras, Cape of Good Hope, Melbourne, and Sydney will be utilised so far as possible. The New South Wales Government have voted 1,000*l*. for other observations in Australia. The English Government have voted 15,000*l*. for all the expeditions, but a much larger sum than this will be actually required. It will be understood that the principal method of observation is De l'Isle's, aided everywhere when possible by all the other methods except the heliometric.

From the account that has been given of the difficulty of determining the longitudes of the different stations it will be seen that no little power of organisation is required for the execution of the foregoing programme. All preparations must be made for the observation of the moon culminators. Alt-azimuths must be made, and also actually invented for the express purpose. Nearly fifty chronometers must be provided, and negotiations must be completed with telegraph companies. The photographic operations have required the invention of a new photoheliograph, and the Janssen method of a new application to it. The observations of contact have required the purchase of a large number of equatoreals; for each station, besides having a 6-inch telescope, has also one or more smaller instruments. One of the larger ones, made by Simms, is shown in Fig. 18. The transit instruments have also been made expressly for this expedition. Besides this all the accessories of these instruments had to be provided. Huts for receiving them had to be made. Forms for entering and reducing the observations had to be prepared and printed. For some of the stations sleeping arrangements, cooking apparatus, washing utensils, and provisions had to be provided. Workmen, masons, and assistant photographers, besides twenty-two observers, had to be collected and trained to the work. When this is considered it will be seen that no ordinary man could fulfil all the duties. Fortunately we have in our Astronomer Royal a man who combines to an exceptional degree theoretical, mechanical, and organising powers; and we may safely say that the present expedition has been completed under a generalship quite unparalleled in the annals of Science. Sir George Airy has accomplished all that was required in a manner that has called forth the applause of those who have been connected with the preparations for this perhaps the most important astronomical event of the century. We must congratulate ourselves upon the fact that he has been most liberally supported on all points by the British Admiralty. If we cannot enter into the same details with regard to other nations, it is only because we have not had the opportunity of learning all their actions. But we cannot conclude this account of the British Government expedition without alluding to the valuable services which have been rendered to it by Capt. G. L. Tupman, R.M.A., who has spent the last three years in training himself and nearly all the other observers in the use of the instruments, seeing the instructions of the Astronomer Royal carried out, ordering the stores, and in the most disinterested manner looking after the expedition; so that (as the Astronomer Royal has lately pointed out) if the observations be successful their success will in a great measure be due to his exertions.

II. Besides the expeditions under the direction of the British Government, another has been prepared which is perhaps the most completely equipped one which has ever been undertaken by a private individual in the interests of astronomy. Lord Lindsay has made preparations to take up his position at Mauritius, provided with means for utilising all the different modes of observation. He will combine his own results mainly with those of the Russians; and it is probable that no station could have been found more suitable for a single observer to occupy when so many different methods are employed. All the instruments are of the most perfect description and made by the best makers. The photographic method which he will employ has been already described. The siderostat has been made expressly for this purpose, and its surface has been tested and found to be truly plane. Lord Lindsay and his assistant Mr. Gill lay considerable stress on the employment of the heliometer, and have discussed its capabilities with great lucidity. They propose to make observations of the external contact by the aid of the spectroscopic method. The expedition will be provided with about 50 chronometers, including one uncompensated. These will be transmitted four times between Aden and Mauritius. It is probable that they will also connect the longitudes of the different stations on that group of islands by chronometers. The German expedition at Mauritius will probably be connected with Lord Lindsay's by a trigonometrical survey. Of these islands two can be connected by direct signals with a heliotrope reflecting the sun's light. From experiments made in Russia, it appears that a signal may thus be seen in a mountainous country with a clear atmosphere at a distance of 200 miles. There is little doubt then that the longitude of each station on this group of islands will be accurately known.

III.—The Germans are sending out five or six expeditions. At Cheefoo the accelerated ingress and retarded egress will be observed; at the Macdonald Islands the retarded ingress and the accelerated egress. The Auckland Islands will be favourable for accelerated egress; Mauritius for retarded ingress, and Ispahan for retarded egress.

They will probably employ all the four methods at most stations, viz. eye-observations of contact, heliometers, photo-heliographs for the distance of centres, and also for position-angles. There will be no photography at Mauritius. Here will be employed four heliometers by Fraunhofer, 3 in. aperture, $3\frac{1}{2}$ ft. focus; four equatorially-mounted telescopes by Fraunhofer $4\frac{1}{3}$ in. aperture, 6 ft. focus; two photo-heliographs by Steinheil, $5\frac{1}{2}$ in. aperture, and two with quadruple object-glasses of 4 in. aperture. Besides these, instruments are required for determining the local time and the longitude; for the Germans lay great stress on De l'Isle's method. For this purpose transit instruments with diagonal telescopes on the Russian method of $2\frac{5}{8}$ in. aperture will be supplied, and alt-azimuths with divided circles 12 in. to 14 in. diameter. The necessity of determining the longitudes accurately has led the German astronomers to consider carfully the best means by which this can be done. Dr. Auwers, to whom the direction of the arrangements has been entrusted, has discussed the matter in a very able manner. It appears from his inquiries that each group of stations will have their longitudes very accurately determined. Thus the stations in east Asia can be connected telegraphically. So also can those about Alexandria; also those about the Caspian Sea and New Zealand. The group of islands near Kerguelen's, the Sandwich Islands group, and the Mauritius group will be determined by chronometers. The only difficulty is to connect these different groups. Many of them will be compared with Greenwich indirectly by telegraph. It is probable that Honolulu will be compared by chronometers with San Francisco and Yokohama, thus completing, as already mentioned, the telegraph and chronometer connection round the world. In any case there is little doubt that before the transit of Venus in 2004 the longitude of Honolulu will be determined by telegraph. Since Lord Lindsay intends to compare the longitude of Mauritius with that of Aden by four chronometer expeditions, aided by an uncompensated chronometer, there is little doubt that the longitude of that group of islands will be

accurately known. The group of islands about Kerguelen's will depend very much upon the British observations of the moon; but it will be well if chronometers could be employed to connect it with the Cape. The Germans rely very much upon the heliometric method. It will be a matter of great interest to learn how these observations agree with other methods as a guide to the arrangements for 1882. The expense of this expedition is about 130,000 thalers, besides the expenses connected with chronometric determinations.

The organisation of the German expedition has been entrusted almost wholly to Dr. Auwers, as secretary of the commission. His contributions to the subject are of great value, and the zeal with which he has superintended the expeditions, even in the minutest details, cannot be overvalued.

IV. The Russians are mainly employed in utilising the Siberian stations. The actual places which have been chosen from which to observe the transit are given in the following list, in order from east to west. The numeral 1 appended to a station means that there are good observers, practised with the model, good equatoreals, and a heliometer or photo-heliograph. The numeral 2 signifies the same without heliometers or photo-heliographs. When the numeral 3 is appended, the observer has not practised with the model, and employs a small telescope. The stations are:—

Yeddo 2	Tachkent 1
Port St. Alga 3	Port Peroffski 1
Nakhodka 2	Fort Uralsk 1
Wladivostock 1	Orenburg 3
Port Possiet 1	Aschura-deh 1
Lake Hanka 1	Teheran 2
Chabarovka 2	Nachitzevan 2
Peking 2	Erivan 1
Blagowvschtchenska 2	Tiflis 3
Nertschinsk 1	Taganrok 3
Xhita 1	Kertch 2
Kiachta 1	Ialta 2
Tomsk 3	Thebes 2

Besides these stations the following will be utilised, but the sun will be very low: at Kazan the sun's altitude will be 8° or 10°, at Nicolaif it will be 6°, and at Charkof and Odessa 5°; at Moscow it will be exactly on the horizon.

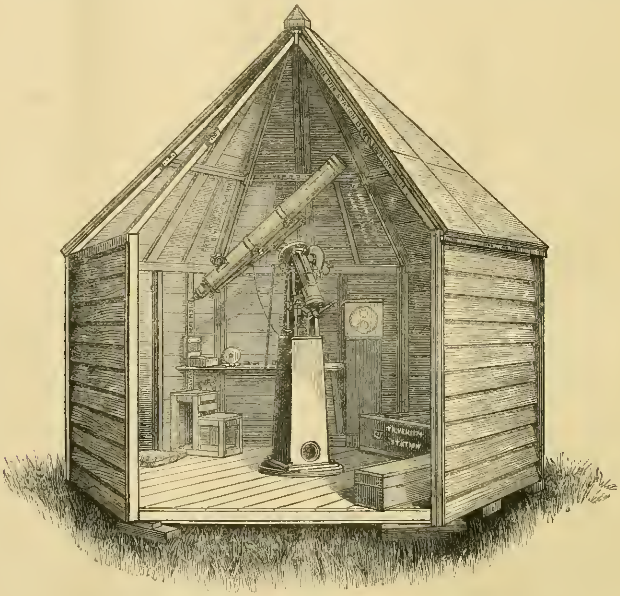


FIG. 18.—6-in. Equatorial of the British Expedition.

As to instruments, the Russians are employing 6-inch and 4-inch equatoreals. Their heliometers are larger than those of the Germans, having 4 in. apertures. Their photo-heliographs are constructed on the English model by Mr. Dallmeyer. The telegraphic connections between the stations have been already discussed. The expense incurred will be defrayed by the Government. Besides this, the State contributes 45,000 roubles. This will be spent mainly on the transport and maintenance of observers and instruments. The different observatories in Russia have shared the expense of providing the different instruments. The whole expedition has been conducted under the superintendence of M. Otto Struve. Some of the expeditions have already started provided with every means for resisting the cold of a Siberian winter. Great attention has been paid to the chances of good weather. The accelerated ingress and retarded egress will thus be admirably observed; and the comparison which M. Struve has made with observers of other countries in practising with the model will render comparisons possible. Moreover, many of the Russian stations are admirably situated for the employment of the method of durations; and if the two internal contacts be observed at any of the stations in the neighbourhood of Kerguelen's Island excellent results may be obtained.

GEORGE FORBES

(*To be continued.*)

ATOMS AND MOLECULES SPECTROSCOPICALLY CONSIDERED *

LET me commence by congratulating you on the circumstance that this School and the Literary Society connected with it are known over a much more extensive area than Whitechapel. It is some time ago since I first heard of the work which you are attempting to do, and which indeed to a large extent you are doing, in this part of London. All friends of Science must deeply sympathise with your efforts, and I looked upon it as my bounden duty to come here and lecture when asked to do so. I have one more remark to offer: as I knew that my audience would consist if not altogether of old students of Science in this school, still of those largely interested in mental culture and in the acquisition of useful knowledge, I thought it right to ask you to follow me into a region which a few men in lands far apart are now investigating—a region which lies outside the known, and which is being explored by means of the spectroscope. I hope to be able to suggest a few thoughts to some of you, in case you have worked with that instrument, and I hope also to be able to place before those who have not, many facts with which they are already acquainted, in a new point of view.

Now, in the first place, what are Atoms and what are Molecules? A chemist will tell you about the atomic weight of certain elements, and you will hear him talk about molecular volumes, and the like. Here is a definition given by Dr. Frankland in his book on Chemistry ("Lecture Notes," p. 2): "An atom is the smallest proportion by weight in which the element (that is to say the element to which the atom under discussion belongs) enters into or is expelled from a chemical compound." He then points out that when atoms are isolated—that is, when they are separated from other kinds of matter—they do not necessarily exist as atoms in the old sense; they go about in company, generally being associated in pairs. He then defines such a combination of atoms as an elementary molecule. Here, then, is put before us authoritatively a chemist's view of the difference between an atom and a molecule.

Let us now go to the physicist and see if we can gather from him his idea of atoms or molecules. It is remarkable that, in a most admirable book, Prof. Clerk-Maxwell's "Theory of Heat," in which you find nearly all that is known by physicists about molecular theories, the word "atom" is not used at all. We are at once introduced to the word "molecule," which is defined to be "a small mass of matter the parts of which do not part company during the excursions which the molecule makes when the body to which it belongs is hot."

Prof. Clerk-Maxwell goes on to give us ideas about these "molecules," which have resulted from the investigations of himself and others; and if you will allow me, I will read a few extracts from his book (p. 286): "All bodies consist of a number of small parts called molecules. Every molecule consists of a definite quantity of matter, which is exactly the same for all the molecules of the same substance. The mode in which the molecule is bound together is the same for all molecules of the same substance. A molecule may consist of several distinct portions of matter held together by chemical bonds, and may be set in vibration, rotation, or any other kind of relative motion, but so long as the different portions do not part company but travel together in the excursions made by the molecule, our theory calls the whole connected mass a single molecule." Here, then, we have our definition of a molecule enlarged. The next point insisted upon by our author is that *the molecules of all bodies are in a state of continual agitation.*

That this agitation or motion exists in the smallest parts of bodies is partly made clear by the fact that we cannot see the bodies themselves move.

Now in a solid body the molecule never gets beyond a certain distance from its initial position. The path it describes is often within a very small region of space. Prof. Clifford, in a lecture upon atoms, has illustrated this very clearly. He supposes a body in the middle of the room held by elastic bands to the ceiling and the floor, and in the same manner to each side of the room. Now pull the body from its place; it will vibrate, but always about a mean position; it will not travel bodily out of its place. It will always go back again.

We next come to fluids: concerning these we read—"In fluids, on the other hand, there is no such restriction to the excursions of a molecule. It is true that the molecule generally can travel but a very small distance before its path is disturbed by an encounter with some other molecule; but after this encounter there is nothing which determines the molecule rather to return towards the place from whence it came than to push its way into new regions. Hence in fluids the path of a molecule is not confined within a limited region, as in the case of solids, but may penetrate to any part of the space occupied by the fluid."

Now we have the motion of the molecule in the solid and the fluid. How about the movement in a gas? "A gaseous body is supposed to consist of a large number of molecules moving very rapidly." For instance, in this room the molecules of the air are travelling about twenty miles in a minute. "During the greater part of their course these molecules are not acted upon by any sensible force, and therefore move in straight lines with uniform velocity. When two molecules come within a certain distance of each other, a mutual action takes place between them which may be compared to the collision of two billiard balls. Each molecule has its course changed and starts in a new path."

The collision between two molecules is defined as an "Encounter;" the course of a molecule between encounters a "Free path." It is then pointed out that "in ordinary gases the free motion of a molecule takes up much more time than is occupied by an encounter. As the density of the gas increases the free path diminishes, and in liquids no part of the course of a molecule can be spoken of as its free path."

Now the kinetic theory of gases, on which theory these statements are made, has this great advantage about it, that it explains certain facts which had been got at experimentally, facts which had been established over and over again, but which lacked explanation altogether, till this molecular theory, which takes for granted the existence of certain small things which are moving rapidly in gases, less rapidly in fluids, and still less in solids, was launched. The theory in fact explains in a most ample manner, many phenomena so well known, that are termed "laws." It explains Boyle's law, and others, well known to students of this school. This theory, which takes for its basis the existence of molecules and their motions, explains pressure by likening it to the bombardment of the sides of the containing vessel by the molecules in motion; or it tells us that the temperature of a gas depends upon the velocity of the agitation of the molecules, and that this velocity of the molecules in the same gas is the same for the same temperature, whatever be the density. When the density varies, the pressure varies in the same proportion. This is Boyle's law. Further, the densities of two gases at the same temperature and pressure are proportional to the masses of their individual molecules, or, when two gases are at the same pressure and temperature, the number of molecules in unit of volume is the same. This is the law of Gay Lussac.

I have now fairly introduced you to the atom of the chemist and the molecule of the physicist; you will see at once that the methods of study employed by chemical and physical investigators are widely different. The chemist never thinks about encounters, and the physicist is careless as to atomic weight; in his mind's eye he sees a perpetual clashing and rushing of particles of matter, and he deals rather with the quality of the various motions than of the material.

Next let me say a litle more about these "encounters;" and here I must again refer you to Prof. Clerk-Maxwell's book (p. 306). It is assumed that while the molecule is traversing its free path after an encounter, it vibrates according to its own law, the law being determined by the construction of the molecule, or let us say its chemical nature, so that the vibration of one particle of sodium would be like that of another particle of sodium, but unlike that of a particle of another chemical substance, let us say iron. If the interval between encounters is long, the molecule may have used up its vibrations before the second encounter, and may not vibrate at all for a certain time previous to it. The amplitude of the vibration will depend upon the kind of encounter, and will be independent of the number of encounters.

We can imagine a small number of feeble encounters, a large number of feeble encounters, a small number of strong encounters, and a large number of strong encounters.

In the case of feeble encounters, we pass from a small number to a large one by increasing the density.

In the case of strong encounters we pass from low temperature with small density to high temperature with great density.

Increase of density will reduce "free path."

* Revised from short-hand notes of a Lecture delivered to the Whitechapel Foundation School Literary and Scientific Society, March 10, 1874.

Increase of temperature will increase amplitude.

The shorter the free path the more complex the vibrations.

The greater the amplitude the more will the vibration of the molecule be brought out, not merely the *fundamental vibrations*, as we may term them, which we get in the free path, when it is longest, but the *overtones*.

Now why have I risked wearying you with these detailed statements concerning the vibrations of "molecules?" Because we believe that each molecular vibration disturbs the Ether; that spectra are thus begotten; each wave-length of light being set in vibration by a molecular vibration of corresponding wave-length. The vibration is, in fact, the sender; the spectrum is the receiving instrument, in this new telegraphy.

Now there are two questions which I propose to discuss, and they are these:—What light does the spectroscope throw upon molecular questions? and is there any hope that the spectroscope, as researches with it are extended, may aid the study of a subject which lies at the root of chemical and physical investigation?

I have written down several statements, which I propose to discuss one by one. I shall state the experimental basis, when it exists, on which the statements rest and the methods by which the results have been obtained

I shall for a time use the word "particle" to represent a small mass of matter, because it does not tie me to the "atom," or the "molecule" of the chemist, or to the "molecule" of the physicist. "Particle" is a neutral term, which I hope none of you will quarrel with.

1. My first proposition is this:—*When particles are aggregated together, so as to form a solid or liquid, they give out rays of light of certain refrangibilities; and the spectrum is continuous as far as it goes.* This was Kirchoff's first generalisation.

It surely is an important fact from the point of view of the molecular theory that all solids and liquids, with their particles moving as already stated, do give you a perfectly distinct spectrum from that which you get when you deal with any rare gas or vapour whatever. A poker put into the fire becomes of a dull red heat, after a time a white heat is arrived at. As far as the vibrations exist they are continuous, there are no breaks in the series of wave-lengths. You may also get a platinum wire, and drive it to incandescence in the same way by means of electricity. Analyse the light by means of the spectroscope, the spectrum is the same as that of the poker Further, we can go to the sun, and divest it in imagination of the atmosphere which absorbs much of its light, and we know that, with a small exception, we shall get a perfectly continuous spectrum similar to that in the case of the poker or platinum wire. Connected with spectroscopic investigation there is this wonderful fact, that as it deals with matter in the most general way, it is perfectly easy to carry on a line of argument, not by referring to different chemical elements, but to matter, now on the earth, now in the sun, or again in some of the stars. It is a great leveller. In this continuous spectrum we have a spectroscopic fact connected with that kind of molecular motion which physicists attribute to particles so long as they are closely packed together in the solid state, and so long as they have but a small free path as in the fluid state.

2. I now come to my second proposition:—*When particles are in a state of gas or vapour, and are rendered incandescent by high tension electricity, line-spectra are produced in the case of all the chemical elements.*

I have several photographs which I will throw on the screen, showing such spectra as these now in question. We have thus the spectra of the light given off by the vapour of cobalt and of nickel rendered incandescent by means of high-tension electricity. I will next show you the spectra of other chemical elements, such as aluminium and iron compared with nickel and cobalt, pure and impure iron compared with a meteorite. These line-spectra are only to be obtained from gases and vapours, and as a rule only when we employ high-tension electricity.

We get a perfectly distinct spectroscopic result from the one we had before, precisely in the case where according to the physicists we have an enormous motion and agitation of molecules.

3. I now proceed to the next proposition:—*In some cases particles in a state of gas or vapour can be set swinging by heat waves.* I have here some salts of sodium and strontium, these I place in the heat of a Bunsen burner, they are at once dissociated and the particles of the metals are set swinging by the heat waves and we get their longest lines. Now that is not only true for strontium and sodium, but for many other elements. But if I put salts of iron, or of the other heavy metals in the flame, I shall not get bright lines. Or again, in some other vapours, such as sulphur, we only get a spectrum, not of lines, but continuous over a limited part of the spectrum. In fact I may say that with the exception of those elements which easily reverse themselves, this heat is absolutely incompetent to give me anything like a bright line.

4. *Particles, the amplitudes of vibrations of which may either be so slight that no visible light proceeds from them, or so great that they give out light of their own, absorb light of the same wave-length and of greater amplitude passing through them*

Consider how beautiful this statement is when you look at it in the light of its teaching with regard to particles. We throw sodium into a flame and get a yellow light; we place it on the poles of our electric lamp and render it incandescent, and its light is rich yellow.

We have similarly incandescent sodium outside the sun, through which the rays of sunlight pass outwards towards the earth, and we may have similar non-luminous sodium vapour in a test-tube; and the vibration which gives the yellow light, in the case of the sun, and which is invisible in the vapour of the tube, instead of giving a bright line gives a dark one. Let me show you some photographs of the solar spectrum, so that as you have seen the bright lines due to radiation, you may see the dark lines in the solar spectrum which are due to absorption.

Our knowledge of the elements existing in the sun and stars depends entirely upon the principle first suggested by Stokes, that particles are set swinging when light waves pass through them with the particular rate of vibration which they effect.

The elements to which a large number of the Fraunhofer lines are due have been determined by means of the vibrations of particles on the earth. Whether a particle vibrates on the earth or on the sun it does not matter to the spectroscope, the vibration is the same, but as the particle is set vibrating at the sun by a greater amplitude of the light passing through it we get a dark line instead of a bright one. To show that in the stars, representing to us other suns, the spectra are very various I will exhibit spectra of the three classes of stars into which most may be grouped. In the middle we have a simple line spectrum, in the centre a more complex one, and at the bottom a channelled spectrum.

5. Next I have to point out to you that *line spectra become more complicated as the particles are brought nearer together, provided the state of gas or vapour be retained.* See the importance of this observed fact in connection with the molecular theory. If in the solid the particles can only oscillate round their mean position, if in the gas they can go through with enormous rapidity a tremendous number of various movements of rotation and vibration, and along their free path; and if spectroscopically we can follow these movements by differences in the phenomenon observed, is it too much to hope that in the coming time we shall have an enormous help in our inquiries? We get a solid or liquid condition, and a continuous spectrum; we get the most tenuous gaseous condition and then the phenomenon is changed, and the spectrum consists of a single line. So far indeed as the visible spectrum goes, it is possible by working with the gas at low pressure, and not too high temperature, to get a spectrum from any gas or vapour of only a single line, and as you increase the density, and thus force the particles closer together, and make the conditions of the gas approximate in the way of aggregation more to those of a solid, so does the spectrum get more and more like that of a solid, till we see at last a bright continuous spectrum. Take, for instance, hydrogen, and use, not an ordinary air-pump, but a sprengel mercury pump; use this for three or four hours, and observe the spectrum of the gas. It is a single line. Fill the tube again with gas, at ordinary atmospheric pressure, double the pressure, or multiply it ten or more times, and what becomes of the line? Not only does that green line which first appeared get more and more obvious and thick, but more lines appear, and they get thicker, till at last there is such a background of continuous spectrum that these are all invisible as lines. At twenty atmospheres the spectrum is as continuous as that of a solid.

6. Here is my sixth proposition:—In the case of metals *there are two different ways in which the continuous spectrum is approached.* Mind I do not say reached, for there may be much more to learn on this point. To render this clear I must show you some more photographs and explain the method by which they have been obtained. Here I have a coil and a jar, and here the poles. We drive the metal of which these poles are composed into vapour, the vapour is rendered incandescent; the spectrum we should get would therefore be one of bright lines. Now,

instead of bringing the spectroscope close to the poles, in which case, in every part of the spectrum, we should get light from every part of the spark, I prefer to use a lens, by means of which I throw an image of the spark on the slit; then in each strip of the total visible spectrum is the spectrum of some particular part of the vapour. Think the matter over a little for yourselves. These poles are perpetually giving off vapour, which is constantly going away; some of it is being oxidised, some of it is travelling away along the currents of air set up. What follows? There must be more vapour close to the pole than in the interval between the poles; that will be still more true if I make the interval between the two poles longer. In the part between the two poles, if they consist of two different elements, we have three distinct spectra. In the upper part, a region rich in the upper vapour; in the lower, one rich in the lower vapour; between them one which is rich in neither. We have then at least three distinct layers, so to speak, in the spectrum, the spectrum of the vapour of the upper pole the spectrum of the vapour of the lower one, and also of the central region. The number of particles of each vapour will decrease from each pole. You will see in a moment that much the same condition of affairs will be brought about, if, instead of using a spark, I use an electric arc, in which the pure vapour of the substance which is being rendered incandescent

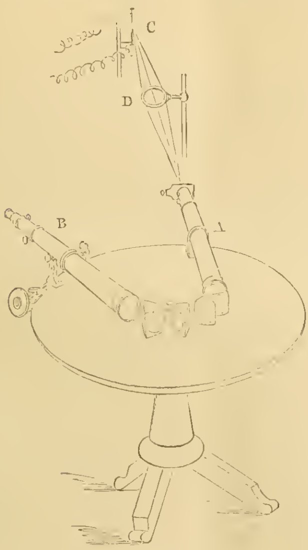


Fig. 1 —C, spark; D, lens; A, collimator; B, observing telescope.

fills the whole interval between the poles, the number of particles being smaller at the *sides* of the arc. Now I can throw an image of such a *horizontal* arc on a vertical slit; the slit will give then the spectrum of a section of the arc at right angles to its length. You have a photograph of such a spectrum of iron now before you. I wish to draw your attention to the long and the short lines. The vapour which exists furthest from the core of the arc has a much more simple spectrum than that of the core of the arc itself. The spectrum of the centre consists of a large number of lines; that furthest from the centre consists of one line. If you picture to yourselves the particles getting nearer to each other, as you get nearer the source of supply, you see that the nearer the particles are together the more they bang about and the more lines we get in the spectrum. It is important to notice that vibration once begun always goes on; it never gives *place* to others, although it may give *rise* to others; so that you get the largest number of lines in the centre, where the particles are closest together. Now I have specially to refer to the fact that the way in which the continuous spectrum is built up varies in different substances. Here I have a photograph giving the spectrum of aluminium and calcium compared with that of the Lenarto meteorite. The spectra of calcium and aluminium differ generically from that of the meteorite. I want to draw attention to the thick or winged lines you get in the case of aluminium and calcium. These spectra are good specimens of those which give a continuous spectrum by thickening the lines, while the elements in the meteorite are as good specimens as I could put before you of those which produce a continuous spectrum by increasing the number of their lines.

There is another remarkable fact connected with this.

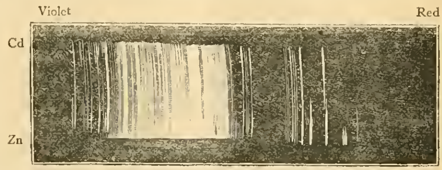


Fig. 2.—Long and short lines of zinc and cadmium.

You see a thin dark line in the centre of the thick bright lines; this is due to the absorption by the rarer cooler vapour lying outside this vapour. This is almost invariably observed in the substances giving us the lines thickening as the continuous spectrum is approached, while iron does not give us any such reversal. It is well to see if one can group facts together. That is the first business of a man of Science. It is extraordinary that in all the substances I have yet examined the question of specific gravity decides whether the substance should have its spectrum complicated by thickening or increasing

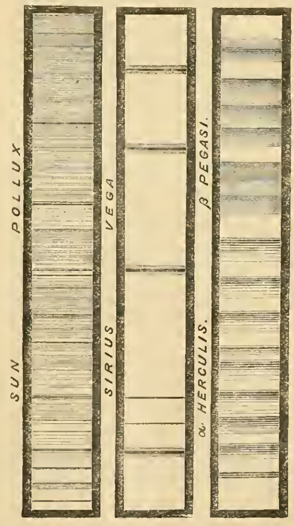


Fig. 3.—Long and short lines of iron.

its lines. You know the specific gravity of iron is high. In the case of aluminium, magnesium, sodium, and others where this is low you have the widening of the lines and the easy reversal.

So much for the continuity of the spectroscopic record of the continually increasing distance of particles from particles. We began with a solid and a continuous spectrum, we end with a tenuous gas and a spectrum of a single line, and we partly bridge over the gap between these states in two different ways.

J. Norman Lockyer

(*To be continued.*)

COL. GORDON'S JOURNEY TO GONDOKORO

WE have been favoured with the following remarks concerning Colonel Gordon's journey to Gondokoro. Colonel Gordon, "His Excellency, the Governor-general of the equator!" arrived at Khartoun on March 13, and had with him a *Pall Mall Gazette* of Feb. 13; he writes on the 17th from Khartoum as follows:—

"At this season of the year the air is so dry that animal matter does not decay or smell, it simply dries up hard; for instance a dead camel becomes in a short time a drum.

"The Nile, flowing from the Albert Nyanza below Gondokoro, spreads out into two lakes; on the edge of these lakes aquatic plants, with roots extending 5 ft. into the water, flourish; the natives burn the tops when dry, and thus form soil for grass to grow on; this is again burnt, and it becomes a compact mass. The Nile rises and floats out portions, which, being checked in a curve of the channel, are joined by other masses, and eventually the river is completely bridged over for several miles, and all navigation is stopped.

"Last year the governor of Khartoum went up with three companies and two steamers, and cut away large blocks of the vegetation; at last one night the water burst the remaining part, and swept down on the vessels, dragging them down some four miles, amidst (according to the Governor's account) hippopotami, crocodiles, and large fish, some alive and confounded, others dead or dying, the fish being crushed by the floating masses. One hippo was carried against the bows of the steamer and killed, and crocodiles 35 ft. long were killed: the Governor, who was on the marsh, had to go five miles on a raft to get to the steamer.

"The effect of these efforts of the Governor of Khartoum is that a steamer can now go to Gondokoro in twenty-one days, whereas it took months formerly to perform the same journey."

Colonel Gordon left Khartoum on March 21, and in his last letter from Fashoda, 10° N., he touches on some of the scenes on the banks of the river—the storks, which he was in the habit of seeing arrive on the Danube in April, laying back their heads between their wings and clapping their backs in joy at their return to their old nests on the houses, now wild and amongst the crocodiles 2,000 miles away from Turkey; the monkeys coming down to drink at the edge of the river, with their long tails, like swords, standing stiff up over their backs; the hippos and the crocodiles. Such scenes to a lover of nature, as Col. Gordon is, doubtless would serve to make up in some measure for the loss of civilised society and comforts.

THE EXTINCT FAUNA OF THE MASCARENE ISLANDS*

THE members of the scientific expedition about to start for Rodriguez should make themselves acquainted with what has already been done towards the working out of its wonderful extinct fauna. We therefore beg leave to call their attention, and that of naturalists in general, to a recent contribution of M. Alphonse Milne-Edwards to our knowledge of this subject, published in the "Annales des Sciences naturelles."

In this excellent memoir M. Milne-Edwards describes the objects disinterred during some researches made in the caverns of Rodriguez under the direction of Mr. Edward Newton, the Colonial Secretary of Mauritius, as also the contents of a small collection from Mauritius itself, made in the same recent formation whence the complete skeletons of the Dodo were latley obtained.

* "Recherches sur la Faune ancienne des iles Mascareignes." Par M. Alph. Milne-Edwards. Ann. Sc. Nat., sér. 5 Zool., t. xix.

The remains described and figured are entirely those of Birds, to the extinct forms of which class the author of this memoir has lately devoted so much of his attention. The most remarkable form thus restored to us is certainly the rail-like bird, apparently allied to the *Ocydromus* of New Zealand, which is proposed to be called *Erythromachus leguati*. This bird is of greater interest, as there can be little question that it is the *Gelinote* of which the old voyager Leguat speaks, as abundant in the island 200 years ago, and as being "grasse pendant toute l'année et d'un goût délicat," although we cannot quite understand how the pectoral muscle can have been sufficiently large to provide much sustenance to the hungry mariners of those days! Besides the *Erythromachus*, M. Milne-Edwards resuscitates species of owls, pigeons, parrots, and herons, and concludes his useful memoir with some pregnant remarks upon the general character of the ancient fauna of the Mascarene Islands.

We trust that the new expedition, soon about to start for Rodriguez, will not fail to succeed in obtaining a much more intimate acquaintance with both the ancient and modern fauna of this remote island.

NOTES

THE annual meeting of the Linnean Society was held on Monday, in conformity with the terms of the charter, when Prof. Busk presided. The following officers were elected:—President, G. J. Allman, M.D.; Treasurer, Daniel Hanbury; Secretaries, Frederick Currey; and St. George J. Mivart. The five members of the present Council recommended to be removed were—Dr. Braithwaite; J. D. Hooker, C.B., M.D.; J. G. Jeffreys, LL.D.; Daniel Oliver; W. W. Saunders. The five Fellows recommended to be elected into the Council in the room of the above were—Major-Gen. Strachey; W. T. T. Dyer; J. E. Harting; W. P. Hiern; J. J. Weir.

THE Annual Report, dated Jan. 31, 1874, of Mr. Gould, Government Astronomer to the Argentine Republic, has come to hand, containing an account of the work done at Cordoba Observatory during the past year. Judging from this and the previous report, and from the amount of encouragement given to Mr. Gould by the Argentine Government, it seems likely that Cordoba Observatory will produce as valuable results as any other observatory in the southern hemisphere. The observations of the stars between 23° and 80° of S.D. have been diligently continued, the heavens for this purpose being divided into a number of zones of convenient size. More than 70,000 observations of stars have in this way been made, and Mr. Gould confidently hopes that by the middle of this year the zone-observations will be completed, by which time he calculates that about 65,000 different stars will have been observed. Besides this a large number of observations for instrumental corrections have been made, besides repeated and careful observations of five or six stars in each zone for the purpose of detecting any errors of observation in the other stars of the zone. A considerable amount of photographic work has also been done, though Mr. Gould has been sadly hampered in this department. A variety of other useful astronomical work has been done at the observatory, which, under Mr. Gould's superintendence and by the liberality of the Argentine Government, is being gradually brought to a condition of great efficiency.

Mr. Gould is also provisional director of the Argentine Meteorological Office, which has been established for only about two years; here also he has set to work in a thorough manner with results that promise well for the future, notwithstanding the difficulties that have met him in the getting together of good instruments. He has endeavoured to collect all the meteorological

observations on record, made at any time in any portion of the national territory or its immediate vicinity; and very excellent progress has been made in this direction. He has also enlisted coadjutors to make systematic observations in various parts of the country, and soon he hopes to have the country well dotted with such observers. A considerable amount of work has been accomplished in tabulating and computing the results thus far collected. By the end of another year it is expected that sufficient observations will be available to permit the publication of a volume devoted exclusively to the meteorological statistics of the Argentine Republic.

DR. BURMEISTER, well-known for his thorough knowledge of the natural history of the region of La Plata, where he has resided for many years, has been, we learn from the *Academy*, nominated to the post of Director of the Natural History and Physical Faculty of the University of Cordova, where seven chairs are already held by German professors.

THE delegates of the Oxford University Museum have appointed Mr. H. J. Stephens Smith, M.A., Balliol College, Fellow of Corpus Christi College, to the keepership of the University Museum, vacant by the lamented death of Prof. Phillips. The stipend of the keeper is 80*l.* per annum, with an official residence adjacent to the museum. The appointment of Mr. Smith will have to be ratified by convocation. The Professorship of Geology, vacant also by the demise of Prof. Phillips, and worth 300*l.* per annum, is still vacant, though no official announcement of the vacancy has been made.

THE first party of the English expedition for observing the transit of Venus took its departure on Saturday afternoon in the Government transport *Elizabeth Martin*, from Woolwich. The stores include cases of astronomical and photographic apparatus to the extent of nearly 150 tons measurement, besides provisions and other necessaries, as some of the party will be for several weeks located in inhospitable regions. Of the gentlemen who left on Saturday, Lieut. Neate, R.N., will be chief astronomer at Rodriguez, in the Indian Ocean, and Lieut. Hoggan, R.N., one of his assistants; Lieut. Goodridge, R.N., one of the astronomers at Christmas Harbour, Kerguelen, which lies between the Cape and Australia; Mr. J. B. Smith, astronomer and photographer at the same station; and Lieut. Cyril Corbett, C.B., is to be chief astronomer at a second station in the same island. There are to follow—Mr. Burton, astronomer and photographer at Rodriguez; the Rev. F. S. Perry, F.R.S., chief astronomer at Christmas Harbour; the Rev. W. Sidgreaves, astronomer at the same station; and Lieut. Coke, R.N., who will act as astronomer with Lieut. Corbett at the second station, Kerguelen.

WE greatly regret to hear that the Rev. R. T. Lowe, the well-known author of a "Flora of Madeira," was among the passengers who lost their lives in the recent wreck of the *Liberia*.

THE French Academy has elected M. de Tchebycheff, the eminent geometer of St. Petersburg, foreign associate, in place of the late M. De la Rive, and M. Ollier of Lyon, a corresponding member in place of the late Dr. Guyon.

SCIENCE is beginning to make headway in the re-constituted University of Strasburg. A new observatory (under the direction of Prof. Winnecke) is to be commenced at once, and an 18-inch refractor has been ordered. The Physical Cabinet (under the direction of Prof. Kundt) already possesses a very fine collection of the newest apparatus, and the professor has a class of fifty men.

IN a small pamphlet, reprinted from the *Wiener Abendpost*, Karl von Littrow takes advantage of the foundation of the new observatory of the Vienna University to give a history of the old observatory, which has been in existence for more than a century, and of some of the work which has been done in it. The new observatory has apparently been carefully planned, and will be well provided with the most approved instruments.

WE would draw attention to the valuable Notes concerning the work of the *Challenger* between Simon's Bay and Melbourne, in the *Times* of Monday and Tuesday. Very important observations have evidently been made on the currents, temperature, and life of the southern seas. Some interesting observations are made regarding icebergs, and the remarkable similarity of the fauna of the southern seas to that of the northern is noticed. "We scarcely expected," the writer says, "to find the water so deep, but it agrees with our former observations, which lead us now always to expect to find the deepest water near the land. To account for this we can only reason that no large part of the surface of the earth can be raised higher than another by means of a volcano or otherwise, unless at the same time a corresponding hollow or depression is excavated in the neighbourhood. To form a hill, the earth must be removed from somewhere else."

PROFS. DONDERS and Th. W. Engelmann have published, in Dutch, the results of their inquiries made during 1873 on the passage of blood-cells through the vessel. Working with a unilocular microscope, they have not been able to find any aperture by which the white corpuscle can pass through the vessel.

THE last number of the *Journal of Botany* contains a sketch by Mr. B. D. Jackson of the life of William Sherrard (1658-1728). Mr. Jackson's object is thus stated:—"The whole life of William Sherrard was so intimately connected with that of the leading men of Science in his day, that a comprehensive account of his career would be an epitome of his times. The exigencies of space, however, forbid more than a sketch of his life, designed to correct certain errors which appear in all the accounts that have come under my notice, copied apparently from one book into another." Mr. Jackson says of him:—"Whilst we cannot admit him as the equal of his contemporaries, Ray and Tournefort, who originated systems, yet the services he rendered to botany at a period termed by Linnæus 'the golden age,' must make his name as lasting as the science. His intercourse with the leading men in the science both at home and abroad was intimate and frequent; he was generous even to excess in distributing seeds and dried plants, an unfailing patron of deserving naturalists, and crowned his useful life by the bequest of his library and herbarium (the most authentic and one of the largest at the time) to the University of Oxford, with the endowment of 3,000*l.* for the professor of botany."

WE are glad to learn that the anticipations expressed in one of our recent numbers as to the management of the future office for Maritime Meteorology in Germany, have been fulfilled by the appointment of Herr W. von Freeden to the post of director. Herr von Freeden was for many years at the head of the Navigation School at Elsfleth, near Bremen, and since 1867 has superintended the Seewarte at Hamburg. The best results may be hoped for from his long experience and his known zeal for Science.

IT is requested that those members of the University of Cambridge who desire to avail themselves of the facilities for study at the zoological station at Naples, for which a grant has been made from the Worts Travelling Bachelors' Fund, will send their names to Mr. Foster, Fellow of Trinity College, on or before October 1. The nominations will be made by the Board of Natural Science Studies early in October.

AN expedition is being fitted out for an exploration of the Arctic Seas. Capt. Wigans, Sunderland, has engaged Mr.

Lamond's splendid steam yacht *Diana*, and will proceed *viâ* Nova Zembla, sailing from Dundee on June 1. Capt. Brown, Peterhead, will command the *Diana*.

On the 20th inst. a large representative meeting of various corporate towns was held at the Society of Arts, Adelphi, under the presidency of Lord Hampton, in reference to the national museums. The following resolutions were passed unanimously:—1. "That all museums and galleries supported or subsidised by Parliament should be made conducive to the advancement of education and technical instruction to the fullest possible extent, and that special Parliamentary funds should be granted to assist local and provincial museums in the acquisition and loan of objects, and with building grants, and thus extend their usefulness." 2. "That in the opinion of this meeting all national museums and galleries should be placed under the authority of a Minister of the Crown, with direct responsibility to Parliament, thereby rendering unnecessary for the purposes of executive administration unpaid and irresponsible trustees except those who are trustees under bequests or deeds, who might continue to have the full powers of their trust, but should not be charged with the expenditure of money voted by Parliament." The chairman was requested to submit to the Prime Minister the foregoing resolutions, and press their importance on his attention.

We cannot regret that Lord Hampton's motion for the appointment of a Minister of Education in the House of Lords last Friday was lost. Lord Hampton does not seem to understand what is really required, and the Duke of Richmond's reply under the circumstances was perfectly appropriate and conclusive.

It is known that several years ago the German Astronomical Society undertook the systematic revision of star catalogues for the boreal hemisphere up to the 9th magnitude. That heavy task has been undertaken by fourteen observatories—Cambridge (England), Christiania (Norway), Palermo (Italy), Neufchâtel (Switzerland), Leyden (Netherlands), Harvard College and Chicago (U.S.), Pulkowa, Dorpat, Helsingfors, Kazan (Russia), Berlin, Leipsig, Bonn (Germany). The boreal hemisphere has been divided into zones, each of which has been allotted to two different observatories. Pulkowa was entrusted with the care of observing fundamental stars numbering 539. The work is just half done, and will be finished by the end of 1875, when every star marked by Lalande in his "Histoire celeste," and Argelander in his star catalogue, will have been revised.

A cholera conference is to meet in Vienna in the course of the autumn, to discuss the best methods of preventing the propagation of the disease. Prof. Pettenkofer, who has carefully watched the progress of cholera in Munich since its outbreak nearly a year ago, will be present, and will no doubt have valuable information to contribute. The number of deaths, which last winter amounted to 55 a-day in Munich (as a maximum), had sunk last month to 2 per diem.

The German Society of Anthropology is industriously collecting material for the Prehistoric map, which it was resolved, at the meeting of April 1870, to prepare for publication. Among other points to be indicated on this map will be the position of the most notable Prehistoric settlements, fortifications, lake-dwellings, cave-dwellings, burial mounds, and other places of sepulture. By a judicious use of colours, the various periods—Stone, Bronze, and Iron—will be indicated, and altogether the map will be one of great value to the student of archæology and ethnology.

We have already referred to the treatment by the French Government of M. Alglave, Professor in the Law Faculty of Douai, and editor of *La Revue scientifique*. M. Alglave had been delegated temporarily to the faculty of Grenoble, but as he had undertaken to deliver a course of lectures at Lille, and had moreover been designated secretary to the approaching session of the French Association at that town, he petitioned the minister to permit him to remain at Douai; the reply was absolute dismissal from his post without delay. Such is a specimen of how French ministers use their "little brief authority."

Last Thursday a handsome new aquarium, well stocked with marine and fresh-water fish, was opened at Manchester. The sea-water is brought by train in barrels from Blackpool, a distance of about 40 miles, and a constant supply is maintained.

Mr. J. W. Douglas, the well-known entomologist, has become one of the editors of the *Entomologist's Monthly Magazine*.

The first part of the third issue of Sowerby's "British Wild Flowers" (Van Voorst) is now out; the descriptions with an Introduction and a Key to the Natural Orders, being by C. Pierpoint Johnson, Botanical Lecturer at Guy's Hospital.

The additions to the Zoological Society's Gardens during the last week include a Wild Boar (*Sus scrofa*) from Algeria, presented by Mr. W. F. Tempest; an Ourang-outang (*Simia satyrus*) from Borneo, deposited; a Racoon-like Dog (*Nyctereutes viverrinus*) from Amoorland, new to the collection; a Great Bustard (*Otis tarda*), European; five Red-legged Falcons (*Erythropus vespertinus*), European, purchased; three Temminck's Tragopans (*Ceriornis temmincki*) and three Peacock Pheasants (*Polyplectron chinquis*), hatched in the Gardens; and two Hairy Armadillos (*Dasypus villosus*), born in the Gardens.

THE FLORENCE INTERNATIONAL BOTANICAL CONGRESS

The International Botanical Congress commenced its sittings at Florence on May 15, under the presidency of Dr. Hooker, Prof. Parlatore being disabled by illness from filling that post. The vice-presidents elected were Mr. Bentham and Dr. Moore for Great Britain, M. de Candolle for Switzerland, M. Fenzl for Austria, MM. Planchon, Weddell, and Baillon for France, MM. Reichenbach, Hofmeister, Wendland, and Karl Koch for Germany, and MM. Regel, Bunge, Gelernoff, and Wolkenstein for Russia. At the Congress England was represented by Professors Bentham, Allman, and Masters, Drs. Hooker and Ball, Messrs. Smee, Hiern, and Maw; David Moore represented Ireland, and Charles Moore Australia.

On the first day a paper was read by Dr. Planchon on *Phylloxera vastatrix* and the vine disease; on vegetable palæontology by M. Carnel; on the development of *Cynomorium coccineum*, by Dr. Planchon; M. Famintzin on the spores of *Aethalium*.

At the second meeting, May 18, Prof. de Candolle, presided, and among the papers read was one by Mr. W. P. Hiern, of Cambridge, on the determinations of the fossils that have been referred to *Diospyros* or allied genera. At the third meeting, May 20, Dr. Bunge, a Russian botanist, presided, and the papers included one by De Candolle on Alpine plants. On the 16th took place the inauguration of the bust of Philip Barker Webb, an English botanist, who left his valuable herbarium to Florence. An oration was made by Dr. Bolt, of Berlin.

The International Horticultural Exhibition, which took place concurrently with the Congress, was opened by the King on the 15th, and the following day 1,800 people were present.

The show was held in a new iron building in the middle of the town, which is to be used as a market. The *Italian News*, published in Rome May 19, says: "The Floral Exhibition has proved a decided success, in spite of the bad weather which accompanied its inauguration. There has been a large daily attendance. The show was remarkably complete, and the prizes have been awarded with such justice that no jealousies have been allowed to mar the pleasure of the recipients."

It is proposed that the conference for next year shall be held in London.

SCIENTIFIC SERIALS

THE *Geographical Magazine*, May.—The principal article in his number is a translation by Col. Yule, C.B., of some of the notes appended to the Russian edition of his "Essay on the Oxus," by the late Alexis Fedchenko; they are extremely interesting.—Mr. E. D. Morgan contributes a paper on the new Russian province of Amu Daria, which is accompanied by a map.—Mr. E. G. Ravenstein's paper On the Viti or Fiji Islands, with the excellent map which accompanies it, will be very acceptable to many at the present time.—The number contains a very curious and interesting paper purporting to be the autobiography of a slave, under the title of My parentage and early career as a slave.

THE *Geological Magazine* for May, contains the following original articles:—The shell-bearing gravels near Dublin, by the Rev. Maxwell Close, F.G.S.; On some new Devonian fossils, by Prof. H. Alleyne Nicholson, F.R.S.E.; On the substitution of zinc for magnesium, by E. T. Hardman, F.R.G.S.I.; The volcanic history of Ireland—address to the Royal Geological Society of Ireland, by Prof. Hull, F.R.S., president; On a raised beach at Tramore, by E. T. Hardman.

THE *American Journal of Science and Arts*, April 1874.—We have here the continuation of Prof. Leconte's interesting paper On the great lava flood of the North West, and the structure and age of the Cascade mountains. There has been much speculation as to the origin of the "prairie mounds," which consist of a drift soil of earth, gravel, and small pebbles. Prof. Leconte considers they are entirely the result of surface erosion acting under peculiar conditions, viz. a treeless country and a drift soil consisting of two layers, a finer and more movable one above, and a coarser and less movable one below.—Mr. Chase gives an account of the auriferous gravel deposit of Gold Bluff.—Mr. Meek continues his notes on some of the fossils figured in the recently issued fifth volume of the Illinois State geological report; and Mr. Verril gives results of recent dredging expeditions on the coast of New England.—In a paper On the lignites and plant-beds of western America, Mr. Newberry calls in question some of Mr. Lesquereux's conclusions, and seeks to show that several of the beds are Cretaceous and not Eocene.—Among the remaining matter we find notes on a mass of meteoric iron found at Howard co. Ind. (with remarks on the molecular structure of meteoric iron); on the parallelism of coal seams; and on recent earthquakes. We may also notice, in the Scientific Intelligence, a lengthy abstract of a paper by Josiah Cooke, jun., On the vermiculites, their crystallographic and chemical relations to the micas, with a discussion of the cause of variation of the optical angle in these minerals.

Poggendorff's Annalen der Physik und Chemie, Jubelband.—The hearty co-operation with which the proposal was met, to commemorate the jubilee of the scientific veteran who has for years edited the *Annalen*, is here represented in a collection of more than sixty papers of original research, many of them by well-known investigators. We can do little more than briefly glance at some of the subjects that are treated, of which there is great variety. Electricity and magnetism meet with a considerable share of attention; and we may first of all note some interesting studies, by M. Wüllner, on discharges of the induction current in spaces filled with rarefied gases. This research betokens considerable minute care. Variations were made, in the form of the tubes used, degrees of rarefaction, direction of spark, velocity of rotating mirror in which the light was reflected, &c.; the influence of magnets was also observed, and some striking peculiarities of striation in the image of the discharge are brought to light, and shown in drawings.—M. Hittorff examines from a different point of view the conduction of electricity by gases.—Prof. Blaserna, of Rome, studies extra currents; and he points out that at the moment of closure the current begins to flow, first slowly, then more quickly, till it reaches a maximum, from which it descends, by a series of oscillations, between maxima and minima, to zero.—M. Reiss, in reference to what he terms the electric induction of a non-conductor in itself, enunciates the proposition that at the under surface of a free non-conducting plate, whose upper surface is electrified, there is an electric layer of the same sign with the electricity of this surface, while immediately above there is an electric layer of the opposite sign.—The heat-action of electric disjunction currents forms the subject of a communication from M. Edlund; and M. Kohlrausch describes the action of polarisation on alternating currents; also a sinus-inductor. The electromotive force of liquid batteries, the thermo-electric properties of topaz, spar, and arragonite, the action of magnets on discharges in rarefied gas, the conductivity of glass for electricity and heat, and some peculiarities of galvanic polarisation, are also treated; and of the more theoretical papers, we may specify one by Prof. Feilitzsch, On the poles of equal normal intensity in the magnetic field of a galvanic battery current, and one On a general theorem for calculating the action of magnetising spirals, by Dr. von Waltenhofen.—Perhaps no scientific serial presents such a rich collection of material in the department of mineral chemistry as *Poggendorff's Annalen* during these fifty years. The influence of Berzelius has made itself powerfully felt; both his spirit and his method being evidently reflected in the researches by his students, among whom Prof. Heinrich Rose occupies the first rank. Those who are interested in this branch will find in the *Jubelband* a valuable *résumé*, by Prof. Rammelsberg, of the work of the *Annalen* in reference to it; and a list is given of forty young chemists who have laboured on various mineral forms, under Rose's direction.—In a paper On the struggle for existence among molecules, by M. Pfaundler, an ingenious parallel is drawn between the phenomena of production of certain chemical compounds through partial dissociation and reciprocal reaction, on the one hand, and production of species through natural selection (according to Darwin's theory) on the other; and this article is followed by one On the equivalent of *vis viva*, by M. Wilhelm Weber.—The phenomena of light and heat are studied in various aspects. In a note On the spectrum of aurora, Prof. Angström considers that the yellow light (characteristic of all auroras) arises from fluorescence or phosphorescence. An electric discharge is supposable, which, though in itself faintly luminous, is rich in ultra-violet light, and is thus capable of producing strong fluorescence. It is also known that oxygen, and several compounds of it, are phosphorescent. Prof. Angström thinks it unnecessary to have recourse to "variability of gas-spectra under varying conditions of pressure and temperature."—M. Zöllner has a paper of photometric researches on the physical character of the planet Mercury, in which he comes to the conclusion that Mercury has a surface closely resembling that of our moon; it is without an atmosphere.—Mr. Bolzmann studies the connection between the turning of the plane of polarisation and the wave-length of various colours; M. Ketteler, the specific law of so-called anomalous dispersion; M. Knoblauch, the reflection of heat and light rays from inclined diathemanous and transparent plates; and M. Dufour the reflection of solar heat from the Lake of Geneva.—A curious phenomenon is discussed by Prof. Lommel, viz. the appearance of a luminous halo round the shadow of one's head in wet grass, especially when the sun is low. He supposes it to arise from light being refracted through the drops, received by the surface below, and sent back through the drops to the luminous source; the light thus suffering a fourfold refraction, and also a diffuse reflection. It is a like cause to that which explains the shining of cats' eyes in the dark.—In experimenting on the specific heat of water at various temperatures, M. Bosscha arrives at results somewhat different from those of Regnault.—M. Hagenbach continues his experiments on fluorescence.—There are several papers referring to new and improved instruments. The practical physiologist will be interested in some new arrangements, by Dr. du Bois Regmond, for studying the physics of nerve and muscle, including a mercury key, a double commutator, a "frog pistol," and a spring myographion.—M. Barentin describes an improvement on Poggendorff's machine for demonstrating acceleration; M. Gorst a spectroscope with fluorescent eye-piece; M. Melde a wave-apparatus for showing Chladni's sound-figures; M. Rudorff an improved Bunsen photometer; while M. Jolly makes a new determination of the expansion coefficients of some six gases, and investigates the action of air thermometers.—The theoretical limits of capability of the microscope forms the topic of an able memoir by M. Helmholtz.—Some hydraulic researches by M. Meyer prove that pressure is propagated in water with the velocity of sound; and that the Poisseuille law holds good for outflow of water not only through capillary tubes, but also through wider tubes, provided these are sufficiently long (thus it was found to hold for 250 to 3,000 m. length in a tube 7 mm. diameter).—M. Karsten communicates an instructive account of recent scientific researches on the temperatures, saltness, &c., of the Baltic and North Seas.—In mechanics we have a number of bending-experiments from M. Buff, in reference to elasticity of various substances—iron, glass, wood, &c.; and among the few chemical subjects treated

(not to prolong our enumeration) are the constitution of chlorhydric acid and its salts (Thomsen), new sulphur salts (Schneider), and the volume constitution of some oxides (Schröder).—The only paper from an English source appears to be that of Prof. Tyndall's, On propagation of sound through the atmosphere.—A well-executed portrait of Prof. Poggendorff is prefixed to this interesting volume.

Astronomische Nachrichten, Nos. 1,984, 1,985, and 1,987.—These numbers contain a long paper by Prof. E. Kayser on some new applications of the level to astronomical instruments, especially to the alt-azimuth.—A table of the eclipses of Jupiter's satellites, observed at Toulouse from Jan. 4 to April 1, appears in No. 1,985.—Observations of planets 135 and 136, are given by H. G. von der Sande Bakhuyzen, J. Paliser, and E Stephan.—No. 1,987 contains a paper by C. Hornstein, On the daily variation of the horizontal magnetic force of the earth. The author points out the correspondence between the sun-spot period and the variation above mentioned, the maximum and minimum of each, according to the table, appears to occur at the same time.—R. Luther gives a number of observations on the positions of the minor planets and variable stars. The elements of Winnecke's comet are given by W. Schur as follows:—

$$\begin{aligned} T &= \text{March } 14{\cdot}0356 \text{ Berlin mean time} \\ \Omega &= 274^\circ\ 7'\ 5'' \\ \Pi &= 302^\circ\ 15'\ 41'' \\ i &= 31^\circ\ 32'\ 26'' \\ \log. q &= 9{\cdot}947502. \end{aligned}$$

Prof. Winnecke communicates the discovery of the above comet.—Prof. Weiss gives an ephemeris of Winnecke's comet I. Position for May 18, R.A. 15h. 22m. 15s., D. + 43° 8′, decreasing in R.A. about 15′ a day, and increasing in D. a few minutes.—C. Bruhns gives positions of Winnecke's and Coggia's comets.—Dr. J. Holetschek gives an ephemeris for Coggia's comets as follows:—

12h. Berlin time.

	R.A. h. m. s.	D. ° ′
May 23,	6 13 38	+ 67 21·0
June 4,	5 51 14	+ 63 9·5
,, 16,	5 12 0	+ 47 5·0
,, 28,	4 49 50	+ 11 6·1

Prof. Peters, A. de Jasparis, and G. Bümher also give observations on the two above-mentioned comets,

Journal de Physique, April.—This number begins with a note in which M. Desains describes an improved method of studying Newton's coloured rings; the plane is made movable to and from the lens by means of a fine micrometric screw, so that the pressure can thus be varied; and the rings are observed with monochromatic light, either direct from a flame, or isolated from the spectrum.—In a paper On transformation of optical achromatism of object-glass into chemical achromatism, M. Cornu finds that, given an achromatic astronomical telescope, the object-glass of which is formed of a convergent lens of crown glass and of a divergent lens of flint glass, this object-glass may be transformed into one capable of giving satisfactorily distinct photographic images, by separating the two lenses to an extent dependent on the nature of the two glasses. With the glasses used in optics, a separation of 1½ per cent. of the focal distance of the object-glass is sufficient, and the chemical focus is very near the optic focus. The aberrations produced by this separation may, the author thinks, be entirely neglected. Using an excellent telescope 100 mm. aperture and 1·40 m. focal distance, and separating the two glasses 15 mm. he succeeded in photographing a scale, divided into millimetres, placed at 40 metres distance; the lines were quite distinct; the relation of the empty spaces to those filled in was quite recognisable, and with a microscope and micrometer it was possible to measure the thirtieth part of the intervals.—This paper is followed by the first part of one in mathematical physics, in which M. Blavier studies the electric resistance of the space inclosed between two cylinders.—A new rheostat is described by M. Crova, in which two platinum wires pass down to the bottom of a long graduated tube containing mercury, the height of which can be varied through elevation or depression of a spherical vessel communicating with the bottom of the glass tube, through a tube of caoutchouc.—There are, further, notices of M. Seebeck's recent researches on motion of sound in bend and bifurcating tubes, M. Dufour's on reflection of solar light at the surface of Lake Leman, &c.

Bulletin Mensuel de la Société d'Acclimatation de Paris.—The February number of this *Bulletin* commences with a paper by M. Decroix, on the consumption of horse-flesh in France, as meat, from which it appears that hippophagy is largely on the increase.—The question of silkworm culture again occupies a prominent position in the report, and a statement of the services rendered by acclimatisation in Egypt is very interesting. The *Eucalyptus globulus*, the cocoa tree, the silkworm, the *Cytisus cajan* of Madagascar, or Ambrevade, are among the recent acquisitions of that country.—The cultivation of tea in Java is the subject of a valuable paper by M. E. Prillieux; in 1826 the first seeds of the tea-plant were sown in that island; and in 1867 the annual production was 1,600,000 lb. The very best qualities often thrive in that country.—The introduction of the African ostrich into France is proposed. The plumage of a male ostrich is valued at from 300f. to 500f. (12*l.* to 20*l.*); that of a female at about half that, while the plumage of the American ostrich is sold at 15f. to 20f. the kilogramme (12*s.* to 16*s.* per 2 lb.)—The system of oyster-culture, till recently so successfully adopted in France, is threatening to collapse; and some valuable hints thrown out by M. D. de Mayréna may be of service in assisting to arrest the decay.—In the Jardin d'Acclimatation 335 mammalia and 2,647 birds were received during January and February, amongst which were a new monkey, *Lemur catta*, two St. Hubert bloodhounds, some Viellot's pheasants of Java, two emus, a very fine ostrich, and an Indian duck (*Anas pœcilorhynca*), a curious-looking bird, with a beak orange at the root, black in the middle, and pure white at the tip; the plumage is a grey colour.

Bulletin de l'Academie Royale de Belgique, No 3, 1874.—This number opens with a tribute to the memory of M. Adolphe Quetelet, in the form of six discourses delivered at the funeral of that eminent *savant* on Feb. 20 last, by MM. Keyser, Ed. Mailly, &c., representing various learned Societies.—In the department of Science we find an account of M. Louis Henry's continued researches on diallylic derivatives. In a previous paper he had shown that allylic compounds combine directly with hypochlorous acid to produce glyceric compounds; and he here extends the observation to diallylic compounds, diallyl having been found to combine directly with hypochlorous acid and form a diallylic dichlorhydrine.—In a second note of researches on camphor, M. Dubois describes an advantageous mode of preparing brominated camphor. It rests on the previous formation of an additional brominated product, $C_{10}H_{16}OBr_2$; which is then decomposed into brominated camphor and bromhydric acid, $C_{10}H_{15}BrO + BrH$. Among the numerous products obtained from action of iron, heated red, on camphor-vapour, M. Dubois finds a terpene $C_{10}H_{16}$, which he regards as important with reference to the composition of camphor.

Archives des Sciences Physiques et Naturelles, April 15.—This number commences with a chemical paper, by M. Eugene Demole, On distillable oxygenated bases derived from glycol and aromatic amines. It appears that when a primary amine is in presence of oxide of ethylene it is not a molecular combination that is produced, but a true product of substitution of glycol. The secondary base which thus forms possesses still a hydrogen replaceable by alcoholic radicals, and the product of this substitution is a tertiary base; which, again, is susceptible of the addition of alcoholic iodides to form quaternary iodides indecomposable by alkalis.—In the next paper, M. Dufour studies the phenomenon which occurs when two masses of air, differing in hygrometric state, are separated by a partition of porous earth; a diffusion takes place, in which the more abundant current passes from the drier to the more humid air. The activity of diffusion depends on temperature only indirectly, in so far as this occasions difference of vapour-tension on the two sides of the partition. It depends little, if at all, on fraction of saturation. The difference between the quantities or tensions of water-vapour on the two sides is the important element; the diffusion is nearly proportional to this difference.—A spectroscope with fluorescent ocular is described by M. Soret. The method consists in placing a plate of a transparent and fluorescent substance (uranium glass, or a fluorescent liquid between two thin plates of glass) in the eye-glass of a spectroscope, at the focus of the object glass, and observing the spectrum with an ocular inclined to the axis of the eye-glass. It is specially applicable to solar light, and renders distinctly visible the spectrum from H to N, without the necessity of working in a dark chamber. It is less delicate than the photographic method, but much quicker.—M. Achard investigates the action of differential manometers with two liquids.

SOCIETIES AND ACADEMIES

London

Zoological Society, May 19.—Dr. E. Hamilton, vice-president, in the chair.—Mr. Sclater exhibited a skin of the new Japanese Stork (*Ciconia boyciana*), and read an extract from a letter recived from M. Taczanowski, relating to its occurrence in the Amoor territory.—Letters were read from Dr. W. Peters relating to the locality of *Poriodogaster grayi*, and from Dr. Hector containing a correction to his article on *Cnemiornis*, published in the Society's "Proceedings."—Prof. Newton exhibited and made remarks on two original letters, the property of Dr. J. B. Wilmot, written from Mauritius in 1628, and referring to the Dodo.—A communication was read from Mr. G. E. Dobson, containing an account of some experiments made on the respiration of certain species of Indian fresh-water fishes.—A communication was read from Mr. W. H. Hudson, containing an account of the habits of the Burrowing Owl (*Pholeoptynx cunicularia*) of the pampas of Buenos Ayres.—Two communications were read from Mr. W. C. McIntosh. The first of these was entitled "Contributions to our Knowledge of the British Annelida;" and the second contained the first portion of an account of the Annelida collected during the *Porcupine* expeditions of 1869 and 1870.—A communication was read from Dr. J. E. Gray, F.R.S., containing a list of the species of feline animals (*Felidæ*).—A second communication from Dr. Gray contained the description of a new species of Cat from Sarawak, proposed to be called *Felis badia*.—A communication was read from M. L. Taczanowski, entitled "Description d'une nouvelle espèce de *Mustela* du Pérou Central."

Geological Society, May 13.—John Evans, F.R.S., president, in the chair.—The following communications were read:—Note on some of the generic modifications of the Pleiosaurian pectoral girdle, by Harry G. Seeley, F.L.S. The restorations and interpretations of the Pleiosaurian pectoral girdle given by Conybeare, Hawkins, Owen, Huxley, Cope, and Phillips, were discussed and reasons given for dissenting from their views. The old genus *Pleiosaurus* was divided into two families, the Pleiosauridæ, containing the genus *Pleiosaurus*, and the Elasmosauridæ, with *Eretmosaurus*, *Colymbosaurus*, and *Murænosaurus*. A new type was taken for the genus *Pleiosaurus*, which showed distinct clavicles. *Eretmosaurus* has neither clavicle nor interclavicle, and the scapulæ, concave in front, are blended in the median line, and blended laterally with the coracoids. Its type is *Pleiosaurus rugosus* of the Lias. *Colymbosaurus* has for its type *Pleiosaurus megadeirus* of the Kimmeridge clay. It has no inter-clavicle, the scapulæ are prolonged forward in a wedge and backward, so as to meet the coracoids in the median line, and inclose two coraco-scapular foramina. *Murænosaurus* is founded on a new type from the Oxford clay. It has no interclavicle, but the scapulæ are prolonged forward to meet in the median line; they are not prolonged backward to meet the coracoids, hence but one coraco-scapular foramen is formed. A similar condition marks the pelvic girdle.—*Murænosaurus leedsii* Seeley, a Pleiosaurian from the Oxford clay (Part I.), by Harry G. Seeley, F.L.S. All parts of the animal, except teeth, ribs, and hind limbs, were described. The pre-maxillary bones extend bird-like between the nares to the frontals. The foramen parietale is between the parietal and frontal, and directed backward. The cerebral lobes of the brain have a chelonian form, are prolonged in olfactory nerves, like those of *Teleosaurus*, and have the optic lobes moderately developed. The exoccipital bones do not enter into the occipital condyle. The basisphenoid is perforated by the carotids, as in *Ichthyosaurus*. The hypoglossal nerve does not perforate the exoccipital bone. There are 44 cervical, 3 pectoral, 20 dorsal, 4 sacral, and the first 8 caudal vertebræ preserved.—On the remains of *Labyrinthodonta* from the Keuper Sandstone of Warwick, preserved in the Warwick Museum, by L. C. Miall. The author considered that *Labyrinthodon ventricosus* Owen is not a distinct species, and that *L. scutulatus* Owen has not been proved to be a Labyrinthodont. The species as identified by the author are as follows:—*Mastodonsaurus jægeri* Von Meyer, *M. pachygnathus* Owen, *Labyrinthodon leptognathus* Owen, *Diadetognathus* (g.n.) *varvicensis*, sp.n.

Chemical Society, April 16.—Prof. Odling, F.R.S., president, in the chair.—Dr. Corfield delivered his lecture On the sewage question from a chemical point of view. The lecturer, after remarking that he was going to consider the question of the value of chemical evidence on the sanitary view of the subject, compared the various systems for treating sewage, all of which might be reduced to two classes; the first, that of conservancy, where more or less of the solid matter was retained in the neighbourhood of habitations, and the other where the whole of the excretal matter was removed along with the foul water by means of sewers. He emphatically condemned the former as poisoning the wells in the neighbourhood and liable to give rise to disease, for it was a fact that the smallness of the death-rate at any large town was proportional to the efficiency of the means used for the removal of the sewage. He subsequently discussed the various methods of rendering sewage innocuous, showing that the only one of any value for this purpose was that of intermittent surface irrigation.

Royal Horticultural Society, May 13.—Scientific Committee. A. Grote, F.L.S., in the chair.—The Rev. M. J. Berkeley exhibited *Claviceps microcephala*, produced by the ergot of *Anthoxanthum*, which generally gave rise to *Claviceps purpurea*. The former species was rufous when fresh but purple when dry, and possibly the two species were not distinct.—Prof. Thiselton Dyer read the following extract from a letter from Dr. Thwaites to Dr. Hooker under date March 31:—"The leaf disease in our coffee is just now in abeyance in the estates I passed by on my way to Newera Eliya, but it is such a treacherous disease in the way of its appearance, and disappearance, and reappearance, that one cannot predict with any certainty what it is going or not going to do. There cannot be the least doubt that the disease at Tellicherry is the same as what our coffee estates are suffering from (*Hemileia vastatrix*)."—Col. Beddome had heard in India that the leaf disease existed in the Wynaad district (which included Tellicherry), and that it was the same as that of Ceylon.—The Rev. M. J. Berkeley reported that he had carefully examined the leaves of the diseased plants of *Daphne indica* exhibited by Mr. Smee, and that he failed to detect the presence of any organism, vegetable or animal, which could account for the diseased state of the tissues.—Prof. Thiselton Dyer read the following letter from Baron von Mueller:—"From Melbourne will be sent to you by this month's post a dried branch of *Correa lawrenciana*, with flowers as brilliantly red as any of the showiest varieties of *C. speciosa*. . . . In my recent journey to Mount Kosciusco from the west, I saw only plants of *C. lawrenciana* with red flowers, whereas on the southern brooks I saw always only the variety with the greenish flowers. Possibly the plant may prove hardy in Britain, as it ascends here to 4,000 feet." Prof. Thiselton Dyer also read the following communication from Mr. Jackson, Curator of the Kew Museum:—"The insects accompanying this were taken from a piece of a trunk of a copal tree (*Trachylobium hornemannianum* Heyne), recently received at the Kew Museum from Zanzibar through the Foreign Office. The wood was for the most part riddled through and through with insect borings, evidently the work of white ants. Mr. Frederick Smith, of the British Museum, to whom I sent some of the living insects, replied:—"The insect you have found in the copal wood is a species of white ant (*Termes*). It appears to belong to the modern genus *Eutermes*, and to be *E. lateralis* Walker. It is extremely interesting to see a living *Termes*, and it is the first time I have done so. There is a European species found in the warmer parts of France and Italy."

General Meeting.—J. A. Hardcastle in the chair.—The Rev. M. J. Berkeley commented on the effects of the late inclement weather. The crop of peas in the neighbourhood of London was practically destroyed. Messrs. Standish sent cuttings of various Japanese plants grown by them at Ascot which had escaped hitherto without injury, while many of the more commonly cultivated shrubs had suffered severely.

Philadelphia

Academy of Natural Sciences, Dec. 16, 1873.—Dr. Carson, vice-president, in the chair.—Remarks on Fossil Elephant Teeth. Prof. Leidy observed that the fossil elephant teeth, presented this evening by Mr. Richard Peters, were obtained by him in Mexico. In appearance the fossils resemble some others, obtained in New Mexico and Chihuahua, referred to in his recent work, "Contributions to the Extinct Vertebrate Fauna of the Western Territories." All appear to have pertained to the coarse-plated variety of molars referred to a species by Dr. Falconer with the name of *Elephas columbi*. Some of the specimens had been found in association with remains of the mastodon, the extinct and near relative of the elephant. The two genera were contemporaneous, and were repre-

sented by many species during the middle and later Tertiary periods, but no remains of either have yet been discovered in the early Tertiary deposits. It is probable that both are successors from a common stock which existed at a period intermediate to that in which were formed the known Eocene and Miocene deposits. The molar teeth in the two genera differ in a striking manner, and so widely, that early observers thought those of the mastodon were adapted to a carnivorous habit. That the course of evolution was from the more simple to the more complicated type would appear to be confirmed in the fact that the temporary molars have proportionately shorter crowns and longer roots than in those of the permanent series.

BOSTON, U.S.

Society of Natural History, Dec. 3, 1873.—Prof. John McCrady read a paper on the food and reproductive organs of the oyster, with an account of a new parasite. This parasite apparently destroys, for the time at least, the fertility of the oyster, and to its abundance may perhaps be due the seasons of short spawn, often noticed by those engaged in the oyster culture. The parasite seems to be a new species belonging to the genus *Bucephalus* and may be called *Bucephalus cuculus*.—Prof. Alpheus Hyatt gave a description of his investigation for the past fourteen years upon the Ammonites of the Jurassic period, showing the connection of the forms in the family Arietidæ, and tracing them all to one species, *Amm. psilonotus* of Quenstedt.—Dr. H. A. Hagen read a paper on the origin of the so-called "Tailed Man," often described and pictured by the older authors. In an attempt to copy from a number of old works the figures of this fabulous creature, it gradually became evident that these figures were copies one from another, with slight changes, by the accumulation of which a "tailed man" was gradually constructed. The origin of all these figures is a poor representation of the "Wanderoo" (*Simia silenus* Linn.), given by the old knight, Bernhard von Breydenbach, in his "Voyage to Palestine" in 1486.

VIENNA

Imperial Academy of Sciences, Feb. 5.—Prof. Linnemann made some further contributions towards a knowledge of allyl compounds and acrylic acid. He finds that this acid is completely changed, by sulphuric acid and zinc, at moderate temperature, into propionic acid; also (contrary to present views), that allyl-alcohol, especially in acid solution, takes up hydrogen, and passes into propyl-alcohol.—Prof. Puschl, in a note on specific heat of carbon, offered an explanation of this being different (in the diamond) at different temperatures. He supposes, that for its internal radiation, at ordinary temperature (from the surfaces of the atoms), the diamond is much less opaque than a metal, and that it is more opaque the higher the temperature. Hence the diamond is radiated through by obscure heat, more abundantly the lower the temperature of the source of this; in other words, its opacity for obscure heat increases with the temperature of the source. The same will hold for other kinds of carbon, with this difference, that the opacity of the transparent diamond for a particular kind of direct heat must have a maximum which is not to be looked for in untransparent carbon. He desires that physicists, who have the opportunity, would test the diamond in reference to this point.—M. Puluj gave an account of experiments to determine the constant of friction of air as function of the temperature. According to the theory of gases (with the hypothesis of molecular shocks) the constant referred to must be proportional to the absolute temperature. The author finds it proportional to the $\frac{2}{3}$ power of the absolute temperature, or $\eta = \eta_0(1 + \alpha\theta)^{\frac{2}{3}}$; which comes nearer to the law than the older determinations by Maxwell and Meyer, and argues the correctness of the hypothesis named.

Feb. 12.—Prof. Dvorák communicated a memoir on the conduction of sound in gases. He shows how the peculiar acoustical behaviour of hydrogen does not contradict theory, but may be simply explained through resonance. The *vis viva* which the same sounding body, with equal excursions in equal times, gives in different gases, is proportional to the root of the product of the density and expansive force of the gas.—Prof. Leitgeb presented a paper on the growth of *Fissidens*; it conforms to the laws of growth of other mosses.—M. Stefan communicated a memoir on the theory of magnetic forces. The first part treats on calculation of the magnetic force of electric currents; the second, the action of a magnet on an internal point; and the third, the theory of magnetic induction. It is shown, rom a series of experiments, that all kinds of iron and steel permit the same maximum of magnetisation, that the resistance of iron and nickel to magnetisation is at first very great, then decreases to a minimum, which is reached when the induced magnetic moment is a third of its maximum, and thereafter the resistance increases to an indefinite extent. From these data a formula is constructed for the magnetic molecular force.

PARIS

Academy of Sciences, May 18.—M. Bertrand in the chair. M. Chasles read a paper entitled "Questions relating to series of similar triangles subjected to three common conditions." —M. Serret presented a note accompanying the presentation of vol. vi. of Lagrange's works. The volume contained eleven memoirs on various astronomical subjects. On the magnetic bundles formed by separate laminæ, by M. Jamin.—M. Faye communicated a letter with a reply by M. E. Gautier, who maintains the old views of Galileo concerning the nature of sun-spots. —New apparatus for the transfusion of blood, proposed by M. Mathieu; a note by M. Bouley.—M. A. Ledieu presented the continuation of his thermodynamical researches entitled "General ideas on the mechanical interpretation of the physical and chemical properties of bodies."—Note on some thermometric observations during winter in the Alps, by Dr. Frankland.—On the influence of ferments on surgical maladies (second note), by M. A. Guérin.—On the combinations of arsenic with molybdic acid, by M. H. Debray.—Note on the employment of iron shot for replacing leaden shot in rinsing bottles, by M. Fordos.—On soluble starch, by M. Masculus. Starch is dissolved in acidulated boiling water, the acid neutralised, and the solution filtered and evaporated to a syruppy consistence. An abundant granular deposit is obtained, which is washed with cold water, and then with alcohol. This soluble starch gives all the reactions of natural starch, and is decomposed by diastase in the same manner, but with greater ease.—On the transmission of the irritation from one point to another in the leaves of *Drosera*, and on the part which the tracheæ appear to play in these plants, by M. M. Ziegler. The author concluded, that the tracheæ, or the fibres surrounding them, transmit the irritation from one hair to another, and that the movements of the hairs of the circumference of the leaves are not reflex movements induced by an irritation proceeding from a centre situated elsewhere than in the leaf.—On the concussion of bodies, by M. G. Darboux.—On the temperature of the sun, a note by M. J. Violle.—Studies on electric chronographs, and researches on the induction spark and on electro magnets, by M. M. Deprez.—On the motion of the air in pipes, by M. C. Bontemps.—M. F. A. Abel communicated his fourth memoir on the properties of explosive bodies.—Note on the decomposition of tungstate and of molybdate of sodium by sal-ammoniac, by M. F. Jean; these substances when boiled with solution of sal-ammoniac disengage ammonia, the liquid remaining acid.—On the constitution of clays, by M. T. Schlœsing.—On the identity of bromoxaform and of pentabrominated acetone, by M. E. Grimaux. The author's experiments show that methylic alcohol and methylic acetate are not attacked in the cold by bromine, but at 150°—170° the latter body is transformed into methylic bromide and bromacetic acids. The substance formed by the action of bromine upon the alkaline citrates is pentabrominated acetone, and the chlorinated bodies obtained by the action of chlorine on citric acid and citrates are chlorinated derivatives of acetone and not of methyl-acetic ether.—Experimental study on the influence of the injection of bile on the organism, by MM. V. Feltz and E. Ritter.—On the hind foot of the *Hyænodon parisiensis*, by M. G. Vasseur.

CONTENTS

THURSDAY, JUNE 4, 1874

SCIENTIFIC WORTHIES

III.—Charles Robert Darwin

CHARLES ROBERT DARWIN was born at Shrewsbury on Feb. 12, 1809. He is the son of Dr. Robert Waring Darwin, F.R.S., and grandson of Dr. Erasmus Darwin, F.R.S., author of the "Botanic Garden," "Zoonomia," &c.; by the mother's side he is grandson of Josiah Wedgwood, F.R.S., the celebrated manufacturer of pottery. Mr. Darwin was educated at Shrewsbury School under Dr. Butler, afterwards Bishop of Lichfield, and in the winter of 1825 went to Edinburgh University for two years. He there attended to Marine Zoology, and read before the Plinian Society at the close of 1826 two short papers, one on the movement of the ova of Flustra. From Edinburgh Mr. Darwin went to Christ's College, Cambridge, where he took his Bachelor of Arts degree in 1831. In the autumn of 1831, Capt. FitzRoy having offered to give up part of his own cabin to any naturalist who would accompany H.M.S. *Beagle* in her surveying voyage round the world, Mr. Darwin volunteered his services without salary, but on condition that he should have the entire disposal of his collections, all of which he deposited in various public institutions. The *Beagle* sailed from England Dec. 27, 1831, and returned Oct. 22, 1836.

Mr. Darwin married his cousin, Emma Wedgwood, in the beginning of 1839, and has lived since 1842 at Down, Beckenham, Kent, of which county he is a magistrate.

The Royal Society awarded to Mr. Darwin, in 1853, the Royal Medal, and in 1864 the Copley Medal. In 1859 the Geological Society awarded him the Wollaston Medal. He is an honorary member of various foreign scientific Societies, and is a Knight of the Prussian Order of Merit.

Since his return from South America in the *Beagle* Mr. Darwin's life has been comparatively uneventful, even for a scientific man; indeed, so far as the public is concerned, the main events in Mr. Darwin's career have been the publication of his works and papers, which have been far more numerous than many are aware of. We give below a list of them.

General Works

Journal of Researches into the Natural History and Geology of the countries visited by H.M.S. *Beagle*, 1845.

On the Origin of Species by means of Natural Selection, 1859.

This was preceded by a sketch, entitled "On the variation of organic beings in a state of nature;" published in the *Journal of the Linnæan Society*, vol. iii. (Zool.), 1859, p. 46.

The Variation of Plants and Animals under Domestication. 2 vols. 1868.

The Descent of Man, and Selection in relation to Sex. 2 vols. 1871.

The Expression of the Emotions in Man and Animals. 1872.

Zoological Works

The Zoology of the voyage of H.M.S. *Beagle*, edited and superintended by C. Darwin, 1840; consisting of five parts.

A monograph of the Cirripedia, Part 1, Lepadidæ; Ray Soc., 1851, pp. 400.

A monograph of the Cirripedia, Part 2, the Balanidæ; Ray Soc., 1854, pp. 684.

A monograph of the Fossil Lepadidæ; Pal. Soc., 1851, pp. 86

A monograph of the Fossil Balanidæ and Verrucidæ; Pal. Soc., 1854, pp. 44.

Observations on the Structure of the genus Sagitta; Ann. Nat. Hist., vol. xiii., 1844.

Brief descriptions of several terrestrial Phanariæ, and of some marine species; Ann. Nat. Hist., vol xiv., 1844, p. 241.

Botanical Works

On the various contrivances by which British and Foreign Orchids are fertilised, 1862.

On the Movements and Habits of Climbing Plants; Journ. Linn. Soc., vol ix., 1865 (Bot.), p. 1.—This Paper has also been published as a separate work.

On the action of Sea-water on the Germination of Seeds; Journ. Linn. Soc., vol. i., 1857 (Bot.), p. 130.

On the Agency of Bees in the Fertilisation of Papilionaceous Flowers; Ann. Nat. Hist., vol. ii., 1858, p. 459.

On the Two Forms or Dimorphic Condition of the species of Primula; Journ. Linn. Soc., vol. vi., 1862 (Bot.), p. 77.

On the Existence of Two Forms and their reciprocal Sexual Relations in the genus Linum; Journ. Linn. Soc., vol. vii., 1863 (Bot.), p. 69.

On the Sexual Relations of the Three Forms of Lythrum; Journ. Linn. Soc., vol. viii., 1864, p. 169.

On the Character and Hybrid-like nature of the illegitimate Offspring of Dimorphic and Trimorphic Plants; Journ. Linn. Soc., vol. x., 1867 (Bot.), p. 393.

On the Specific Difference between *Primula veris* and *P. vulgaris*, and on the Hybrid Nature of the common Oxslip; Journ. Linn. Soc., vol. x., 1867 (Bot.), p. 437.

Notes on the Fertilisation of Orchids; Ann. Nat. Hist., Sept. 1869.

Geological Works

The Structure and Distribution of Coral-reefs, 1842; pp. 214.

Geological Observations on Volcanic Islands, 1844; pp. 175.

Geological Observations on South America, 1846; pp. 279.

On the Connection of the Volcanic Phenomena in South America, &c.; Trans. Geol. Soc., vol. v.; read March, 1838.

On the Distribution of the Erratic Boulders in South America; Trans. Geol. Soc., vol. vi.; read April, 1841.

On the transportal of Erratic Boulders from a lower to a higher level; Journ. Geol. Soc., 1848, p. 315.

Notes on the Ancient Glaciers of Caernarvonshire; Phil. Mag., vol. xxi., 1842, p. 180.

On the Geology of the Falkland Islands; Journ. Geol. Soc., 1846, pp. 267.

On a Remarkable Bar of Sandstone off Pernambuco; Phil. Mag., Oct. 1841, p. 257.

On the Formation of Mould; Trans. Geol. Soc., vol. v., p. 505; read Nov. 1837.

On the Parallel Roads of Glen Roy; Trans. Phil. Soc., 1839, p. 39.

On the Power of Icebergs to make Grooves on a Submarine Surface; Phil. Mag., Aug. 1855.

An account of the Fine Dust which often falls on vessels in the Atlantic Ocean; Proc. Geol. Soc., 1845, p. 26.

Origin of the Saliferous Deposits of Patagonia; Journ. Geol. Soc., vol. ii., 1838, p. 127.

Part Geology; Admiralty Manual of Scientific Inquiry, 1849. Third ed., 1859.

Two British naturalists, Robert Brown and Charles Darwin, have, more than any others, impressed their influence upon Science in this nineteenth century. Unlike as these men and their works were and are, we may most readily subserve the present purpose in what we are called upon to say of the latter by briefly comparing and contrasting the two.

Robert Brown died sixteen years ago, full of years and scientific honours, and he seems to have finished, several years earlier, all the scientific work that he had undertaken. To the other, Charles Darwin, a fair number of productive years may yet remain, and are earnestly hoped for. Both enjoyed the great advantage of being all their lives long free from any exacting professional duties or cares, and so were able in the main to apply themselves to research without distraction and according to their bent. Both, at the beginning of their career, were attached to expeditions of exploration in the southern hemisphere, where they amassed rich stores of observation and materials, and probably struck out, while in the field, some of the best ideas which they subsequently developed. They worked in different fields and upon different methods; only in a single instance, so far as we know, have they handled the same topic; and in this the more penetrating insight of the younger naturalist into an interesting general problem may be appealed to in justification of a comparison which some will deem presumptuous. Be this as it may, there will probably be little dissent from the opinion that the characteristic trait common to the two is an unrivalled scientific sagacity. In this these two naturalists seem to us, each in his way, pre-eminent. There is a characteristic likeness, too—underlying much difference—in their admirable manner of dealing with facts closely, and at first hand, without the interposition of the formal laws, vague ideal conceptions, or "glittering generalities" which some philosophical naturalists make large use of.

A likeness may also be discerned in the way in which the works or contributions of predecessors and contemporaries are referred to. The brief historical summaries prefixed to many of Mr. Brown's papers are models of judicial conscientiousness. And Mr. Darwin's evident delight at discovering that someone else has "said his good things before him," or has been on the verge of uttering them, seemingly equals that of making the discovery himself. It reminds one of Goethe's insisting that his views in Morphology must have been held before him and must be somewhere on record, so obviously just and natural did they appear to him.

Considering the quiet and retired lives led by both these men, and the prominent place they are likely to occupy in the history of Science, the contrast between them as to contemporary and popular fame is very remarkable. While Mr. Brown was looked up to with the greatest reverence by all the learned botanists, he was scarcely heard of by anyone else; and out of botany he was unknown to Science except as the discoverer of the Brownian motion of minute particles, which discovery was promulgated in a privately printed pamphlet that few have ever seen. Although Mr. Darwin had been for twenty years well and widely known for his "Naturalist's Journal," his works on "Coral Islands," on "Volcanic Islands," and especially for his researches on the Barnacles, it was not till about fifteen years ago that his name became popularly famous. Ever since no scientific name has been so widely spoken. Many others have had hypotheses or systems named after them, but no one else that we know of a department of bibliography. The nature of his latest researches accounts for most of the difference, but not for all. The Origin of Species is a fascinating topic, having interests and connections with every branch of Science, natural and moral. The investigation of recondite affinities is very dry and special; its questions, processes, and results alike—although in part generally presentable in the shape of Morphology—are mainly, like the higher mathematics, unintelligible except to those who make them a subject of serious study. They are especially so when presented in Mr. Brown's manner. Perhaps no naturalist ever recorded the results of his investigations in fewer words and with greater precision than Robert Brown: certainly no one ever took more pains to state nothing beyond the precise point in question. Indeed we have sometimes fancied that he preferred to enwrap rather than to explain his meaning; to put it into such a form that, unless you follow Solomon's injunction and dig for the wisdom as for hid treasure, you may hardly apprehend it until you have found it all out for yourself, when you will have the satisfaction of perceiving that Mr. Brown not only knew all about it, but put it upon record long before. Very different from this is the way in which Mr. Darwin takes his readers into his confidence, freely displays to them the sources of his information, and the working of his mind, and even shares with them all his doubts and misgivings, while in a clear and full exposition he sets forth the reasons which have guided him to his conclusions. These you may hesitate or decline to adopt, but you feel sure that they have been presented with perfect fairness; and if you think of arguments against them you may be confident that they have all been duly considered before.

The sagacity which characterises these two naturalists is seen in their success in finding decisive instances, and their sure insight into the meaning of things. As an instance of the latter on Mr. Darwin's part, and a justification of our venture to compare him with the *facile princeps botanicorum*, we will, in conclusion, allude to the single instance in which they took the same subject in hand. In his papers on the organs and modes of fecundation in Orchideæ and Asclepiadeæ, Mr. Brown refers more than once to C. K. Sprengel's almost forgotten work, shows how the structure of the flowers in these orders largely requires the agency of insects for their fecundation, and is aware that "in Asclepiadeæ . . . the insect so readily passes from one corolla to another that it not unfrequently visits every flower of the umbel." He must also have contemplated the transport of pollen from plant to plant by wind and insects; yet we know from another source that he looked upon Sprengel's ideas as fantastic. Instead of taking the single forward step which now seems so obvious, he even hazarded the conjecture that the insect-forms of some Orchideous flowers are intended to deter rather than to attract insects. And so the explanation of

all these and other extraordinary structures, as well as of the arrangement of blossoms in general, and even the very meaning and need of sexual propagation, were left to be supplied by Mr. Darwin. The aphorism "Nature abhors a vacuum" is a characteristic specimen of the Science of the Middle Ages. The aphorism "Nature abhors close fertilisation," and the demonstration of the principle, belong to our age, and to Mr. Darwin. To have originated this, and also the principle of Natural Selection—the truthfulness and importance of which are evident the moment it is apprehended—and to have applied these principles to the system of nature in such a manner as to make, within a dozen years, a deeper impression upon natural history than has been made since Linnæus, is ample title for one man's fame.

There is no need of our giving any account or of estimating the importance of such works as the "Origin of Species by means of Natural Selection," the "Variation of Animals and Plants under Domestication," the "Descent of Man, and Selection in relation to Sex," and the "Expression of the Emotions in Man and Animals,"—a series to which we may hope other volumes may in due time be added. We would rather, if space permitted, attempt an analysis of the less known but not less masterly, subsidiary essays, upon the various arrangements for ensuring cross-fertilisation in flowers, for the climbing of plants and the like. These, as we have heard, may before long be reprinted in a volume, and supplemented by some long-pending but still unfinished investigations upon the action of Dionæa and Drosera—a capital subject for Mr. Darwin's handling.

Apropos to these papers, which furnish excellent illustrations of it, let us recognise Darwin's great service to Natural Science in bringing back to it Teleology: so that, instead of Morphology *versus* Teleology, we shall have Morphology wedded to Teleology. In many, no doubt, Evolutionary Teleology comes in such a questionable shape, as to seem shorn of all its goodness; but they will think better of it in time, when their ideas become adjusted, and they see what an impetus the new doctrines have given to investigation. They are much mistaken who suppose that Darwinism is only of speculative importance and perhaps transient interest. In its working applications it has proved to be a new power, eminently practical and fruitful.

And here, again, we are bound to note a striking contrast to Mr. Brown, greatly as we revere his memory. He did far less work than was justly to be expected from him. Mr. Darwin not only points out the road, but labours upon it indefatigably and unceasingly. A most commendable *noblesse oblige* assures us that he will go on while strength (would we could add health) remains. The vast amount of such work he has already accomplished might overtax the powers of the strongest. That it could have been done at all under constant infirm health is most wonderful.

ASA GRAY

THE AUSTRALIAN MUSEUM

THE authorities of the British Museum may congratulate themselves on their not being the only governing body which is considered to be on an antiquated and improvable foundation, which calls for a radical and speedy change. In Australia the same cry has been raised before the Parliament of the Colony, with respect to the Museum at Sydney. There the biological collection seems to be much in need of improvement, of a greater spirit of enterprise in its management, and of a more liberal view being taken by its authorities of the rapid advances which are adding day by day to the importance of the subject which it so materially assists in teaching.

We may reasonably ask, what is given as the cause of this want of energy and progressive spirit in the colonial institution? Curiously enough it is the same as that which is being urged by all scientific men in this country against our national collection, which has found its most powerful expression in the Report of the Royal Commission on Scientific Instruction and Advancement of Science, noticed by us a short time ago (NATURE, vol. ix. p. 397), namely, that it is in the hands of a body of irresponsible trustees with a distributed authority, instead of under the management of a paid superintendent, who alone is accountable for all that is done.

It is the so-called "conservative spirit" of the authorities against which so much evidence of inefficiency is becoming so prominent. Science—and Natural Science especially—has been making such rapid progress of late years, that the mechanism by which it has to be taught, the elaborate nature of which is only fully understood by those who are actual workers within its confines, has not a sufficient inherent "go" to do the work expected of it. Just as by means of manual labour it was possible to thrash the cereal products of this country with profit in former times, whilst in the present day foreign competition makes the much more speedy steam apparatus absolutely essential; so when libraries of ancient manuscripts and the beautiful artistic remains of bygone days were the subjects which formed the most important topics for the consideration of the museum government, the bodies of trustees worked very well. The task they had on hand, being stamped with the name of fine art, was rather a pleasure than a labour; and the members of the board derived a *prestige*, and other advantages, from being able to follow their wonted tastes without any feeling of incompetency, or any scruples as to the general acceptance of their decision.

The biological element in our national collection has, however, introduced a different state of things. Those who can afford, from their pecuniary advantages, to spend their time and energies in unremunerative committees, are not the class who dirty their hands with the preliminary training necessary for a zoological or a botanical education. Neither of these subjects were whipped into them at Eton or at Harrow; they were too old to begin them, except perhaps in a very amateur manner, at Oxford or at Cambridge; and consequently when they find themselves appointed to any authoritative post in after life they set to the work with the antipathy they have always felt against "stinks."

How can a body so constituted be expected to forward the progress of Natural Science? The subject is a modern one. It is in need of hard organising work being done by experienced men who take a true interest in the object to be attained. Such men must be paid, not by paltry salaries no better than that of a banker's clerk; for

how can men of ability and education be expected to present themselves as candidates for the posts, when there are so many much more remunerative ways in which they may get a larger competency?

If we look round at our public institutions we find that the machinery of those which prove themselves to be the most successful is that in which a single officer has the control, he being frequently re-elected, and responsible only to a body which criticise all his actions, and to which he refers all serious questions of finance and management. Inefficiency on the part of the officer under this arrangement allows of his replacement without difficulty, at the same time that he is continually kept up to his work by the superior governing body, who find it a much easier task to detect faults than they would to remedy them themselves.

The case of the Australian Museum is somewhat peculiar. That institution seems to be in the hands of a few collectors of the old school, who treat it as a plaything of their own, rather than a public institution, supported by public funds. They have a curator, Mr. Gerrard Krefft, of whose very high scientific position in the mother country they cannot be fully aware, or they would be more liberal to him, and give him more opportunities for the employment of his abilities. The naturalist who on seeing the curious new mud-fish from Queensland was enabled to say from a superficial examination, that it "is allied to Lepidosiren, and is Ceratodus"—a statement which Dr. Günther's superb monograph on that fish so strongly substantiates—and who has done such excellent work with regard to the Marsupialia, both recent and extinct, deserves greater opportunities than he evidently possesses under the tender mercies of amateur trustees, especially when they include among their numbers men such as a Mr. Macleay, who has thought it worth his while to refer to this journal in terms which clearly indicate either that he has never heard of it or of the Royal Commission whose recommendations we reproduced, or that he has not the least sympathy with the subjects of which it treats; the latter of which tendencies must make him quite unsuitable for the position which we regret to see he holds as one of the governing body.

The complaint of Mr. Cooper, who applied for a select committee to inquire into and report upon the condition and system of management of the museum, was that—

"As a rule a body of trustees was not the proper body to manage such institutions. Persons who were unpaid and irresponsible did not take that interest in the institution they ought to do, and would not devote their time to it. The Government found the whole of the money to pay the cost of the institution, and surely they ought to have a voice in its management. In asking for the committee, he had not the slightest desire to censure the trustees. He believed they did the best they could, but many of them could not devote the time that was necessary."

In the discussion which followed it was shown that on all occasions it is difficult to get a quorum, except on an occasion like that in which it was proposed to employ the museum-building as a ball-room during the visit of the Duke of Edinburgh to Sydney, when of the twenty members of the committee, the ten official were in favour of its employment as such, in opposition to those who sat by election.

A committee was finally appointed to consider the question of appointing a permanent officer, and if they then conclude their deliberations by placing Mr. Krefft in a position worthy of his scientific attainments, they will confer as great a benefit on zoology generally, as they will show a power of appreciating worth, independent of petty party-spirit.

RIBOT'S "ENGLISH PSYCHOLOGY"

English Psychology. Translated from the French of Th. Ribot. (Henry S. King and Co.)

SEEING that the doctrines of the English school of Experimental Psychology are "unknown, or very nearly unknown, in France," M. Ribot has certainly done a very useful work in giving to the French people an analysis of the conclusions in mental science arrived at by Hartley, James Mill, Herbert Spencer, A. Bain, G. H. Lewes, Samuel Bailey, John Stuart Mill. The most substantial objection that could be urged against such an undertaking is the difficulty of doing satisfactorily the thing attempted. In no department of knowledge claiming the name of Science is there so little settled doctrine; indeed, Mr. Lewes has just told us in his "Problems ot Life and Mind" that there is still wanting the materials for its construction as a science; nor is there in any science so little agreement among the authorities, or so great probability that honest application may be rewarded with an entire misapprehension of their meaning. The book before us is of course M. Ribot's answer to this objection; and we are bound to say that, considering the special difficulty of the task, and remembering the object he had in view, it is a very worthy and valuable performance. While there is probably not one of the writers whom he has undertaken to expound who would not object to his rendering of one or other of their opinions, all must, we think, agree in regarding M. Ribot as a highly appreciative student, and must feel grateful to him for this attempt to spread their opinions. Indeed to us M. Ribot seems rather to err in the direction of wishing to present in the most favourable light, and to make the most of, the views of each writer in turn.

Partly, perhaps, to this same amiable disposition may be referred the impression of greater agreement among the authorities given by a perusal of M. Ribot's pages than by a study of the authors themselves. Mr. Herbert Spencer is, and with all justice, placed at the head of our psychologists; and Prof. Bain is made to differ from him in no essential particular—an interpretation which we are inclined to believe would be accepted much more willingly by Prof. Bain himself, who now recognises the doctrine of inheritance, and would fain have it understood that his disagreements with Mr. Spencer on some other points "are more apparent than real," than by his less clear-sighted disciples. The account of Prof. Bain's theory of the *supposed* acquisition of voluntary power opens with a statement that here we have "the idea of progress, evolution, and development." But the instructed student in these matters must know that the growth of voluntary power that Prof. Bain would explain is not the evolution of Mr. Spencer; it is, on the contrary, a description of the manner in which, according to his imagination, each individual acquires those

powers which, according to the doctrine of evolution, they do not acquire, but inherit. For the benefit of those who would now save this theory by maintaining that it meant or means something that was never intended, we would quote the example given in illustration by M. Ribot:—"Few of our necessities are so pressing as thirst; nevertheless an animal does not distinguish at first that the water in the pond can appease it; it is only later in his wanderings that he comes to apply his tongue to the surface of the water (happy accident) and to feel the relief which it affords, and thus to learn what he ought to will." Few of the poor animals, we fear, would ever reach maturity if they had not more of instinct than Prof. Bain would here allow them. Yet what Prof. Bain has written about instinct he claims, and M. Ribot thinks "justly, as one of the most original portions of his work." Unfortunately for the fame of this celebrated psychologist, it appears from the progress of research that exactly in those departments where he has been most original have his conceptions been least in accordance with the order of Nature.

M. Ribot's most serious labour seems to have been in bringing together, in a more or less connected form, the psychology which has hitherto been scattered through the writings of Mr. George Henry Lewes. This original thinker and highly suggestive writer is the only one of our psychologists whose work may not be regarded as finished. The volume recently published ("Problems of Life and Mind") does not supply material for an estimate of the work on which he has long been engaged. But while continuing to agree with Mr. Spencer much more than any other of the authorities, Mr. Lewes encourages his readers to hope for important and permanent additions to mental philosophy; and to put the prospects of the work at the lowest, he will certainly compel the school to which he belongs to gravely reconsider some of their fundamental positions.

When in his conclusion M. Ribot attempts to bring forward the points on which the writers are agreed, the "fundamental propositions" to which he reduces them are unsatisfactory in two ways. Many of them are so vague in expression as not to exclude rival theories; while others have a sufficient amount of precision to make them flat contradictions of the clearly expressed and reiterated opinions of some of the authorities. We are, for example, not surprised to hear a disciple of Mr. Mill and Prof. Bain express his astonishment that his masters should have fathered on them the realism they have so vigorously opposed. M. Ribot's words are explicit:—"Outside of us, and independently of our perceptions, there exists a material world which condemns idealism. It is conformable to the data of the sciences to believe that this material world, taken in itself, does not resemble the perceptions of it which we have; this condemns vulgar realism." It surely says little for idealism that M. Ribot, after studying and expounding the arguments in its favour, should thus end with making our idealists agree with that very realism which Prof. Bain has described as unworthy the name of Philosophy.

After recognising the shortcomings referred to, it remains to be repeated that the author deserves the thanks of everyone interested in the spread of mental science in France. But we are unable to find any reason for the book having been translated into English. No English student ought to go to M. Ribot for the opinions of Mr. Mill or Mr. Spencer. Should any not already familiar with the topics discussed attempt to read the work, they will frequently be much perplexed by the exceeding carelessness of the translation. If they are amused to read that "*melodies* are described in pathological treatises," they may be a little puzzled to make out how "all Science is *contradicted* by the double action of analysis and synthesis," or in what sense "so long as the living being has no consciousness he leads a purely psychological life." And we would hint to any innocent young persons disposed to pin their faith to Locke, that they may be in some danger of being misunderstood should they follow the uniform usage of the translator and describe themselves as "*sensualists*."

DOUGLAS A. SPALDING

OUR BOOK SHELF

Africa: Geographical Exploration and Christian Enterprise. By A. Gruar Forbes. (London: Sampson Low and Co. 1874.)

WE can recommend this moderate-sized volume as an interesting popular *résumé* of the progress of discovery in Africa from the earliest time to the present day. The author writes mainly from the point of view of missionary enterprise, but seems to have read with diligence and intelligence the greater part of the literature of modern African travel, with which his book is mostly concerned, and has made therefrom a creditable compilation showing the progress of discovery from Bruce downwards. The first chapter gives a brief account of the topography, climate, and productions of Africa; and the accompanying pretty clear map shows the route of the leading explorers. We notice one or two signs of carelessness or haste; for example, on p. 4, Mr. Forbes states that "the most westerly point is Cabo Verde, in long. 51° 25′ E., lat. 10° 25′ N., the distance between the two points being about the same as its length." Again, at p. 115, "Sahara Desert" ought surely to be "Kalahari Desert."

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Ocean Circulation—Dr. Carpenter and Mr. Croll

IN the interests of Science, of scientific discussions, and of scientific men let me be allowed to protest very earnestly against the manner in which Dr. Carpenter has thought fit to reply in your columns to the defence which Mr. Croll made against the representation of his views, given in NATURE, vol. ix. p. 423. I take much interest in the subject under discussion—the great fundamental cause of the distribution of heat over the globe, and am most anxious to arrive at the true solution of the problem—a result, however, which will be indefinitely postponed if such letters as that of Dr. Carpenter in NATURE, vol. x. p. 62, are to become common.

Mr. Croll, discarding unimportant details, asked attention to one or two cardinal "misapprehensions" on which Dr. Carpenter had been proceeding. But the Doctor, instead of plainly grappling with these alleged "misapprehensions," runs off to call attention to a footnote of another paper of Mr. Croll's, brings forward some statement of Mr. Croll's views about the relative saltness of different portions of the ocean (about which, however, not a single word is said in the letter that has called forth Dr. Carpenter's reply), and concludes by another *argumentum ad hominem*, of which I am sure every reader of his papers must now be weary.

Now I strongly object to have dust thrown in my eyes in this way. Dr. Carpenter does not attempt to deal with any one of the cardinal and crucial arguments in Mr. Croll's letter. He raises a cloud about "averages," repeats his joke about ten children to every marriage, and with other irrelevant matter, including an introduction of the Astronomer Royal

and Prof. Mohn, suddenly disappears. Not, however, without adding a sentence which I am sure he will in the end regret. He says he has "been forced by the personal attacks in which Mr. Croll has latterly thought fit thus to indulge to retort upon him." Why, the discovery of anything "personal" in Mr. Croll's writings would be as great a find as the true theory of oceanic circulation. I do not know any papers in our contemporary scientific literature more thoroughly undeserving of such a charge. Surely a man may call in question, nay, may even take a little quiet fun out of another man's opinions or crotchets without laying himself open to the stigma of being guilty of "personal attacks." Besides, it seems to me that Dr. Carpenter's charge is inappropriate. Mr. Croll, remarking "with some reluctance" that he was "compelled to refer" to Dr. Carpenter's continual quotation of eminent physicists who had adopted his views, while none had shared in the objections to them, merely assured Dr. Carpenter that such was not the case, and made reference to one person as an illustration, but without giving the person's name. The Doctor, as everybody knows, has been profuse in his use of this kind of argument. And now the moment it is used against himself, he denounces the introduction of "personal attacks!"

I purposely avoid entering into the merits of the question. What, in common with every sincere well-wisher of Science, I desire to see, is its thorough, honest and courteous discussion. Dr. Carpenter's high position gives a weight to what he says and does, which adds much to the regret with which his letter will be perused. That this protest may be received on its own merits and without reference to the pen which holds it, I withhold my name.

F. R. S.

Proportionality of Cause and Effect

MR. HAYWARD now affects the air of an injured man, and complains of being charged with "confusing issues" which he neither "raised nor accepted." He may be convicted out of his own mouth. The following passage occurs in his last letter but one (NATURE, vol. x. p. 25):—"It should be noted that my principal 'exemplification of *unconsciously-formed preconceptions*' was of Mr. Spencer's own choosing, namely, Newton's 'Second Law of Motion.'" In his last he says:—"The object of my remarks was simply to test the truth of a definite assertion of Mr. Spencer that 'the Second Law of Motion is an immediate *corollary of the preconception* of the exact quantitative elation between cause and effect.'"

Now let the words italicised be compared. In the first passage Mr. Spencer is said to hold that the Second Law of Motion is a preconception. In the second he is represented as maintaining that it is a *corollary* from a preconception. Is not this "confusing issues"?

Mr. Hayward has the choice of two alternatives. He may admit that one of these statements is a misrepresentation of Mr. Spencer's doctrine, as was alleged. Does he refuse to do this? Then he may transfix himself on the other horn of the dilemma, and boldly assert that in his view a preconception and a corollary from a preconception are one and the same thing. But until Mr. Hayward can arrive at some agreement with himself as to the terms in which he shall state Mr. Spencer's theory, the conclusion of impartial outsiders will probably be that he is not yet in a position to pronounce authoritatively on the merits of it.

"A Senior Wrangler" is good enough to say that my letter makes him feel "something like Alice behind the looking-glass." After this amenity, one may be pardoned for stating the position which *his* mental altitude leaves. A famous metaphysician once wrote an essay to prove that the narrow discipline of mathematics produces an incapacity for general reasoning. Sir W. Hamilton would have found his *à priori* arguments confirmed if he could have read the letter of "A Senior Wrangler."

The "Senior Wrangler" quotes a sentence of mine to the effect that "the experiences these propositions record all implicate the same consciousness—the notion of proportionality between force applied and result produced; and it is out of this latent consciousness that the axiom of the perfect quantitative equivalence of the relations between cause and effect is evolved." He does not quote a previous passage in which it is said:—

"Here, as in the examples about to be given, the relation between cause and effect, though numerically indefinite, is definite in the respect that every additional increment of cause produces an additional increment of effect; and it is out of this and similar experiences that the idea of the relation of proportionality grows and becomes organic."

It might have been supposed that the doctrine so expressed was effectually guarded against misapprehension. Are not the preconceptions derived from the child's muscular experiences described as *numerically indefinite* (*i.e.* not expressible in *proportional numbers*)? Is it not said that out of them the idea of the relation of proportionality *grows?*" In the very sentence quoted by the "Senior Wrangler," is it not said that the notion of proportionality is *implicated* in the child's consciousness, and that the physical axiom comes from this *latent* consciousness? And yet the "Senior Wrangler," looking down from his mathematical heights, and catechising me as he would a schoolboy, asks me whether I know "what proportionality means"?

But for the letter of a "Senior Wrangler," one would have believed that it was made clear to everyone that the notion of proportionality generated by these early experiences was vague and general, not exact. How else should I have said that from it "the axiom of the perfect quantitative equivalence of the relations between cause and effect is *evolved?*" After thrice reading "First Principles" does not the "Senior Wrangler" know that being evolved includes passing from indefiniteness to definiteness? How then can he pretend that it is meant that the child gets from his experiences the knowledge that a double effort produces in all cases just double the result? The argument obviously implied is that this is the *finished conception* finally arrived at by the adult, as holding in those cases where causes and effects are uncomplicated.

Having but limited space, and assuming that the requisite qualifications would be made by unbiased readers, I passed over all those details of the child's experiences which would have been required in a full exposition. Of course I was aware that in the bending of a stick the visible effect does not increase in the same ratio as the force applied; and hardly needed the "Senior Wrangler" to tell me that the resistance to a body moving through a fluid increases in a higher ratio than the velocity. It was taken for granted that he, and those who think with him, would see that out of all these experiences, in some of which the causes and effects are simple, and in others of which they are complex, there grows the consciousness that the proportionality is the more distinct the simpler the antecedents and consequents. This is part of the preconception which the physicist brings with him and acts upon. Perhaps it is within the "Senior Wrangler's" knowledge of physical exploration, that when the physicist finds a result not bearing that ratio to its assigned cause which the two were ascertained in other cases to have, he immediately assumes the presence of some perturbing cause or causes, which modify the ratio. There is, in fact, no physical determination made by any experimenter which does not assume, as an *à priori* necessity, that there cannot be a deviation from proportion without the presence of such additional cause.

Returning to the general issue, perhaps the "Senior Wrangler" will pay some respect to the judgment of one who was a Senior Wrangler too, and a great deal more—who was distinguished not only as a mathematician but as an astronomer, a physicist, and also as an inquirer into the methods of Science: I mean Sir John Herschel. In his "Discourse on the Study of Natural Philosophy," he says:—

"When we would lay down general rules for finding and facilitating our search, among a great mass of assembled facts, for their common cause, we must have regard to the characters of that relation which we intend by cause and effect."

Of these "characters" he sets down the third and fourth in the following terms:—

"Increase or diminution of the effect, with the increased or diminished intensity of the cause, in cases which admit of increase and diminution."

"Proportionality of the effect to its cause in all cases of *direct unimpeded* action."

Observe that, in Sir J. Herschel's view, these are "characters" of the relation of cause and effect to be accepted as "general rules for *guiding* and facilitating our search" among physical phenomena—truths that must be taken for granted *before* the search, not truths derived *from* the search. Clearly, the "proportionality of the effect to its cause in all cases of direct and unimpeded action" is here taken as *à priori*. Sir J. Herschel would, therefore, have asserted, with Mr. Spencer, that the Second Law of Motion is *à priori;* since this is one of the cases of the "proportionality of the effect to its cause."

And now let the "Senior Wrangler" do what Sir J. Herschel

has not done or thought of doing—*prove* the proportionality of cause and effect. Neither he, nor any other of Mr. Spencer's opponents, has made the smallest attempt to deal with this main issue. Mr. Spencer alleges that this cognition of proportionality is *à priori*: not in the old sense, but in the sense that it grows out of experiences that precede reasoning. His opponents, following Prof. Tait in the assertion that Physics is a purely experimental science, containing, therefore, no *à priori* truths, affirm that this cognition is *à posteriori*—a product of conscious induction. Let us hear what are the experiments. It is required to establish the truth that there is proportionality between causes and effects, *by a process which nowhere assumes* that if one unit of force produces a certain unit of effect, two units of such force will produce two units of such effect. Until the "Senior Wrangler" has done this he has left Mr. Spencer's position untouched.

Bayswater, May 20 JAMES COLLIER

The Great Ice-Age

IN reply to Mr. Belt's letter (p. 62), I did little more than express an adverse opinion to his theory, because to discuss it would have required an essay. I expressed this because I notice that unless something like a demurrer is entered against a new theory it is apt to be taken for granted in subsequent text-books and papers written by those who have had no opportunities of obtaining a practical knowledge of the subject. For the above reason I must answer his strictures very briefly.

(1) I fail to see why the Scandinavian sea-beaches are irrelevant. (2) I have more than once read Mr. Tiddeman's paper, and without committing myself to all its conclusions, think I may quote it as assuming that the Lake district (as distinguished from North Lancashire) was the centre of a great ice-sheet; not that it was over-ridden by ice coming from somewhere further north. The same might be expected to be the case with the Welsh mountains; and Mr. W. Kingsley has brought forward good evidence of the existence of an ice-sheet there also. (3) Mr. Belt appears to forget that shells have been found not only at Moel Tryfaen, but also near Llyn Ffynnon-y-gwas, about two miles west of the peaks of Snowdon. Does Mr. Belt mean to say that Snowdon could not protect itself in the heart of its own domain better than this? If the Lake mountains had an ice-sheet, surely Snowdonia? Mr. Belt asks for evidence of the shore of the glacial sea. I reply that to me these and the Moel Tryfaen beds, not to mention others, appear to be far more probably littoral deposits than transported. For example, I think it in the highest degree improbable that the Vale Royal shells (Lyell, "Antiquity of Man," p. 317) could be brought to their present position (more than 1,100 feet above the sea) by any ice-sheet without the cold being enough to cover *all* the higher ground in Britain with ice, and so protect it. I did not deny a glacier might push a stone before it up-hill; my contention was that the enormous force which would be exerted on beds scooped out as described, and shoved some 1,500 feet up-hill for miles over broken ground, would crush the shells to a far more comminuted state than they are now in. With regard to Holderness, Mr. Croll's view of the shells there appears to me to be at present only a *theory* of which Mr. Searles V. Wood, jun., has effectually disposed (Geol. Mag. 1872). I grant there are some difficulties in the submergence theory; my position is that those in Mr. Belt's are very much greater.

A recent perusal of Mr. J. Geikie's suggestive book, the "Great Ice Age," has brought before my mind more strongly than ever a dilemma, which, as it appears to me, the modern school of Glacialists cannot escape.

He speaks of the till as a *grund moräne* or *moraine profonde* formed between the glacier and the rock, while he attributes the majority of rock-basins to the action of the glaciers. Now it appears to me that if the glaciers could pass over considerable deposits of this *moraine profonde* without sweeping it clean away, then their action as erosive agents must have been comparatively feeble; or, if they could scoop out great rock basins like the Alpine and (buried) Highland lakes, then they would have peeled off almost all the till from the land. As it appears to me, the analogy with a river, by means of which Mr. J. Geikie (p. 88) seeks to escape from a portion of this difficulty, does not hold. When a river begins to deposit sand and gravel largely, its work as an erosive agent at that place is almost over. Besides we cannot conceive a nearly solid mass, like a huge glacier, changing its motion so rapidly as a stream of water. Difficult as it undoubtedly is to explain some of the lake-basins, it appears to me that the great bulk of his evidence, with regard to till and other deposits over which ice-streams have passed, shows how slight under ordinary circumstances is their erosive power; and this has been confirmed by every journey that I have made among the Alps. I may add also that from study of the same regions my faith in a *moraine profonde* is much shaken. I believe that, except possibly as a very local and exceptional phenomenon, it exists solely in the imagination of the eminent geologists of whom Mr. Geikie is a disciple. T. G. BONNEY

St. John's College, Cambridge, May 26

Photographic Irradiation

IN the paper referred to by Prof. Forbes (NATURE, vol. x. p. 29) what is ordinarily called Photographic Irradiation was attempted to be explained by us, not as being caused by reflections from the back of the plate, but as being due to the sum of all the optical imperfections of the instrument with which the photograph is taken.

If Mr. Stillman (p. 63) will refer to our original paper, published in the *Monthly Notices* for June 1872, he will find that only the cloudy indefinite haze which surrounds the image of a luminous object, and which has frequently been called halation, was referred by us to reflection from the back of the plate.

When an over-exposed photograph is taken upon an opaque plate a marked fringe of irradiation still remains, and experiments were instituted by us which appeared to show that this is not to be accounted for by any circulation taking place within the thickness of the collodion or by the chromatic dispersion of the lenses; but when the oblique pencils from the edges of the lenses were stopped out the irradiation fringe was found to be greatly decreased. We were led to conclude that irradiation is to be accounted for by the fact that each luminous point in the object is not accurately represented by a luminous point in the image, but rather by a luminous patch of sensible area, the central and more intense portion of which prints itself first in the photograph, giving comparatively sharp picture prints when the exposure is short; but as the picture is still further exposed, the outer portions of the luminous patches imprint themselves, and by their overlapping cause the blurred appearance to which has been given the name of irradiation. LINDSAY

A. COWPER RANYARD

Uncompensated Chronometers and Photographic Irradiation

WITH regard to the employment of uncompensated chronometers (NATURE, vol. x. p. 63), I have every reason to believe that the Russians alone have tested them. For some reason which is not easily discovered, the employment of a negatively compensated chronometer has not given any very remarkable results. The Russians have employed simply an uncompensated chronometer; and have obtained very remarkable results as mentioned in my article on the Transit of Venus to which Prof. Everett has alluded.

With regard to the prevention of photographic irradiation, of course various means have been employed for dry plates; but I believe that Lord Lindsay and Mr. Ranyard were the first to experiment on the matter exhaustively. I believe Mr. Stillman would be interested in reading their paper in the *Monthly Notices*. At the same time all honour is due to the photographers named by him for their experiments.

Birkenhead, June 1 GEORGE FORBES

The Seal Fishery

CAPT. DAVID GRAY, of the steamship *Eclipse*, has done good service to the cause of humanity in writing, and Mr. Buckland in publishing, the letter on the seal fishery which appears in *Land and Water* for May 9. The fearful cruelties perpetrated year after year, and the enormous waste of life entailed by the reckless manner in which the seal fishery is prosecuted, are well known, but no steps have hitherto been taken to regulate a trade which, if carried on within proper bounds, would continue to yield great profits, but if still pursued with such utter disregard to consequences must soon end in the extermination of the whole race. As an instance of the wastefulness of the mode of proceeding, Capt. Gray says that five ships attacking a pack of seals, in four days killed about 10,000 old seals; "add 20 per cent. for seals mortally wounded and lost, gives an aggregate of 12,000 old ones; add 12,000 young which died of starvation, gives 24,000; but this is not all. The men spread on the ice, so that the old ones that were left alive could not get on to suckle their young. The consequence was that the whole of the young

brood was destroyed, and had these seals been left alone for *eight or ten days*, I am quite within the mark when I say that, instead of only taking 300 tons of oil out of them, 1,500 could as easily have been got, and that without touching an old one." In one day by the men of the five ships upwards of 4,000 old seals were taken, "the young ones in thousands yelling for their mothers, following the skins as the men dragged them to the ships, and sucking the crangs, *i.e.* skins, in desperation." The maternal love for its offspring was made use of to save the men trouble, as a seal killed when giving suck was more easily secured, and often seals desperately wounded were seen administering nourishment to their young ones. The plight of the young ones which had lost their mothers was pitiful in the extreme; they were seen huddling together for heat, "and trying to suck one another," till they at length succumbed. Capt. Gray exclaims, "surely there is influence enough left in Great Britain to prevent a continuation of such barbarity. I overheard some of my men saying to one another, 'It is a shame this sort of work;' and so it is. It is a shame that any civilised Government should allow its subjects to perpetrate such cruelty when it could so easily be prevented. The remedy is simply, *let the ships be kept from sailing before March* 25; ships now sail from Feb. 25 to March 1. This would give a fortnight to make the passage, and find the seals in; by that time the young would be beginning to be worth taking, and a fearful waste of life put a stop to that now annually occurs." The accounts of the cruelties practiced in sealing are sickening in the extreme, the only thing considered being how to deprive as great a number of their skin and blubber in as short a time as possible. Mr. Brown (Proc. Zool. Soc., 1868) remarks: "Seals are very tenacious of life, and difficult to kill, unless by a bullet through the brain or heart. They are so quickly *flensed* (the operation of removing the blubber and skin) that after having been deprived of their skin they have been seen to strike out in the water; so that the sympathies of the rough hunters have been so excited that they will pierce the heart several times with their knives before throwing away the carcass." These movements Mr. Brown attributes to reflex action, but considering the haste of the operation, and the seal's known tenacity of life, it is quite as likely that it was merely a stunned and not a dead animal thus deprived of its skin and blubber. It is terrible to dwell thus upon the horrors of this cruel trade, which make even the hardened participators sicken and relent, but it is necessary that it should be done, in order, if possible, to reach the hearts of Englishmen, and enlist their sympathies. If these beautiful and harmless creatures must be sacrificed for our requirements, it is a duty incumbent upon us to see that their destruction is carried out mercifully, and with the infliction of as little suffering and waste of life as possible.

In a commercial point of view the reasons for exercising some supervision over the seal fishery are as strong as those dictated by mere humanity. The revenue produced by this branch of industry is considerable. Mr. Brown estimates the annual value of the Greenland fishery alone at 116,000*l*. (Proc. Zool. Soc., 1868, p. 439), and ominously adds: "Supposing the sealing prosecuted with the same vigour as at present, I have little hesitation in stating my opinion that, before thirty years shall have passed away, the 'seal fishery' as a source of commercial revenue will have come to a close, and the progeny of the immense number of seals now swimming about in the Greenland waters, will number comparatively few." We cannot plead want of warning, for we have numerous instances of marine animals which have been exterminated by untimely slaughter (See Prof. Newton's "Extermination of Marine Mammalia," NATURE, vol. ix. p. 112). Steller's Mantee survived its discovery only about twenty-seven years; the Atlantic Right Whale, which formerly gave employment to a great number of hardy fishermen in the Bay of Biscay and English Channel, is probably exterminated; the Northern Right Whales are gradually driven farther and farther north, and the risk of following them is becoming proportionately greater; the same may be said of the walrus. The northern fur-seal was rapidly passing away, and but for the timely intervention of the Russian and American Governments would probably have been lost; and from our antipodes comes an appeal repeating all the cruelties and waste of life to which our northern seals are subjected, and pleading for protection on behalf of the southern fur-seals (W. A. Scott, "Mammalia, Recent and Extinct," Sydney, 1873).

The question arises, how is this wanton destruction to be stopped and the fishery to be placed on a sounder footing? In order that it may be done effectually, the regulations must, without doubt, be "international;" and no time should be lost in carrying them into effect. The British Association has rendered good service in obtaining an Act to protect sea-birds during their breeding-time, and if, assisted by men of practical experience such as Capt. Gray, they were to urge upon the Government some course of action, they would be supported by all the scientific bodies and leading naturalists in the kingdom.

Norwich, May 12. THOS. SOUTHWELL

THE COMING TRANSIT OF VENUS *

VII.

IN our last article the preparations of Britain, Germany and Russia were enumerated; those of the French, Americans, Dutch, and Italians must now be spoken of.

V. The French will occupy the following stations:—Yokohama, Pekin, New Amsterdam or St. Paul's, and Campbell Island; all equipped as first-class stations, besides Tientsin, Sagou, Numea, and probably Nukahiva in the Marquesas, as secondary stations. Yokohama and St. Paul's will make an excellent combination for the method of durations; at Campbell Island also the durations will be considerably lessened. But the longitude of these places will be determined, so that if only one contact be observed, De l'Isle's method will be applied. MM. Wolf and André have made a series of experiments on the formation of the "black drop;" numerous trials have also been made with a view of employing the photographic method as successfully as possible, and it is possible that spectroscopic observations of external contact will be made. The preparations are by no means so far advanced as might have been wished. This is partly due to the disturbed state in which the country has been since the late war.

We are glad to be able to state that the French will employ the daguerreotype process of photography. This method has many advantages, and it is much to be regretted that no experiments have been made by other nations to test its applicability. Photographs taken by this process are well known to be much more delicate and give clearer details than any others, while photographic irradiation is reduced to a minimum. It is even possible to correct for curvature of field by employing prepared plates whose surfaces are portions of spheres, a thing which would be impossible by any other process. There can be no shrinking of the film. The only objection is, that we cannot print copies from the plates conveniently. But it is not likely that we should trust to measurements of a printed copy even from a glass negative. The French are relying mainly upon the photographic method, and have chosen their stations for determining thus directly the least distance between the centre of the sun and Venus. With the apparatus proposed by MM. Wolf and Martin, the size of the sun's image will be 60 millimetres; they hope to determine the instants of internal contact with a probable error of one second of time. The commission into whose hands the business has been entrusted has drawn up a detailed report containing contributions not only from the astronomers of France, but also from the most celebrated physicists and experimentalists: 300,000 fr. has been voted for the enterprise. M. Tisserand of the Toulouse Observatory will aid in the actual observations; and M. Jannsen will proceed to Yokohama.

M. Dumas takes the lead in the preparations. In a letter dated May 12, he says tha the expeditions are on the point of starting, and that the Marquesas probably, and Numea certainly, will be occupied for De l'Isle's method.

VI.—The Americans have a grant of 150,000 dols. They have paid great attention to the application of photography with the assistance of Mr. Rutherford, whose success in photographing the moon is so well known,

* Continued from p. 69.

They employ a lens of 40 ft. focus, as already described. They will measure both angles of position and distances from the centre, and the probable error of any measurement will be less than 1-100 per cent. They have encountered some trouble in the manufacture of their siderostats. Besides photography eye-observations of contact will also be made. A very able report has been drawn up from the computations of Mr. Hill, who deserves great credit for the manner in which he has completed it. This report has reference to the choice of stations; and is accompanied by very valuable charts. Other reports have been made upon the application of photography.

The expeditions are to be composed of five persons each. The stations of observation and the heads of parties are as follows:—Wladivostock, Siberia, Prof. A. Hall, U.S.N.; Nagasaki, Japan, Mr. G. Davidson, U.S. Coast Survey; Peking, China, Prof. James C. Watson; Crozet's Island, South Indian Ocean, Capt. Raymond, U.S A.; Kerguelen's Island, South Indian Ocean, Lieut.-Commander George P. Ryan, U.S.N.; Hobart Town, Tasmania, Prof. W. N. Harkness, U.S.N.; New Zealand, Prof. C. H. Peters; and Chatham Island, South Pacific, Mr. Edwin Smith, U.S. Coast Survey.

The whole organisation has been entrusted to a commission, the secretary of which is Prof. Newcomb, who has done so much valuable work for astronomy; he has taken great pains to insure success for the expedition, and has visited Europe to discuss the preparations necessary and to examine the instruments to be employed.

VII.—The Italians have arranged to send out three expeditions furnished with spectroscopes for the observation of external contact. Little is known about these expeditions.

VIII.—The Dutch are sending one expedition to the island of Bourbon or Réunion. It will be furnished with a photo-heliograph, which Dr. Kaiser will manipulate; Dr. Oudemans will also make observations with a heliometer.

Having now completed our description of the details, and having also given an account, so far as possible, of the preparations of the various nations for the observations, we shall cast a general view over the whole subject, and recapitulate some of the principal details.

The coming transit of Venus will be observed from about 75 stations, at many of which there will be a large number of instruments. The expense of the whole of the expeditions will amount to between 150,000*l.* and 200,000*l.* It may seem to some that the results to be arrived at are not worth so great an outlay, but the general voice of the non-scientific as well as of the scientific world has contradicted this. Wherever knowledge can be gained it is worth being gained; and when individuals are unable to bear the cost, it is fitting that the expenses should be incurred by those governments that are really the gainers from many scientific researches for which the investigator himself frequently receives no reward. But apart from this, these expeditions will lead to most valuable results. The sun's distance being known, the Lunar Theory may be vastly improved, and it will be possible to determine longitudes with much greater accuracy than at present. Still more will the tables of Venus be capable of re-adjustment. Even now we can calculate her place with great accuracy, and this is fortunate, since it enables us to predict the exact time at which Venus will first come in contact with the sun, viz. 1874, Dec. 8d. 14h. 4m. The error to which this is liable, owing to the tables, is not likely to exceed five minutes. Mr. W. H. M. Christie, chief assistant of the Royal Observatory, has determined the probable error in the calculated time of contact arising from this cause.* He has employed observations of Venus taken at this node at the following dates:—1872, June 28; 1873, Jan. 18; 1873, Sept. 14; he has thence deduced the error in the tabular position of Venus, and from this the error in the time of contact in the coming transit. It appears from each of these three comparisons that the tables of Venus give us the time of contact too early; according as we adopt the first, second, or third of the above observations, the error will be 7·4m., 5·3m., or 4·2m.

* Monthly Notices of the R. A. S. xxxiv. 300.

Besides the astronomical advantages to be gained from the coming transit, there are several collateral issues of no small importance. In the first place, the longitudes of a host of stations all over the globe will be accurately determined, and it is a remark by no means unworthy of notice that the simple observation of the local time of contact will give the inhabitants of east Africa and of all Asia an accurate means of determining their absolute longitudes. If, moreover, as has been proposed, San Francisco and Japan are to be compared directly as to longitude, the whole circuit of the globe will be completed by telegraphic and accurate chronometric determinations.

Again, with the host of vessels by which scientific men will proceed to their stations, meteorological, and sometimes even magnetical, instruments will be provided. These vessels will be traversing the different oceans of the globe about the same time, and thus the meteorology of the world will be much better understood. Many observers will be enabled to take note of interesting phenomena, such as hurricanes, volcanoes, and earthquakes. In addition, naturalists will be appointed to accompany some of the expeditions; birds and marine animals will be probably very generally collected; the Royal Society has given funds to aid in this matter. The Rev. A. E. Eaton, who has made valuable collections at Spitzbergen, will examine the marine life of Kerguelen's Island. Rodriguez is particularly interesting from a naturalist's point of view; it is one of the few islands in mid-ocean which have not been raised by volcanic agency. The remains of some extinct birds have been found there. The Royal Society has appointed a geologist, a botanist, and a naturalist to go to this island. There is little doubt that Science in general will gain greatly by these expeditions.

As to the main observation we can have no doubt from the large number of expeditions, and from the multiplicity of methods to be employed, that we shall obtain excellent results, although the actual reduction of the observations will be exceedingly laborious. Each nation, while it generally adopts some special method for its choice of stations, will also utilise other methods. We have seen that the English, while they rely chiefly on De l'Isle's method, will employ all the others except the heliometric, while the Germans depend mainly upon the heliometric method. The French and Americans have chosen their stations with reference to photography. The Russians are to compare observations of all kinds with different nations. These countries have all co-operated in the most harmonious manner, partly by correspondence, and partly by the personal visits of astronomers to different nations.

Although the observations are to be made at the end of the present year, the actual reduction of the observations will take so long that we cannot hope for the complete and final results as to our distance from the sun before the year 1876. At each of the British stations the observers will remain at least three months to determine their longitudes.

Here we may leave the subject. The preparations are for the most part completed; many of the observers of different nations are on their way to their various posts. It says a great deal for the civilisation of the world that on December 8 of the present year those quarters of the globe will be thickly studded with emissaries from so many nations to observe an important astronomical phenomenon.

It will be well to conclude this series of articles with a statement of the arrangements which have been made as to observers on the British expeditions. It is extracted from instructions published under authority:—

Appointments of Observers to the several Districts of Observation, and Subordination of Observers

1. Capt. G. L. Tupman, R.M.A., is head of the entire enterprise, and is responsible through the Astronomer Royal to the Government for every part. Every observer is responsible to Capt. Tupman.

2. When the different expeditions are separated, the observers in each district of observation are responsible to the local chief of the district, and the chief to the Astronomer Royal. The districts of observation and the observers will be the following, the name first following that of the local chief being that of the deputy, who will, if necessary, take his place :—

3. District A. Egypt : Chief, Capt. C. O. Browne, R.A., astronomer ; Observers, Capt. W. de W. Abney, R.E., astronomer and photographer ; S. Hunter, astronomer.

4. District B. Sandwich Islands : General Chief, Capt. G. L. Tupman, R.M.A. : Deputy, if necessary, Prof. G. Forbes.

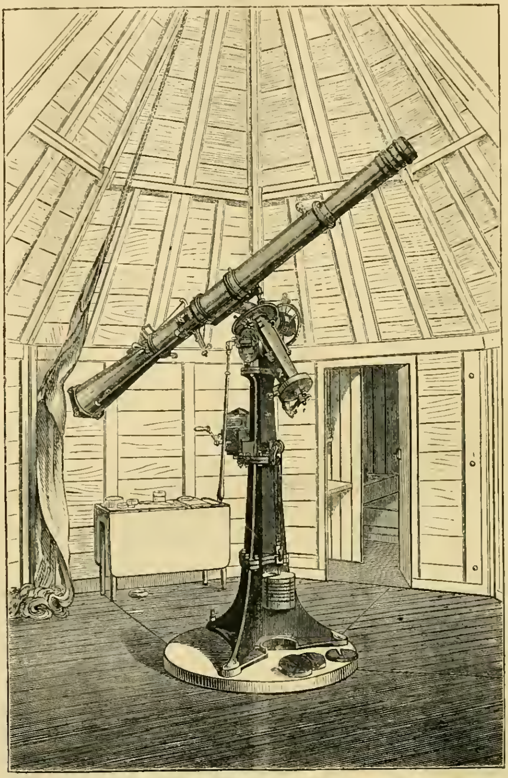


FIG. 19.—Photo-heliograph of the British Expeditions.

Sub-divisions of the Sandwich Islands :—Honolulu : Chief, Capt. G. L. Tupman, astronomer ; Observers, J. W. Nichol, astronomer and photographer ; Lieut. F. E. Ramsden, R.N., astronomer and photographer. Hawaii : Chief, Prof. G. Forbes, astronomer ; Observer, H. G. Barnacle, astronomer. Kauai : Chief, R. Johnson, astronomer ; Observer, Lieut. E. J. W. Noble, R.M.A., astronomer.

5. District C. Rodriguez : Chief, Lieut. C. B. Neate, R.N., astronomer ; Observers, C. E. Burton, astronomer and photographer ; Lieut. R. Hoggan, R.N., astronomer and photographer.

6. District D. Christchurch (New Zealand) : Chief, Major H. Palmer, R.E. ; Observers, Lieut. L. Darwin, R.E., astronomer and photographer ; Lieut. H. Crawford, R.N., astronomer.

7. District E. Kerguelen Island : General Chief, Rev. S. J. Perry ; Deputy, if necessary, Lieut. C. Corbet, R.N.

Sub-divisions of the Kerguelen Island :—Christmas Harbour : Chief, Rev. S. J. Perry, astronomer and photographer ; Observers, Revs. W. Sidgreaves, astronomer ; Lieut. S. Goodridge, R.N., astronomer ; J. B. Smith, astronomer and photographer. Port Palliser : Chief, Lieut. C. Corbet, R.N. ; Observer, Lieut. G. E. Coke, R.N.

8. In addition to these gentlemen, three non-commissioned officers or privates of the corps of Royal Engineers will be attached to each of the five districts, and will be under the direction of the chief of each district.

GEORGE FORBES

*ATOMS AND MOLECULES SPECTROSCOPICALLY CONSIDERED**

II.

I now pass on to another part of my subject.

7. *When low temperatures are employed it is generally acknowledged that there is an important difference in kind between the spectra of metals and those of metalloids, taken as a whole.*†

Spectroscopically it is more easy to define the difference between these two great classes of metals than the chemists among you would imagine. I will ask you to take the spectrum of the third class of stars as being as good a representation of the spectrum of a metalloid as anything I can place before you. It is rhythmic, the other two are not. It is a "channelled space" spectrum.* That defines a metalloid spectrum; and a similar spectrum in the case of hydrogen is referred by Angström, Stewart, Schuster, and others to an impurity. I have before referred to temperature and told you that the temperature of a Bunsen burner is enough to set an atom of sodium free from its combination with chlorine and make its vapour give us a bright line. I have told you we cannot do this in the case of iron and other substances. We may say then that we have there a first stage of temperature. Many monad metals give us their line spectra at a low degree of heat. Take some dyad metals such as zinc and cadmium; this first stage of temperature will only make them red or white hot, a much higher temperature is required to drive them into vapour. We get the line spectrum from sodium; do

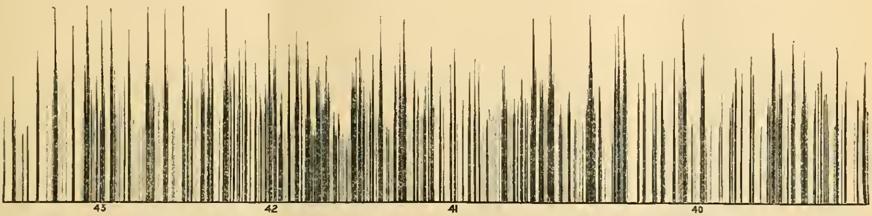


FIG. 3.—Copy of a photograph of the long and short lines of iron between wave-lengths 4,000 and 4,300.

we get that from cadmium when we have melted cadmium? We do not. That is an excessively important point. The first stage of temperature, which gives you a line spectrum in the case of sodium, is powerless to give you such a spectrum in the case of cadmium.

A second stage of heat at least is therefore required to get a line spectrum. If I take sulphur, dealing with it by means of absorption, and heat it, I get a continuous spectrum at the first stage. I increase the heat to the second stage, what do I get then? A line spectrum, as I do in the case of sodium? No! A spectrum like that of the star in the constellation Hercules, not a line spectrum at all. I apply still a higher, a third, stage of temperature and then I get a line spectrum. In the case of the metalloids we have thus three stages of heat with three spectra. If there is such a thing as a particle at all, are we not justified in asking whether there is not some difference between the "particular" arrangements of the metalloids, from those of the metals? and some connection between temperature and the "atomic weights" of the chemist?

Before I go further I will throw these results into a tabular form, which will show you that through these various heat stages in the case of metals like sodium there is a great preponderance of line spectrum, and in the case of metalloids like sulphur there is a great preponderance of channelled space spectrum.‡

	Na.	Cd.	S
Fifth stage—spark	line spectrum	line	line
Fourth stage—arc	line	line	channelled space
Third stage—white heat	lioe	(?)	channelled space
Second stage—bright red heat	lioe	¶continuous absorption in the blue	channelled space
First stage of heat—dull red heat	line	continuous spectrum	continuous absorption in the blue

8. I next state that *A compound particle—that is a particle consisting of two distinct elements—has a vibration which is as peculiar to itself as the vibration of a particle of an element is peculiar to itself.* Thus the salts of strontium have each a distinct spectrum. Take the particle of N_2O_4. The absorption spectrum of this gas you now see on the screen. This particle has a vibration quite of its own. Now it is a gas which it is perfectly easy to dissociate. It is easy to turn it from N_2O_4 to NO_2. We introduce a new spectrum. These facts—and they might easily be multiplied—show then that a compound particle is a perfectly distinct physical thing, with vibrations, rotations, and free paths of its own. There is no apparent connection between the vibrations of a compound particle and those of any of the substances which make up that compound particle.

9. I now come to another important point: *On the whole certain kinds of particles affect certain parts of the spectrum.* Take the bright lines of the metals; if you were to mix together all the known metals in the sun, make a compound which should consist of all of them, put it into the lower pole of an electric lamp and photograph the spectrum, then you would find the majority of the lines would be in the violet end of the spectrum, scarcely any in the red end. That is the reason why the spectrum of the sun, which contains so many of the metals, is so complicated in the violet. If you combine a metal and a metalloid, you will find, in many cases at all events, that the vibrations will lie in the red end of the spectrum; you will also find that there is a connection between the atomic weight of the metalloids and the region of the spectrum in which their lines appear under similar conditions.

You have, in fact, simple particles and short waves, compound particles and long waves. Nor is this all. In many cases we find both ends of the spectrum, and in many cases the more refrangible end only, blocked by continuous absorption. This occurs so often in absorption spectra that one is led to suspect that it is due to some arrangement of particles.

10. Here is another proposition: *In the case of metalloids, and compound gases containing them, the spectrum to a large extent depends upon the thickness of the vapour through which the light passes, and often, if not invariably, the absorption increases towards the red end as the thickness is increased.*

Here is one of the points of the most extreme theoretical importance, and one about which least is known. There is a statement in Prof. Maxwell's book, that if you take a metallic vapour and employ a great thickness of it, you will get from it the same spectrum as you would from a small thickness of great density. This is Prof. Maxwell statement; I venture to think that this is somewhat doubtful, for in questions of thickness the spectroscope can offer the physicist a million of miles or a millimetre to work with, and one would think that such a difference should be enough. If I had a tube with a bore of the size of the lead in this pencil, and had some hydro-

* Continued from p. 7.

† Since this lecture was delivered Prof. Roscoe has established the existence of new spectra of sodium and potassium closely resembling the well-known ones of the metalloids.

‡ Since this lecture was delivered I have carried this branch of the research much further, and it seems one well deserving of the attention of physicists and chemists, as when it comes to be acknowledged that different classes of spectra do truly represent different "particular" aggregations, the contrast between the extremes of metals and metalloids will be beyond question. The result marked thus ¶ I have added from later work.—J. N. L.

* By an oversight last week the illustration here referred to was inserted instead of the present one.—J. N. L.

gen gas rendered incandescent, you would see a line of a certain thickness, with a certain pressure. Looking through the sun's coronal atmosphere in an eclipse, you pierce seven or eight hundred thousand miles of hydrogen gas. The thickness of the lines is the same. Various thicknesses of sodium vapour do not alter the thickness of the lines. But if we pass from metals to the metalloids, then certainly one is prepared to go on with the professor to any extent. I can show you how true his statement is photographically. There is considerable interest attached to the question whether there is or is not any chlorine in the sun's outer atmosphere. I have endeavoured to settle this question, contrasting the absorption chlorine spectrum with the solar spectrum; different thicknesses of chlorine have been employed. It seems that, if we take the metalloids, the absorption of a small thickness often takes place in the violet portion of the spectrum

Now can these results be harmonised? Here I acknowledge we tread on very difficult ground, and with our present knowledge it would be perhaps best to say nothing; but I am not sure that this would not be scientific cowardice, so I will ask, under all reserve, whether the following explanation may not be a probable one? With metallic vapours the lines, though not widened as they are widened by great density, are certainly darkened, but all the lines are not visible—only the longest, generally. Now if we assume that the channelled space spectrum of the metalloids is really, even where it appears continuous, built up of lines,* then the darkening of these lines by greater thickness will not only make those darker that we see with a small thickness but bring others into visibility; and if this goes on till we have a very great thickness we may have an immense difference in the appearance of the spectrum.

11. *Some of the vibrations are very closely connected with others, as evidenced by repetitions of similar groups of lines in different parts of the spectrum.*

Here we are brought face to face with a revelation of the vibrations of particles, which, if I am not mistaken, will be made much of by the mathematical physicist in the future.

I will content myself by giving two or three striking instances, first noticed by Mascart. You will see that the longest line is at work in all of these.

In sodium we may say that the longest line is double; I refer to D' and D". All the lines are double.

In magnesium the longest line is a triple combination. This is repeated exactly in the violet.

In manganese we may almost say that the same thing happens, but the phenomenon is much more absolute in the case of those particles such as sodium and magnesium, which, on other grounds, I suspect to be of the simplest structure.

12. *Our knowledge of the vibrations of particles will be incomplete until the vibration is known from the extreme violet (invisible) to the extreme red (invisible).* In the meantime great help may be got from inferences, and, in the case of metalloids at low temperatures, from the position of their continuous absorption; and it is a question whether light may not be thus thrown upon the opacity of some solid substances and the transparency of others.

I think it not too much to say already, that in the case of some gases and vapours which are apparently transparent it is as certain in some cases that their absorption is in the ultra red, as it is certain that in the case of others the absorption is in the ultra violet. And further it is probable that this absorption is of the continuous or channelled space kind—in other words that no gas is "atomic" in the chemist's sense.

13. *From the fact that we have lines in the spectra of compound gases, it would be hazardous to affirm that the aggregate, which, with the highest dissociating power we can employ, gives us line spectra, could not be broken up if a still higher dissociating power could be employed.*

This proposition has a bearing on the celestial rather than on the terrestrial side of the inquiry, and as my time is drawing to a close I will refrain from enlarging upon it.

There is another branch of the research I am anxious to bring to your notice. I can do this better by experiment than by a simple statement.

The substance which you see here is a piece of gold leaf; it is yellow, as you know, but gold is sometimes blue and sometimes red. It must be perfectly clear to you, that if particles vibrate the colours of substances must have something to do with the vibrations. If the colours have anything to do with the particles it must be with their vibrations. Now as the spectrum in the main consists of red, yellow, and blue, the red and the blue rays are doing something in a substance which only transmits or reflects the yellow light; put the gold leaf in front of the lime light, you will see whether the yellow light does or does not suffer any change. The yellow has disappeared; you have a green colour; the red and blue are absent. The gold leaf is of excessive thickness. What would happen could I make it thinner? Its colour would become more violet. This I have proved by using aqua regia. But here is a solution of fine gold, which lets the red light through. Its particles are doing something with the blue vibrations, or *vice versâ*. Now what is the difference—the "particular" difference between the gold in this solution which is red, and that which is yellow by reflected, and green or violet by transmitted light? It is a question worthy of much study, especially in connection with my ninth proposition. Here are some more experiments. Here is some chloride of cobalt, which is blue. I will put it in this test-tube, to which I will now add water. You see it turns red. I content myself by asking why it turns red? We take some chloride of nickel, which is yellow, and put it into another test-tube: we add water, and I think you will soon see it turns green. First question—Why this change? Second question—Has the green colour of this solution anything to do with the red colour of the solution of gold?

I ask these questions because I believe the spectroscope will in time answer them.

I hope you will acknowledge that the spectroscope has to a great extent vindicated the theory stated by Prof. Maxwell. The question is, Has it taken us further? Perhaps not yet, but I think it will be found that what chemists picture to themselves as the atom, as contradistinguished from what they weigh, and physicists the molecule, is that particular atom, molecule, particle, or whatever name you may choose to call it, which with high-tension electricity gives us a spectrum of lines. You recollect that I said that in many of the monad metals it was obtained in the first stage of temperature; in the case of the dyads and metalloids with higher stages. If the true atom be that which gives a line spectrum, many anomalies will fall to the ground. These are questions the spectroscope raises. If you allow that in the line spectrum an atom is at work, in channelled spectra and continuous spectra molecular aggregations, you will see at once that Prof. Maxwell and others will be able to get a much sharper definition of atom and molecule than they have now; and though atoms are little things, you know they lie at the root of everything, and time spent in investigating them will not be lost.

J. NORMAN LOCKYER

* Thalen's beautiful researches on the spectrum of iodine quite bear out this view.

A BOTANICO-GEOLOGICAL EXCURSION INTO THE GRAMPIANS

THE Scottish Alpine Botanical Club is wont to hold a spring meeting for mingled plant-hunting and conviviality in some Highland district where the Alpine flora can be reached at not too great a distance from oatcakes and whiskey. The Geological class in the University of Edinburgh is in the practice of terminating its labours for the winter by taking an excursion of a week's duration to some part of the country where professor and students can find interesting rocks, with enough of food (such as it may be) to eat, and of beds, or shake-downs, to sleep on. This year the two bodies, drawn together perhaps as much by animal spirits as by scientific enthusiasm, coalesced and held a conjoint gathering at Clova—a lonely hamlet on the Forfarshire Grampians, well known to botanists for the richness of its Alpine flora, and to geologists for its glacier relics and its ancient metamorphic rocks. The following notes by the respective leaders of the plant-seekers and the rock-hunters were communicated to the Edinburgh Botanical Society on the 14th ult.:—

1. *Botanical Notes by Prof. Balfour.*—On Friday, April 24, the botanists visited the lower part of Glen Fee and the western side of Glen Dole. They specially examined the rocks in Glen Fee, where *Oxytropis campestris* grows and along with the plant took specimens of the rock for the determination of the geologists. They also visited

the rocks at the upper part of Glen Dole, where *Astragalus alpinus* grows. These rocks are very rich in plants; they consist of remarkably twisted and contorted gneiss, specimens of which were collected. The vegetation of the glen was in an advanced state, and some plants were gathered in flower which rarely blossom so early. Among them may be mentioned—*Arctostaphylos uva-ursi*, *Vaccinium vitis-idæa*, *Anemone nemorosa*, *Saxifraga oppositifolia*, forming large pink patches on the rocks; *Luzula campestris*, *Empetrum nigrum*, *Eriophorum vaginatum*, and *Cardamine hirsuta*. Among the other plants noticed in flower in the glen at Clova were: *Ulex europæa*, *Sarothamnus scoparius*, *Genista anglica*, *Prunus avium*, and *Ranunculus ficaria*. Among the plants not in flower which attracted notice were: *Silene acaulis*, *Saxifraga hypnoides* and *aizoides*, *Draba incana*, *Pyrola media*, *rotundifolia*, *secunda*, *Oxyria reniformis*, *Gnaphalium supinum*, *Dryas octopetala*. The following ferns were also gathered: *Lastræa oreopteris*, *Athyrium filix-fœmina*, *Polystichum lonchitis*, *P. aculeatum*, *Polypodium alpestre*, *P. vulgare*, *Asplenium viride*, *A. trichomanes*, *Botrychium lunaria*, and *Allosorus crispus*. All the species of British Lycopods except *inundatum* were gathered. Mr. W. B. Boyd collected some good mosses, including *Trichostomum glaucescens*, confined to the rock in Glen Fee on which *Oxytropis campestris* grows. It occurred in considerable abundance and in fruit.

On Saturday 25 the party again went to Acharne, and thence up Glen Esk to Bachnagairn, and by Loch Esk to the White Water and Little Gilrannoch. Again the day was all that could be desired. The snow near the summits of the hills was very refreshing, and on one we had a sufficient extent of snow to give us the benefit of a glissade with our poles. This day the botanists and geologists kept together. We specially examined Little Gilrannoch, one of the rocky summits which is interesting as yielding the *Lychnis alpina*, one of our rarest Alpine plants, and associated with it dwarf specimens of *Armeria maritima* and *Cochlearia officinalis*, the Alpine variety, and *Luzula spicata*. The rocks were specially examined by the geologists.

On Monday 27 the botanists examined Loch Brandy and Loch Wharral, and the rocks around them. We noticed particularly the vast crevasse formed at the top of the Snubb by the separation of a great mass of rock, which is gradually giving way, and will ultimately be precipitated into Loch Brandy. *Saxifraga oppositifolia* was seen as formerly in fine flower. *Azalea procumbens* was also gathered. In Loch Brandy *Isoetes lacustris* and *Lobelia dortmanna* were met with. In ascending the mountains this day we saw a fine effect produced by the thick white mist resting in the valley, while we were on the mountain above it enjoying clear sunshine. Among the mosses collected by Mr. Boyd during the trip may be noticed—*Grimmia unicolor*, *G. donniana*, *Leucodon moensis*, *Andræa campestris*, and *Hypnum catenulatum*.

2. *Geological Notes by Prof. Geikie.*—The main object of the geologists of the excursion was to observe some of the phenomena of the metamorphism of the district, to note the more prominent minerals, to trace the remains of old glaciers, and to connect the general structure of the rocks with the forms of hill, valley, crag, and ravine into which they have been carved. Incidentally, however, they took part in some of the botanical work, their attention being specially directed to the Alpine flora and to the circumstances under which some of the rarer Alpine plants occur. There can be no doubt that, as pointed out by Edward Forbes, our Alpine flora is descended from that which was general over these islands during what is known as the last Ice age. It has been supplanted in the lower districts by the vegetation which has come in with a milder climate; and it survives on the bleak and cold mountain ridges only so long as it can find its congenial temperature there, or so long as the chills and mists of these high regions forbid the further ascent of the plants which, swarming over the country, have driven these northern forms step by step up into these high grounds. It is well-known that the Alpine flora is richer in individuals and in species in the eastern Grampians than anywhere else in Britain. A number of plants are found in no other part of the country, and even in that district several are restricted to mere isolated rocks in some glen or some bare mountain brow. The question proposed to the consideration of the geologists was whether any geological reason could be given for this remarkable distribution, and particularly whether or not the nature of the rocks had had anything to do with it.

Some attention was accordingly paid to the habitat of three of the rarer and more local species. The *Astragalus alpinus* was observed on hard quartzose schist, high up in Glen Dole; the crag on which the *Oxytropis campestris* flourishes is a mass of singularly twisted and gnarled quartzose gneiss, with hard siliceous ribs projecting from its surface and showing the crumpled nature of the rock. But in neither of these cases does the rock apparently differ from many other crags in the neighbourhood, where the peculiar plants nevertheless are not found. In the case of the *Lychnis alpina* a special case seemed at first to be made out in favour of a relation, or at least a coincidence of a local plant with a local rock; for the locality noted as the habitat of this rare plant was found to present shattered knobs of serpentine projecting through the turf, and on these knobs the *Lychnis* grows, together with the *Cochlearia officinalis* and the *Armeria maritima*. This rock was not observed by the party *in situ* in any other part of the district examined. Before it was quitted, however, one of the botanists, who strayed farther over the mountain, returned with a piece of mica-schist, as the rock on which the same plants were found growing only a short distance away. It appeared, therefore, probable that, at the most, difference of rock can have had but a very slight influence in the survival and present distribution of the Alpine flora.

A much more effective influence may be traced to the general physical geography of the country, and especially of the eastern as contrasted with the western districts. The richness of the Aberdeenshire and Forfarshire mountains in Alpine plants, as contrasted with those of equal elevation in Invernesshire and Argyllshire, has long been a familiar fact to botanists. The cause of this contrast seems referable not to any difference in rock and soil, nor to mere differences in height; it appears to be explicable by the much greater breadth of high ground in the east than in the west. Everyone who has ascended some of the Grampian ridges remembers the wide undulating moors which spread out before him at heights of 2,000 or 3,000 ft. The summits are not peaks, so much as huge swells or mounds rising higher than the rest of the vast tableland. In the western counties, however, the craggy mountains tower often into sharp ridges. They are deeply trenched by glens and arms of the sea, so that relatively a smaller area of land rises out of the ordinary lowland vegetation into the chiller regions above. Add to this that the Invernesshire and Argyllshire hills lie nearer to the warm winds and currents of the Atlantic, and that the Grampian uplands receive the prevalent south-westerly winds after they have been chilled by passing over many leagues of high cold mountain ground. It is in these eastern parts of the Highlands that snow lingers longest, widest, and deepest—a good index, indeed, of the greater severity of the climate. These facts are suggested as affording some explanation of the comparative abundance of the Alpine flora in that part of Scotland.

Why in that limited district certain plants should be restricted to mere isolated rocks is a question to which no intelligible and satisfactory answer can at present be

given. But even more perplexing is the problem presented by the survival of maritime plants upon some of the highest and bleakest mountain-tops. In such portions the *Cochlearia* or scurvy grass, the *Armeria* or sea pink, with *Silene maritima* and *Plantago maritima*, are found abundantly. They are poor dwarfed forms, it is true, when compared with their contemporaries on the coast, so that the latter habitat is evidently more congenial to them than the bleak uplands. Descendants of the old arctic flora once indigenous in this country down to the sea-level, as it is in northern Scandinavia at the present day, how have they come to be left on our mountain tops? Were they maritime plants originally, and have they been carried up by the gradual elevation of the land? This would involve a former submergence of the country to a depth of at least 4,000 ft.—a limit much beyond that suggested by other geological evidence. Or did they form part of the generally distributed flora whereof some species keeping to the shores have been able amid bare rocks and salt spray to maintain themselves there ever since, while farther inland they have succumbed to the march of the invading Germanic flora, and have been allowed to struggle on in dwarfed and stunted forms only on the bare chill mountain tops, whither the invaders did not care to pursue them?

Some light might possibly be cast on these questions by an examination of the contents of our older peat-mosses. There is reason to suppose that some of these mosses may date back into Glacial times. It would be interesting to discover whether among the plants whose remains went to form the peat any northern species could be detected no longer living in this country, even in our Alpine zone. This line of inquiry is now being prosecuted in Scandinavia, and it is suggested to the botanists of Scotland as a fit subject for their attention.

The more purely geological work by the brethren of the hammer during this excursion, whether when with the botanists among the Grampians or afterwards by themselves along the shore between Dunnottar and Aberdeen, is hardly appropriate in a communication to the Botanical Society.

ON THE FERTILISATION OF CERTAIN LABIATÆ

IN the early part of April of the present year I had an opportunity of watching somewhat closely the mode of fertilisation of some species of Labiatæ, on which some notes may be interesting. The species observed were the three most abundant of the early flowering representatives of the order, *Lamium album*, *L. purpureum*, and *Nepeta glechoma*; the post of observation a bank covered by the three species growing completely intermixed, just outside a cottage-garden where were several hives of bees; the time occupied, several hours on three sunny mornings. The point which interested me most was the constancy with which the same species of insect confined its visits to the same species of flower, notwithstanding the close proximity in which the three were growing, this being perfectly in harmony with Mr. Traherne Moggridge's observations of a similar character respecting the visits of insects to fumitories and other flowers.

My conclusion is not based merely on actually noticing the visits of insects, but on the microscopic examination of the pollen collected on the captured insects. For this purpose the pollen-grains of the three species named offer unusual facilities, those of *Lamium album* being yellow, of *L. purpureum* red, and of *Nepeta glechoma* white.

In *Lamium album* the length of the style is such as to bring the stigmatic surface exactly on a level with the anthers of the shorter pair of stamens, as represented in Fig. 1; one branch of the style is nearly straight and is hidden among the anthers, the other projects at right angles into the opening to the tube of the corolla, so that it must necessarily be struck by any insect entering the flower. The only visitors to the flower seen were two species of humble-bee, *Bombus pratorum** (female) and *Anthophora retusa* (female), the former in large numbers, the latter much more rarely. From the position of the stigmatic surface, both it and the stamens must be struck by about the centre of the head of the bee; and it was on this part that the greater number of pollen-grains were found, and proved to belong exclusively to this species. In no single instance was a hive-bee seen to visit the flowers; Müller states that they obtain the honey from this species entirely by sucking it through holes bitten in the corolla by *Bombus terrestris*.

In *Lamium purpureum* the difference in length between the two pairs of stamens is less considerable and the anthers are consequently closer together, both branches of the style being bent forwards into the mouth of the corolla, as shown in Fig. 2. Although hive-bees were constantly hovering over the flowers, in no single instance did I see either them or the humble-bees visit this species; the only insect observed to settle on it being a butterfly (*Vanessa urticæ*) twice.

The position of the parts in *Nepeta glechoma* is very different. The two pairs of anthers are at a considerable distance from one another (Fig. 3), and the length of

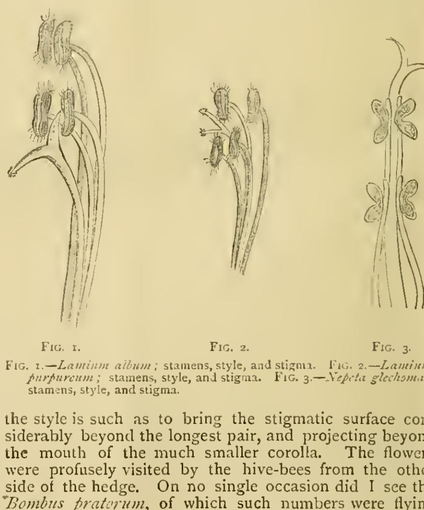


FIG. 1. FIG. 2. FIG. 3.

FIG. 1.—*Lamium album*; stamens, style, and stigma. FIG. 2.—*Lamium purpureum*; stamens, style, and stigma. FIG. 3.—*Nepeta glechoma*; stamens, style, and stigma.

the style is such as to bring the stigmatic surface considerably beyond the longest pair, and projecting beyond the mouth of the much smaller corolla. The flowers were profusely visited by the hive-bees from the other side of the hedge. On no single occasion did I see the *Bombus pratorum*, of which such numbers were flying about, even attempt to enter the flower, and the smaller species, *Anthophora retusa*, only twice; and on each of these occasions she immediately came out again and began industriously to wipe the pollen off her head with her fore-legs, as if she disliked it. Owing to the much smaller size of the flower, and the greater length of the style, the part of the body of the bee touched by the stigma is very different to that in the *Lamium album*, namely, the back of the neck or even of the thorax. Hence even if the insect should visit the two species on the same journey—which, I should infer, is not usual—the pollen of one species would not easily be wiped off on to the stigma of the other. I did not observe any plants of the ground-ivy with the "female" flowers described by

* In this and all other instances I am indebted for the determination of the insects to the kindness of my friend Mr. Edward Newman.

Müller, with which one is familiar in the case of the wild thyme and other Labiatæ; but a large number of flowers in this particular locality had all the anthers bitten off, a depredation which I attributed to the hive-bees, inasmuch as the same was the case in other habitats near hives, but not in those at a greater distance from cottage-gardens. The only other flowers growing on or near the same bank which I observed the bees to visit were the dandelion several times, and *Veronica buxbaumii* once.

At this early period of the year the following species of insects were captured on the dandelion; those marked with an * are not in Müller's list of ninety-three kinds which visit this plant, unless under synonyms which I fail to recognise.—Hymenoptera, *Apis mellifica*, **Halictus lugubris*, **Andrena nana*, *A. varians*, and *A. nitida*; Diptera, **Syrphus clypeata* and *Eristalis arbustorum*; Coleoptera, **Apion apricans*.

The sloe was abundantly visited by **Andrena fulvicrus* (Hymenoptera), both male and female, and by *Eristalis tenax* (Diptera). On opening the abdomen of the latter, it was found to contain abundance of pollen-grains, belonging to the species on which it was then feeding, and to the dandelion, mixed with a few larger triangular pollen-grains, belonging apparently to a Fuchsia; thus confirming the opinion at which I had previously arrived, that the Syrphidæ are large consumers of pollen. The abdomen of the Hymenoptera, on the other hand, contained but a very few pollen-grains, which might easily have been sucked up accidentally along with the nectar; and this was also the case with the hive-bee, the grains in this latter case belonging to the dandelion.

ALFRED W. BENNETT

NOTES

THE Cambridge Museums and Lecture Rooms Syndicate, in their eighth annual report state that the Regius Professor of Physic has again called their attention to the urgent need of better accommodation for the medical examinations. Among the additions which have been made to the collections in the several museums, the bequest of the late Mr. M'Andrew, F.R.S., of the whole of his collection of shells and other specimens, deserves the first mention. It is of the highest scientific value. A most interesting collection of human crania, made by the late Dr. Thurnam, of Devizes, has been presented to the Museum of Human Anatomy, through the liberality of Prof. Humphry. A series of Devonian fossils, of great beauty, presented by Lady Burdett Coutts, deserves special mention, as also does the contribution of several hundred specimens of Palæozoic and other fossils by Prof. Hughes, and the gift of 500 sterna of birds by Prof. Newton and Mr. E. Newton, and of a skeleton of the extinct bird "the Great Auk" by Prof. Newton. The building of the Cavendish Laboratory is now finished, and the Laboratory is open for practical instruction in physics. As the several collections and the number of students in the several departments increase, the current expenditure necessarily increases. The Syndicate are therefore of opinion that the time has arrived when they are obliged to call the attention of the Senate to the necessity of increasing the amount of the annual grant to the museums and lecture-rooms maintenance fund. They suggest, however, that for the current year a special grant of 300*l.* be made to the fund. Appended are the reports of Professors Humphry and Newton, and of the Superintendent, Mr. J. W. Clark, which give details of the past year's work and the additions made to the various collections.

IN a Convocation at Oxford, on May 28, the name of H. S. Smith, F.R.S., Savilian Professor of Geometry, Fellow of Corpus, who had been nominated to the office of Keeper of the Museum, by the delegates, in succession to the late Prof. Phillips, was approved.

THE list of those on whom the honorary degree of LL.D. is to be conferred at the approaching Cambridge commencement is very numerous. We have already mentioned some names; the following is a list of the men connected with Science who are to receive the honour:—Sir Charles Lyell, F.R.S.; Sir James Paget, F.R.S.; M. Leverrier, of the Paris Observatory; Joachim Barrande, of the Royal Society of Sciences of Prague; George Bentham, F.R.S.; and William Lassell, F.R.S.

WE have received the prospectus of a new "College of Science and Literature," which it is proposed to establish at Bristol for the South and West of England and South Wales. Such an institution, if properly organised, would no doubt be of great service, as these extensive and important districts are far distant from any college in which the sciences applied to their various industries can be studied. Judging from the prospectus, the organisers of the scheme have sound notions of what such an institution ought to be, keeping in view as models Owens College and the Newcastle College of Science. Balliol College and New College, Oxford, have come very liberally forward in aid of the scheme, having offered to contribute towards it 300*l.* a year for five years. It is estimated that a capital sum of 25,000*l.* will be required, and an annual subscription of 3,000*l.* for the first five years secured. It is, however, proposed to commence operations when such proportion of these amounts has been guaranteed as may justify the expectation of success. A public meeting is to be held at Bristol on the 11th inst. to inaugurate the undertaking, which we sincerely hope will be taken up heartily by those interested in it.

MR. W. SAVILLE KENT, F.L.S., the late Superintending Naturalist of the Brighton Aquarium, and formerly Assistant in the British Museum, has been appointed to the control of the Manchester Aquarium. This aquarium being constructed on the "circulating" principle, advocated by Mr. Kent, and it being, moreover, intended to make the building subservient more to the instruction and education of the masses rather than for the realisation of extraordinary dividends, we may anticipate from it scientific results of the most gratifying sort. The tank frontage of the Manchester Aquarium presents a length of no less than 750 ft., an amount exceeding that of any aquarium yet constructed. An ample guarantee of the encouraging support this undertaking is likely to receive at the hands of the public is shown by the returns for the first week of its opening, the visitors who passed through the gates during that period numbering over 19,000.

THE Birmingham Natural History and Microscopical Society, whose enterprise we have had frequent occasion to speak of, is contemplating the foundation of an aquarium in Birmingham, and has been seeking information from the managers of various aquaria at home and abroad. The result is not altogether encouraging to those who desire to see an aquarium standing on its own legs as a scientific institution, apart from adventitious attractions. It seems that scarcely any existing aquarium pays that is not attached to or does not form part of some place of amusement; and Mr. Lloyd of the Crystal Palace Aquarium gives it as the result of his large experience that no aquarium can be made to pay its way, unassisted by other attractions, even in the largest centre of population, unless its cost be limited to 3,000*l.* and its annual expenses to 500*l.* Still we hope that, whether as an independent or as a parasitical institution, the Birmingham Society will be brave enough to take steps to establish an aquarium in that busy centre.

FROM the Twelfth Annual Report of the Birmingham Free Libraries Committee, we are glad to see that this system of libraries continues to enjoy increasing prosperity. These annual reports furnish a number of very interesting statistics as to the number and class of books in the libraries, number and occupa-

tion of readers, books most in demand, &c. The total number of books in the various libraries amounted at the end of last year to 69,279, a very large proportion of which are of a scientific character. From the statistics as to books most sought after, and the number of readers in the various subjects, we are glad to see that works of Science enjoy a large amount of patronage. The aggregate issue of works in the reference and lending libraries was 525,610.

We have received several American papers containing descriptions of a marine aquarium in San Francisco, California. It forms part of the many attractions of "Woodward's Gardens," an extensive piece of ground which has been inclosed and laid out by a private gentleman, Mr. Woodward, for the amusement and instruction of the people.

It is gratifying to learn that the lamented death of Prof. Agassiz will not prevent the continuation of the school of natural history at Penikese Island, the results of which during the season of 1873 proved to be of so much educational importance. A circular from Mr. Alexander Agassiz in regard to this states that two or three times as many persons as can be accommodated have already applied to be received during the coming summer, and that great interest is manifested to prosecute the study of nature under the eminent specialists who have been called to assist in the enterprise. The necessity of a permanent endowment is very justly set forth by Mr. Agassiz, and especially the importance of means for paying for the services of the men of science invited to officiate as instructors. He suggests that provision be made by the Legislatures of the several States for the endowment of scholarships, either by the actual payment of the sum of 5,000 dols., or an annual grant of 350 dols. The payment of this sum on the part of any State would entitle it to nominate two teachers for admission during the summer to the Penikese school, the selection to be made from among those most apt in natural history. No charge is made to the students of this school for tuition. It is announced that this school will open on July 7, and close on Aug. 29. Among the gentlemen mentioned as likely to take part in the instruction are Dr. Packard, Professors Wilder, Morse, Mayer, and Jordan, and Messrs. Putnam, Bickmore, Lyman, and others.

The Annual Report of the Trustees of the Museum of Comparative Zoology at Harvard College, Cambridge, U.S., shows that that institution is rapidly becoming one of the first of its kind anywhere. Its already large and valuable collections are constantly being added to, and rapid progress is being made in their systematic arrangement. The museum is open not only to regular students of natural history, but to all scientific men who care to make use of it in aid of their researches. It is in connection with the Harvard Museum that the Penikese School of Natural History was instituted; and, between the two, American students have rare advantages for the study at least of Icthyology.

The German Society for Polar Exploration has, it is said, purchased the harbour of Kristvig, on the Island of Averio, on the west coast of Norway, with the intention of making this in future the starting-point of German explorations of the Arctic regions.

Dr. Gross, the author of "Les habitations Lacustres du lac de Bienne," in which all the stations in that lake of the Stone and Bronze ages are described in detail, has just, says the *Continental Herald*, presented a gem of its kind to the Archæological Museum of the Berne City Library. This is a hatchet of nephrite, 7 in. long, a very scarce kind of stone, and only found in eastern Asia, the occurrence of which in the lake dwellings of Switzerland forms an unsolved puzzle.

The first ascent of a balloon over the Black Sea was made on April 19 from Odessa in the "Jules Favre," measuring 70,000 cubic feet. The ascent took place at 3.10 A.M. in a north-east direction; but as it mounted higher the wind veered and the balloon went out to sea in a south-east direction. It rose to a height of 7,000 Russian feet at a distance of about 16 miles from land. The balloon came to ground at Peresadovka, about 20 miles north from Nikolaeff, at 6h. 39m. A.M.

As the series of annual international exhibitions at South Kensington is to be discontinued after the present year, the Society of Arts have in consideration the organisation of a series of provincial exhibitions of an industrial character, to be held in the centres of the manufacturing districts. The plan is as yet by no means complete, but a principal part of it would be that the special industries of each locality should be, as far as possible, illustrated in its exhibition.

A public meeting was held in the Mechanics' Institute, Nottingham, on Tuesday night, to consider the further development of the movement instituted by the Cambridge University for extending its teaching to the masses of the people. The report of the committee for the past session stated that nearly 2,000 tickets for the lectures and classes were applied for in the town; 1,241 persons attended the lectures, and 615 the classes. There were 143 candidates at the examination, of whom 126 obtained certificates of merit. The financial statement was satisfactory, and the report expressed a belief that the movement would shortly be self-supporting.

At a recent meeting of the Royal Geographical Society of Ireland Mr. W. Harte, County Surveyor, co. Donegal, gave a description of "Supposed evidence of a recent change of level in the surface of co. Donegal." He adduced a number of proofs that there was a general and rapid depression in the surface of the county. Inhabitants had informed him that portions of the coast now covered with 20 ft. of water had been passed over dry-shod by their grandfathers. Many bogs also, of which the trees were still erect and *in situ*, had been recently inundated. That the water had never previously reached a higher level he proved from the fact that none of the bogs now under water had ever been previously inundated, for they were not permeated, as bogs which had been covered by water invariably were, with a fine microscopic sand. The submergence of Donegal was taking place at a rate that was much more rapid than had been suspected; old passes which were used to islands along the coast now no longer existed. The most interesting fact, however, was one brought to light by Mr. Fitzgerald, who found numerous cases of furnaces used by the ancient Irish to smelt the bog iron ore, but which were now under high-water mark.

The ravages caused by the *Phylloxera vastatrix* among the vineyards of France are becoming very serious. More than 150 various remedies have been tried but without success, and the only hope of many scientific men is in the introduction of varieties of vine which are known to be to a certain extent proof against the attacks of this insect. Many American kinds of vine are said to possess the property of resisting the disease for a much longer time than the French vines, and steps are being taken to introduce roots of these varieties into France. In the Department of Hérault alone the produce of wine has fallen from fourteen millions of hectolitres to eleven millions: not only is the fruit destroyed by the effects of the parasite, but the vine itself is destroyed in a year or two; and one female Phylloxera is said to produce two or three millions of young in a year.

At a recent meeting of the Boston Society of Natural History Prof. Morse read a paper on Natural Selection among the Molluscs, instancing the usually small size of certain species in the

Bay of Fundy, near Eastport. Here the tide rushes along with great power, and the molluscs are obliged to cling to the bottom with great tenacity to prevent being swept away. Only the smaller individuals can withstand this by getting into the crevices of the rocks. The species is thus perpetuated by the smaller members, and rarely attains any considerable size.

THE Inspectors of Salmon Fisheries of England and Wales have just issued their annual report. Examples are given of the serious injuries inflicted on salmon rivers—and not only on salmon rivers but on the health of the public—by the pollutions poured into rivers, and it is to be hoped that powers will be given to enforce the removal of such matters from our streams. Altogether the prospects of our salmon rivers appear very favourable, and much good is to be expected from the working of the new Act.

A SEAM of coal has been discovered at Sandwell Park, near Birmingham, 418 yards below the surface.

SOME good popular scientific lectures are at present being given by Prof. Gardner at the Polytechnic.

THE May number of *Annals and Magazine of Natural History* contains, among other articles, a list of butterflies taken by Lieut. Bell on the march to Coomasie, with a description of six new species. Dr. Nicholson describes a new genus of Palæozoic corals from the Niagara group of Indiania, which he names Duncanella, in honour of Mr. P. M. Duncan. Dr. Young gives a description of a new genus of carboniferous Polyzoa, and suggests the name Rhabdomeson. A plate is given illustrating *Rhabdomeson gracile*. There is also a brief note of an apparently new species of humming-bird, of the genus Eriocnemis, by Mr. Elliot. The discussion about Eozoon is continued.

AN excellent device has been forwarded to us for use in field-club excursions. It is designed to promote an interest in common flowers, and can of course be varied and worked without a prize. It consists of a large envelope, with a description, but not the name, of a plant, and directions as to what ought to be done with the plant when found. The particular envelope, forwarded to us by Mr. Higgins of the Liverpool Naturalist's Club, contains the following on its back :—

EXTRA PRIZE.

DESCRIPTION OF PLANT.

Leaves opposite, Sessile, Lanceolate, Acuminate.
Sepals 5, half as long as the 5 deeply-cleft Petals.
Stamens 10, Styles 3, height about 12 in.

Members finding a plant answering to this description should take it to the President or botanical Referee, with their name signed at the foot of this slip. When correct the slips will be initialed and handed to the Secretary. The finder should be prepared to answer questions on the description; but the name of the plant will not be officially announced till after tea.

A Prize or Prizes will be awarded at the end of the Season to those most successful.

Signed, __________________

THE additions to the Zoological Society's Gardens during the past week include a Beisa Antelope (*Oryx beisa*) new to the collection, from Central Africa, presented by Admiral Arthur Cumming; an Indian Gazelle (*Gazella bennetti*), presented by Mr. J. H. Bainbridge; an Indian Ratel (*Mellivora indica*), presented by Mr. L. Macneill; a Maugé's Dasyure (*Dasyurus maugæi*) from Australia, presented by Mr. F. Kirby; two Little Whimbrels (*Numenius minutus*) from the Navigator Islands, presented by Rev. S. J. Whitmee; a Guilding's Amazon (*Chrysotis guildingi*) from St. Vincent, purchased; a Bennett's Cassowary (*Casuarius bennetti*) from New Britain, deposited.

SCIENTIFIC SERIALS

THE *American Journal of Science*, May 1874.—The May number contains the following papers :—On the polarisation of light, by Prof. A. W. Wright. Prof. Wright instituted a series of observations with different instruments, which he describes, obtaining, however, only faint and uncertain results. At last he has been enabled to make observations he considers reliable. He obtained a quartz plate, cut perpendicularly to the axis, and exhibiting by polarised light an unusual intensity of colour. Examined with one Nicol and unpolarised light the plate is perfectly colourless, and shows no trace of its heterogeneous structure. Placed between two Nicols, it showed bands of colour, the plate being a macle, the body consisting of left-handed quartz, crossed by a band of right-handed quartz, bounded by strips of different structure. The plate was used in a tube 11 in. long, and formed an instrument especially adapted to the detection of small degrees of polarisation. The observations were made facing the south-west in a dimmed room, so that the eye should be sensitive. The results of the numerous observations on different evenings were entirely concordant, and are thus summed up by Prof. Wright :—(1) The zodiacal light is polarised in a plane passing through the sun. (2) The amount of polarisation is, with a high degree of probability, as much as 15 per cent. but can hardly be as much as 20 per cent. (3) The spectrum of the light is not perceptibly different from that of sunlight, except in intensity. (4) The light is derived from the sun, and is reflected from solid matter. (5) This solid matter consists of small bodies (meteoroids) revolving about the sun in orbits crowded together towards the ecliptic.—The second article is the first instalment of a communication by Mr. W. M. Fontaine, On the "great conglomerate" of New River, West Virginia.—The third article is by Mr. S. W. Johnson, On the use of potassium dichromate in ultimate organic analysis. Potassium dichromate, the author thinks, possesses all the properties needful for an oxidant in organic analysis, and ordinary kaolin is the best material for diluting it. He gives the details of some of his experiments.—Then follows an article by Mr. C. H. Hitchcock, On the Helderberg Rocks of New Hampshire, which is illustrated by a map, and is to be continued.—The Rev. H. C. Hovey contributes an interesting article on *Rabies mephitica*. The bite of the common skunk (*Mephitis mephitica* Shaw) is often dangerous, and leads to symptoms somewhat analogous to those which follow the bite of a mad dog. Mr. Hovey has obtained particulars of forty-one cases of *Rabies mephitica*, and of these forty were fatal.—Mr. Carey Lea of Philadelphia finds that when silver bromide is treated with pyrogallic acid, after exposure to light, the black substance which remains contains bromine and is resolved by nitric acid into normal silver bromide (left behind as a pale yellow film) and silver which passes into solution. It is, therefore, either a sub-bromide or an oxy-bromide; not an oxide. The existence of these compounds is evidently an argument for doubling the atomic weight of silver, as has recently been proposed on other grounds.—Mr. Meek continues his notes on the fossils figured in the recently-issued fifth volume of the Illinois state geological report.—The brief contributions from the physical laboratory of the Harvard College are also continued. They include No. v., On a method of freezing a magnetic bar from the influence of the earth's magnetism, by John Trowbridge. No. vi. Note on Melde's experiment, by W. Lowery. No. vii. A spark adjuster for the Holtz machine, by James Minot. No. viii. Effect of condensers on the brush discharge from the Holtz machine.—Mr. E. A. Verrill continues contributions to zoology, giving the results of dredging at three stations on the coast of New England, on Cashe's ledge, Jeffrey's ledge, and Stellwagen Bank.—In the "Scientific Intelligence," the section "Chemistry and Physics" consists of notices of papers published in Europe. In section "Geology and Natural History" there is a notice of a communication in the *Overland Monthly* On mountain sculpture in the Sierra Nevada, and on the method of glacial erosion, by E. S. Carr. He holds that glaciers do not so much mould and shape rocks as that they "disinter forms already conceived and ripe." The grain of a rock determines its surface-forms.—There is also an extract from a letter to Dr. Dana, referring to volcanic action in Hawaii, where Mauna Loa has been in full activity since April 1873.—An abstract is given of Prof. W. S. Clarke's experiments on the amount of pressure in the sap of plants. The mercurial gauge has been used on the sugar maple, and observations were made day and night from April 1 to July 20.

The maximum pressure was found to be equal to sustaining a column of water 31·73 ft. high. One of the most interesting portions of the experiments was to determine, if possible, whether any other force than the vital action of the roots is necessary to produce the sap-pressure. A black birch-tree was selected, and a root was severed at 10 ft. from the trunk, and to it was attached a mercurial gauge. This showed a maximum pressure equal to 85·8 ft. of water, and proved that "the absorbing power of living birch rootlets without the aid of any of the numerous helps imposed upon them by ingenious philosophers, such as exhalation, capillarity, oscillation, &c., was quite sufficient to account for the most essential of the curious phenomena connected with the circulation of sap."

Journal of the Franklin Institute, April.—The following are some of the important papers in the number:—Report of the Committee of the Institute on the Westinghouse car-brake. This brake in its simplest form consists of a small steam-engine placed in the locomotive, which, taking steam from the boiler, works an air-pump, which compresses air into a main reservoir, secured beneath the car. By an ingenious arrangement of pipes and automatically acting valves, the air is admitted into a series of brake cylinders, one under each car, the pistons of which are connected with and act upon the ordinary brake-levers, and thus apply the brakes to the wheels. The inventor has made important improvements on this, by means of which the compressed air may be admitted almost instantaneously into the brake-cylinders, and the train brought to a standstill in an incredibly short space of time; *e.g.* a train, going at the speed of thirty miles an hour up a gradient of 29·6 ft. per mile, was brought to a stop in 16 seconds. Scott's legacy, premium, and medal, were awarded to the inventor by the Institute.—The principles of shop-manipulation for apprentices is continued.—On the mechanical calculation of earthwork (or the results of physical measurements in general) according to the prismoidal or other formulæ, by C. Herschell, C.E. This paper relates mainly to the important uses to which the polar planimeter can be put.—Prof. R. H. Thurston contributes two papers which have been published separately: On the thermal and mechanical properties of air and other gas, subjected to compression or expansion; and On the strength, elasticity, and resilience of materials of machine construction; both papers are illustrated with diagrams.

THE *Journal of Mental Science* for April, opens with the third number of the Morrisonian Lectures on Insanity for 1873, in which Dr. Skae and Dr. Clouston still further exemplify the classification of the various kinds of insanity according to the bodily disease or condition with which they are associated. In speaking of Climacteric Insanity it is contended that men between 50 and 60 have a critical period corresponding to that passed through by women between 40 and 50; but the evidence seems far from conclusive. But nothing can be more striking and terribly instructive than the amount of insanity of one kind or another that is unmistakably connected with the organs and functions of generation.—The morbid psychology of criminals by David Nicolson, M.B., continues; and his observations on this unfortunate class are very valuable and well worth recording—especially perhaps may they prove useful "as a basis of comparison for kindred phenomena occurring in circumstances less definite and uniform." No one is likely to be very seriously injured by the common prison delusion "that their food is poisoned;" but if the same painful fancy take possession, as it sometimes does, of individuals in the outer world, it may not be so readily recognised as a delusion, and the consequences may be very mournful.—A psychological study of the character of Jean Jacques Rousseau, by J. Hawkes, M.D., suggests the idea of a washerwoman sounding the Atlantic with her clothes line, and finding it very shallow all over.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, April 1.—In this number Dr. Mohn furnishes a number of data from three years' observations of the temperature in and near Christiania—at the Institute and the Observatory—and of the decrease of heat with height; a station named Frognersäter having been chosen, situated about five miles NN.W. from the Observatory, and 408 metres above the sea. The air within the city is shown (as in other localities) to be warmer than without. The temperature in general decreases with the height, and most quickly in May; in the winter months the decrease is small, and it passes, in December, into an increase. Dr. Mohn studied the meteorological conditions present in three separate cases:—(*a*) Frognersäter warmer than Christiania; (*b*) colder and excessive; (*c*) change of temperature on fall of rain or snow. As regards (*a*), it occurred in cold weather; the wind N.E. or E., and light; atmospheric pressure about 7 mm. above normal; sky most often clear, but sometimes a mist covered Christiania, while Frognersäter was in sunshine. The author inquires at some length into the causes of change of temperature with height, and points out that the elements of greatest influence here are the strength of wind and the relative moisture. The change increases with the former and decreases with the latter. To this is joined the action of precipitates, in so far as this, accompanied by greater relative moisture, contributes to lessening the decrease of temperature with the height.—Prof. Ebermayer follows with a review (in part) of a new text-book of climatology by Dr. Lorrenz and Dr. Rothe. From personal observation he disputes the authors' assertion that the increase of cells in plants takes place only by night.—Among the "Kleinere Mittheilungen," we note some meteorological observations from the northwest coast of Spain.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 7.—"Preliminary Experiments on a Magnetised Copper Wire," by Prof. Balfour Stewart, LL.D., F.R.S., and Arthur Schuster, Ph.D.

1. The following experiments were made in the physical laboratory of Owens College, Manchester:—

A copper wire was wound fifty-three times in one direction round the poles of a powerful electro-magnet, the length of wire encircling these poles being about twelve metres.

A Wheatstone bridge was employed to measure the resistance of the wire, and a very delicate Thomson's reflecting galvanometer, by Elliott Brothers, was likewise used.

Experiments were made at intervals of two minutes; and on each occasion the current was allowed to pass through the bridge for ten seconds, the measurement being taken by the first swing of the galvanometer, which lasted for about eight seconds. Three cells of Grove's battery were used for producing this current, but on the other hand six similar cells were employed for magnetising the electro-magnet.

2. In the first experiments made, the induction-current due to the wire coiled round the magnet affected the galvanometer, but after Dec. 12 a solid key put into the circuit was taken out, so that no induction-current passed.

The following is a specimen of the observations made:—

Dec. 17, 1873.

Time of putting on current. h. m.	Whole deflection observed (increasing deflection denotes increasing resistance).	Condition of magnet.
11 11	312	off
13	317	off
15	311	off
17	345	on
19	328	off
21	306	on
23	303	off
25	293	on
27	300	off
29	290	on
31	307	off
33	283	on
35	292	off
37	288	on
39	302	off
41	292	on
43	309	off

It will be seen from this experiment that the *first effect* of putting on the magnetism was a marked increase of resistance; but with this exception the resistance, when the magnetism was on, was less than the mean of the two resistances on both sides of it, representing the magnetism off.

3. The arrangement remained untouched, as far as we know, from Dec. 15, when it was finally made, until Dec. 19, when the experiments were interrupted during the Christmas holidays; and in all cases the *first effect* of putting on the magnetism was a marked increase of resistance.

It was soon seen that this *first effect* had some reference to the time elapsing since the last experiments were made. For in-

stance, there was on Dec. 18 a marked increase of resistance when the magnet was first put on; but on the afternoon of that day the experiments were repeated, and there was no apparent increase of resistance in this *first effect*. Next, with regard to the *average effect*; on Dec. 16, 17, and 18, this *average effect* of magnetism was a decrease of resistance.

4. The experiments were resumed on Jan. 7, the arrangement having remained untouched during the holidays. From this date until Jan. 10 inclusive, the key was taken out before beginning experiments in the morning; there was no peculiar *first effect*; while, on the other hand, an *average effect* denoting a decrease of resistance came out very prominently. On Jan. 12 and 13 the key was only taken out before magnetising, and on these occasions the *first effect* denoting increased resistance was sufficiently marked.

Our method of procedure was varied in the above manner up to Jan 27; and it was invariably found that whenever the key was taken out before commencing experiments there was no *first effect*; but when it was kept in until before magnetising, this *first effect* was sufficiently marked. These experiments concur in proving that the *first effect* has some reference to the previous treatment of the wire, but they do not prove that it is at the same time connected with the putting on of the magnetism. To determine this point we made a set of experiments on Jan. 22, 26, and 27. When the current had become constant the key was taken out, but the magnetism was not put on; and on these occasions there was no *first effect* of the current upon itself in the direction of increased resistance, but rather in the opposite direction. It thus appears that the *first effect* which increases the resistance has not only reference to the previous treatment of the wire, but depends also on the magnetism being put on.

This result is confirmed by experiments made previous to Dec. 12, in which the key was not taken out at all. For instance, we have on Dec. 9—

First off.	On: First effect.	Second off.
0	+ 54	+ 45

We have hitherto only spoken of the *first effect* obtained after Jan. 7, we now come to the *average effect*. From Jan. 7 to Jan. 27 inclusive, the magnetism was always put on in the same direction, and the *average effect* invariably denoted a decrease of resistance when the magnetism was on.

5. On Jan. 28 the magnetism was reversed; the effect during this day was very irregular. On Jan. 29, 30, 31, Feb. 2, the key was left in until before magnetisation. The *first effect* was now extremely large, but it was suspected that during these experiments the contact of the key was not very good.

On Jan. 29 the *average effect* denoted a decrease of resistance, but on Jan. 30, 31, Feb. 2, 4, 6, the *average effect* denoted an increase of resistance.

6. From Feb. 6 until Feb. 11 the wires were left broken; on Feb. 11 there was a very slight *first effect* in the direction of increased resistance, and a slight *average effect* in the direction of decreased resistance. On Feb. 12 a mercury interruptor was used instead of a metal key, both the wires being broken by it, and its use was continued until Feb. 18. The interruptor was left in over night, and the current was only broken before magnetisation, but no *first effect* was observed.

From Feb. 19 to Feb. 26 one wire only was broken by the fluid interruptor, nevertheless there was no *first effect*.

On Feb. 12, when the fluid interruptor was first employed, there was a very small *average effect* in the direction of increased resistance; but in all the experiments afterwards this *average effect* was in the direction of decreased resistance. The magnetism had been in one direction from Jan. 28, but during the experiment of Feb. 25 it was reversed and retained in this condition through the experiment of Feb. 26 without appearing to affect the results.

7. From these experiments we may perhaps conclude as follows:—

In the *first place* there is a *first effect* in the direction of increased resistance which appears to have reference to three things, namely, the previous state of the wire, the solidity of the circuit, and its magnetisation.

In the *second place* we have an *average effect*, of which the normal state appears to denote a decreased resistance while the magnetism is on, without reference to the direction of the magnetism.

In the *third place*, when in a solid circuit the direction of the magnetism has been recently changed, there appears to be a temporary reversal of the average effect, which appears at first as an increase of resistance. Besides the evidence herein detailed, we have other evidence in favour of the third conclusion; for in some preliminary experiments, in which we frequently reversed the poles, we found an increase of resistance when the magnetism was on.

We are led to conclude, from other experiments besides these, that the effect of the magnetism is not merely confined to the part of the copper wire wound round the poles, but is propagated all along the wire. On Dec. 2, for instance, the current was passed through the wire, the galvanometer being joined as a secondary circuit. The main current was therefore measured. The deflections were as follows:—

297	off	300	off
300	on	302	on
297	off	301	off
300	on		

This shows an average strengthening of the current equal to about 1-200 part of the whole. Were this strengthening due merely to the change of resistance of that part of the wire wound round the poles, the effect as measured by the much more delicate arrangement of Wheatstone's bridge would be much larger than was actually observed.

9. Allusion was made in Article 7 to some preliminary experiments in which increased resistance was observed when the magnetism was put on alternately in different directions. Similar experiments were made, giving the same result with a piece of coke and graphite which were between the poles of the magnet.

10. We have also some evidence that a copper wire, one end of which is wound round the pole of the magnet, changes its position in the electromotive series. Two copper wires were dipped into dilute nitric acid and connected with the galvanometer. A weak current passed through the galvanometer owing to a slight difference in the copper wires, one of which was also connected with the copper wire wound round the magnet. When the magnet was on, the current as a rule changed in intensity; but the effect was small, and the difficulty of having two copper wires which, when joined together and dipped into nitric acid, give a current sufficiently weak and constant, prevented us from getting any decided results.

11. In conclusion we have to state that we regard these results which we have ventured to bring before the Royal Society as preliminary, the correctness of which will, we trust, be confirmed by the further experiments which it is our intention to make.

Mathematical Society, Thursday, May 14.—Dr. Hirst, president, in the chair.—The president having vacated the chair gave an account of his paper On the correlation of two planes. "A correlation is said to be established between two planes, when their points and right lines are so associated that to each point in one of the planes, and to each line passing through that point, respectively correspond, in the other plane, *one* line and *one* point in that line." It was first shown that eight conditions are necessary and sufficient for the establishment of a correlation between two planes: and in the next place it was shown that the problem of determining a correlation between two planes which shall satisfy *any* eight given conditions is susceptible in general of a finite number of solutions. Systems of correlation were then considered: as also the origin and nature of exceptional correlations. Relations were next established between the characteristics and singularities of any system of correlations. An enumeration and classification of the fundamental systems of correlations were then made and illustrated by reference to a table in which the systems were arranged in six groups. Dr. Hirst also touched upon the number and nature of exceptional correlations in the fundamental systems. A table was exhibited showing the number of correlations satisfying eight elementary conditions. If α points in one plane have given polars in the other; β right lines in the first plane have given poles in the second; γ points and δ lines in each plane have given conjugates in the other plane, then $(\alpha\beta\gamma\delta)$ is termed the *signature* of the system of correlations satisfying the above conditions. We see that the systems of correlations corresponding to the signatures $(\alpha\beta\gamma\delta)$ and $(\beta\alpha\gamma\delta)$ are identical. The following two theorems are generalisations of the results arrived at:—(I.) In a system of correlations $(\alpha\beta\gamma\delta)$, the curve of the class $[\alpha\beta(\gamma+1)\delta]$ which represents either of two conjugate points A_1, A_2, breaks up into the other, together with a point on each of the singular lines associated with those which pass through the former. The multiplicity of A_2 on the representa-

tive of A_1 is $[(\alpha+1)\beta(\gamma-1)\delta]$, and that of A_1 on the representative of A_2 is $[\alpha(\beta+1)(\gamma-1)\delta]$. The number of singular lines which pass through A_1 is $[\alpha\beta(\gamma+1)\delta]-[(\alpha+1)\beta(\gamma-1)\delta]$, and the number of those which pass through A_2 is $[\alpha\beta(\gamma+1)\delta]-[\alpha(\beta+1)(\gamma-1)\delta]$. (II.) In a system of correlations whose signature is $(\alpha\beta\gamma\delta)$, the curve of the order $[\alpha\beta\gamma(\delta+1)]$, which represents either of two conjugate lines α_1, α_2, breaks up into the other, together with a line through each of the singular points associated with those situated on the former. The multiplicity of a_2 on the representative of a_1 is $[\alpha(\beta+1)\gamma(\delta-1)]$, and that of a_1 on the representative of a_2 is $[(\alpha+1)\beta\gamma(\delta-1)]$. The number of singular points situated on a_1 is $[\alpha\beta\gamma(\delta+1)]-[\alpha(\beta+1)\gamma(\delta-1)]$, and the number of those situated on a_2 is $[\alpha\beta\gamma(\delta+1)]-[(\alpha+1)\beta\gamma(\delta-1)]$.—Mr. Spottiswoode (the chairman *pro tem.*) and Prof. Clifford spoke on the subject of Dr. Hirst's communication.—Mr. Spottiswoode, F.R.S., next briefly stated some of the results given in his paper On the contact of quadrics with other surfaces. The following were amongst those stated:—Through any m (or $m+1$) points of space 3^{m-2} surfaces, having $2m-2$ (or $2m-1$) independent constants in their equation, can be drawn such that a quadric may be described touching any of the surfaces in the m (or in m out of the $m+1$) points. Thus for example:—the equation of a quartic scroll having a triple line is $(ax+by)zx^2+(cx+dy)wy^2-mx^2y^2=0$; hence, through any three points of space, three quartic scrolls having the same double line can be drawn such that a quadric may be described touching any one of the scrolls in the three points. Again, the equation of a quartic surface having for its nodal line the twisted cubic $p=xz-y^2=0$, $q=xw-yz=0$, $r=yw-z^2=0$, may be put in the form $ap^2+bq^2+cr^2+2(fqr+grp+hpq=0$, hence, through any four points of space, three quartics, having the same twisted cubic for their common nodal line, may be drawn such that a quadric may be described touching any one of the quartics in three of the points. Remarks were made on the paper by the president and by Prof. Clifford.—A paper by Mr. J. H. Röhrs, communicated by Prof. Cayley, was taken as read. Its subject was "The Rotation of a Hollow Sphere filled with viscous fluid and made to rotate about an axis through its centre under the action of an external impressed given periodic force."

Meteorological Society, May 20.—Dr. R. J. Mann, president, in the chair.—The following papers were read:—Some remarks on the estimation of wind force, and on the relation between pressure and velocity, by C. O. F. Cator, in which he first expressed a strong opinion on the impossibility of *estimating* the force of the wind with any degree of accuracy; but thought that for any useful purpose it must be obtained from *instrumental* observation. He then referred to the different notations for describing the wind, and condemned Beaufort's (0 - 12) as eminently unsatisfactory, both on account of the means by which the numbers were arrived at, and also especially because of the difference of standard for the lower and higher numbers. He suggested that during an observation the wind could not practically be described as an absolute force, on account of its frequent variations, but as a varying force, extending over two or three numbers; and then proceeded to account for the difference of force, as estimated, at any stations from different directions although the velocity as shown by Robinson's cups might be the same—partly by the position of the observer not being identical with that of the cups, and partly from the surrounding objects. He then suggested a new scale, and that whether pressure or velocity were the basis, it should increase in arithmetical progression, and concluded by expressing his preference for the former.—On the weather of thirteen winters, by R. Strachan.—On a new deep-sea and recording thermometer, by H. Negretti and J. W. Zambra.—On a new mercurial minimum and maximum thermometer, by S. G. Denton.

Anthropological Institute, May 26.—Prof. Busk, F.R.S., president, in the chair.—Mr. Hyde Clarke read a paper entitled "Researches in Prehistoric and Protohistoric comparative philology, mythology, and archæology, in connection with the origin of culture in America, and its propagation by the Sumerian or Akkad races." The author began with the illustrations of the common origin of culture in Asia, Africa, and America in a chronological series of the distribution of languages in the old and new worlds in the Prehistoric and Protohistoric epochs. These included the Negritos or Pygmeans, the Cannibal races, the Carib-Whydah-Aino, the Honduras African, the Khond-Wolof, the Agaw-Guarani, the Vasco-Kolaro-Lesghian, the Ugrian, the Sumerian, &c. New facts in comparative grammar were adduced, embracing the names of animals, of weapons, the series of negative terms, and the connection of philology, mythology, and archæology, with a table of convertible equivalents of primary radicals. The second part of the paper was devoted to a special consideration in detail of the community of the Aymara and Quichua of Peru, the Maya of Yucatan, and the Mexican with those of Cambodia, Pegu, and Indo-China, and of these again with the newly-deciphered Sumerian or Akkad (cuneiform) and the connection with Georgian and Etruscan. These were combined with the monuments, arts, and archæology of the respective countries. The author, referring to his identification of the languages of the Brazil with the Agaw of the Nile, and the Akkads of the Caucasus, supported the view that culture had been introduced into South America across the Pacific by Easter Island, and suggested that it was from one original source in high Asia.

Paris

Academy of Sciences, May 25.—M. Bertrand in the chair.—The Perpetual Secretary announced the death of M. Antoine-Marie-Rémy Chazallon, correspondent for the section of geography and navigation.—The following papers were read:—Note on the movement of the conical pendulum, with consideration of the resistance of the air, by M. H. Resal.—M. P. Desains presented the continuation of his paper on solar radiation. The author has employed in these experiments a modification of Nobili and Melloni's thermo-electric apparatus.—On the transformation of iron into steel, by M. Boussingault. The author's observations and analyses tend to show that melted steels of superior quality are really iron and carbon. As the quality improves sulphur diminishes, and they are generally free from phosphorus, while manganese and silicon rarely exceed 1·1000.—Observations on the spectrum of comets, by P. Secchi. The author has observed the spectrum of Winnecke's and Tempel's comet, and also of Coggia's. The results in the latter case point again to the existence of carbon in these remarkable bodies. In the same paper further evidence was adduced that the line 1,474 does not belong to iron; and the author communicated also an observation on the effect of atmospheric oscillation on the appearance of Jupiter's first satellite just before passing on to the planet's disc.—On the Vidal ebullioscope, by M. E. Malligand and Mlle. E. Brossard-Vidal. This instrument is for the valuation of wines, and other alcoholic liquids.—On a new mineral species from the province of Lerida, by M. X. Ducloux. The analysis agrees with the formula $Sb_2O_5+4CuAgCO_3$.—On the conditions of the persistence of sensibility in the peripheral extremity of sectioned nerves, by MM. Arloing and L. Tripier.—On the addition of elliptic functions, by M. E. Catalin.—M. l'Abbé Aoust presented a paper in reply to the observations made by M. Serret on his paper on the integrals of curves which have an even polar surface.—M. Ch. Bontemps communicated his third note on the motion of the air in pipes.—On the action of sulphur urea and of carbon disulphide on silver urea, by M. J. Ponomareff.—Researches on germination, by MM. P. P. Dehérain and E. Landrin. Experiments on grain have shown that no gas is so hurtful to germination as carbon dioxide.—On ammonia and ammonium phenate in the treatment of cholera and diseases produced by ferments *à propos* of serpent bites, by Dr. Déclat.

CONTENTS

Errata.—Omit "so" in p. 62, col. 2, line 22 from bottom; p. 63, col. 2, line 20 from top, for "individual" read "undivided."

THURSDAY, JUNE 11, 1874

METEOROLOGY—PRESENT AND FUTURE

METEOROLOGY has been happily divided by Dr. Balfour Stewart into two great sections, viz. physical meteorology and climatic meteorology.* The object of physical meteorology is to obtain a knowledge of the physics of the earth's atmosphere and surface; whereas climatic meteorology is properly the practical application of this knowledge in investigating the temperature, humidity, and movements of the air, together with the other atmospheric conditions which make up the climate of a place.

Owing to the complexity of the subject, the first step in meteorological inquiry is to lay down on the globe for each month of the year lines marking out the mean temperature, mean pressure, mean wind-direction, and mean rainfall. Roughly approximate averages are all that are required to begin with in order to mark strongly the broad features of the geographical distribution of these fundamental elements, from a knowledge of which the guiding principles of future inquiry can alone be safely obtained. Thanks chiefly to the labours of Dove, Buchan, and the Admiralties of Holland, the United States, and Great Britain, this preliminary information has been collected and placed in a handy diagrammatic form before the public; not, it is true, with the desired fulness, since considerable portions of the globe are still either not at all or very imperfectly represented. Nevertheless, enough is known to form a good basis for future action.

It is curious to note an undertone running through the works of nearly all writers on climate to the effect that if, for any place, the *mean* temperature, pressure, humidity, aqueous precipitation, and movements of the atmosphere be stated, its climate is thereby known. Nothing can be more fallacious, the truth being that such information does not enable us to define the distinctive characteristics of any climate. To do this we must have exact observations of, at least, the daily range of temperature, and humidity, the rate of movement of the wind over the place, the drying qualities of the air, the degree of cloudiness of the sky, and the manner, whether in drizzling or in heavy showers, in which the rain falls. And since the climate of a place cannot be properly defined except by comparison with the climates of other places, absolute uniformity of instruments, and their position, and in the methods of observation at different places is indispensable; for if this be not attended to, their climates cannot be compared.

Those conversant with the subject are aware how little has really been done towards making comparable and exact observations of atmospheric temperature and humidity, and wind, and towards laying down sound methods of discussing the observations so as to deduce results which will define numerically the distinctive features of climate. For instance, even as regards such striking facts as the arresting of the growth of trees, seen at so many points round the British coasts, we are not yet in a position to say whether the results be due to mechanical, chemical, or more purely climatic influences. To take a much simpler illustration, no one could venture to institute, on the basis of the temperature observations as at present made in different parts of the British Isles, a comparison of the climates of Shetland and Cornwall, Ayrshire and Kent, &c., in respect of their most essential characteristic, viz. the daily range of temperature, owing to the want of uniformity in the methods of observation.

In truth meteorology can as yet scarcely be said to have done more than collect the rough materials for future action, or rear the scaffolding for the future building. But the time has surely come when something more ought to be attempted. Researches in physical meteorology ought now to be systematically undertaken, and climatic meteorology prosecuted with more rigorously uniform methods of observation than has yet been done. We shall briefly indicate a few of the more important lines of research to be followed under these heads.

There is no question in meteorology calling so urgently for extensive, elaborate, and necessarily expensive, experiments and observations as that of the vapour of the atmosphere. Indeed, upon the right investigation and discussion of this element the great problem of weather changes depends. The vapour of the atmosphere as an absorbent and radiant of heat, and the relation of the pure gases of the atmosphere to the solar rays, are questions imperatively calling for investigation. Intimately bound up with the same inquiry is the temperature of the sky at different heights above the horizon and at different hours of the day, and the temperature of the clouds in connection with their formation and classification—all questions of the utmost importance, particularly in their bearing on the vital subject of terrestrial radiation.

Continuous observations with reference to the heating and actinic rays of the sun in order to ascertain the law of their periodicity and their relation to the sun-spot period already ascertained, and photographic and spectroscopic observations of the sun, are also clearly essential to the progress of meteorology, there being an intimate connection between sun observations on the one hand, and meteorology, as well as terrestrial magnetism, on the other. The electricity of the atmosphere also requires special and extensive investigation.

There is another large and difficult field of inquiry, which yields in practical importance to none, viz. investigations by which are sought to be attained the means of valuing scientifically the observations made at stations of the second order, to which alone we can look for carrying out the practical problems of the science in their bearings on health, agriculture, commerce, and other great national interests. Since the observations at these stations are not made by accomplished scientific men or skilled manipulators, it is indispensable that the instruments and methods of observation be of the simplest description. Only those refined methods of observation which are consistent with great simplicity are admissible for general adoption at ordinary stations. Thus observations of atmospheric temperature can be carried on at these stations with instruments and methods of observing which are strictly uniform with each other. But a question arises, how near do the results approximate to the true mean temperature of the air at the times of observation? The answer to this important question can only be obtained by special physical researches undertaken for the purpose. Again, it is highly probable that

* NATURE, vol. i. p. 101.

the dry and wet bulb hygrometer will, from its great simplicity and on the whole very satisfactory working, continue to be the most suitable instrument to put into the hands of ordinary observers for observations of the humidity of the atmosphere; and since the dew-point, elastic force of vapour, and humidity are not directly observed by this instrument, but are only deductions from the observations, it is most desirable that the methods of reducing the observations be the best attainable. The tables at present in use, while tolerably good for the temperatures ordinarily observed in this country, are very inaccurate for times of great drought and heat. Indeed it is essential to the development of this important branch of meteorology that the tables for the reduction of the hygrometric observations be submitted to a thorough revision, since reductions by different methods now in use give in extreme cases, from observations of the same air, dew-points differing fully 20°·0 from each other. Extensive experiments and observations are also required in order to ascertain the conditions of a good position for the anemometer, to devise some means for comparing velocity anemometers, and to determine the relation of the velocity of the wind to the pressure which it exerts. These important practical questions, of which we are at present altogether ignorant, can only be adequately investigated at an observatory devoted to researches in physical meteorology.

In order to complete the preliminary meteorological survey of the earth's atmosphere and surface it is indispensable that measures be taken to obtain observations from the less frequented regions of the ocean, from Arctic and Antarctic regions, large portions of British America, South America, Africa, and Polynesia; as well as observations of underground temperature obtained by improved methods at greater depths and from a more extended area of the earth's surface than have hitherto been made; and observations of the temperature of lakes at the surface, at great depths, and at their outflow. Till this be done our knowledge of terrestrial physics must be very imperfect. The extent of the British dependencies, the regions into which British commerce penetrates, and the readiness British "exiles" show to forward meteorological inquiries, point out that it is mainly to Great Britain we are to look to fill up the present blanks in the meteorology of the globe.

In working out the great national question of *local climates* it is absolutely indispensable that uniformity as regards instruments and methods of observation be secured at the different stations. This many-sided problem admits of different methods of treatment according as the inquiry is directed to agriculture, commerce, public health, or any of those other interests or pursuits which are more or less influenced by weather and climate. In investigating local climate in these relations new lines of inquiry must be set on foot. The nature and importance of some of these inquiries may be illustrated by referring to two lines of research recently taken up by the Scottish Meteorological Society, and noticed in NATURE at the time. It is proposed to inquire into the influence of the sea on climate, particularly the extension inland of this influence, which has so marked an effect on animal and vegetable life and such important bearings on the national prosperity, by establishing strings of stations from different points on the coast, and extending from the sea-shore to about two miles inland. It is further proposed to investigate certain of the more important practical problems—such as the relation of wind-force to the barometric gradient—by thickly planted *storm-stations*, radiating in lines in various directions from Edinburgh.

If meteorology is to be built on the solid ground of rigorously attested facts, it is imperative that measures be taken for the prosecution of such lines of investigation as those now indicated. To those who have given any consideration to the matter it is unnecessary to add that in no other way can the meteorology of the British Isles be placed on a thoroughly sound and satisfactory footing.

With reference to the means by which these physical and climatic researches in meteorology are to be carried on, it may be suggested whether, considering the local influence and knowledge which are absolutely essential for the successful prosecution of inquiries into local climates, it would not be the best as well as most economical course for the Government to avail itself of the assistance of the Meteorological Societies. On the other hand, the physical researches we have indicated, together with storm warnings, ocean meteorology, and some other departments of climatic meteorology beyond the power of Societies, can only be undertaken by the Government. In the future development of the meteorology of the British Isles, the co-operation of the Meteorological Societies with the Central Department is necessary, each having its own separate sphere of action, and each being to a large extent dependent on the other.

RECENT FRENCH GEOLOGICAL WORKS

Principes de Géologie Transformiste. Par Gustave Dolfuss. (Paris, Savoy, 1874.)

Eléments de Géologie et de Paléontologie. Par Ch. Contjean. (Paris, Baillière et Fils.)

THESE two recent French publications connected with Geology we propose to notice briefly together. In M. Dolfuss's earnest and suggestive little book another proof is given of the way in which the views of the Evolution School are permeating the minds of the rising generation of students in every branch of Science. If we may judge of the author from a perusal of his work, he is an enthusiastic palæontologist, who, drinking at the fountains of Darwinism, seeing clearly enough the tendency of modern thought, and full of dreams about the great future of his favourite science, has with the eagerness of a neophyte rushed forward to preach the creed which he so firmly believes. Whether or not this surmise be a true one, the book has much of the earnestness, ambition, vagueness, and inexperience of an early literary venture of an aspirant to fame. The real downright earnestness of the writer is one of the best features of the book. But we imagine that this quality would not have been impaired by a little delay in publication. The historical summary shows how limited is the author's range of reading. He speaks, for example, of Hutton having attributed everything in geology to the action of fire—an utter misconception and misstatement of the doctrines of the great philosopher.

He very properly claims for Constant Prevost a high

place in the list of writers by whom modern geology has been mainly influenced. Indeed the great merits of that far-seeing man are not properly understood and acknowledged even in his own country; they are almost unknown among ourselves. At the same time it is a great mistake to attribute to him, as M. Dolfuss does, the founding of the school whose leading principle is "the present the key to the past." Again Lyell's *Principles* are spoken of as having appeared in the same year (1827) with Prevost's early speculations. But the first volume of the first edition of Lyell's work was not published until 1830. While acknowledging the value of the English geologist's writings, M. Dolfuss passes a rather severe, and we think not wholly justifiable, criticism upon their style, going even so far as to say that it needs real courage to follow the author of the "Principles of Geology" through his weary digressions and diffuse detail of facts. In short, M. Dolfuss looks at the historical development of geological thought through a French pair of spectacles. And in his account of the present condition of geology, the doings of his friends in France bulk as largely as those of all the rest of the world put together. This is a very innocent vanity, especially as it is coupled with profound respect for, though inadequate knowledge of, the "opinions contemporaines à l'étranger." But it evidently deprives its author's summary of the weight which a broad and impartial review would have had.

As regards M. Dolfuss's facts, he certainly does not trouble us with any measure of that wearisome detail which he deplores in some English writers. Indeed, his references to the geological formations are so sketchy, that great portions of them might have been as well omitted. Greater development might have then been given to those whence the author can cite the largest body of evidence in favour of his views. It would have been still better, however, had he been aware of the researches made in other countries, notably in Britain, regarding the physical geography of former geological periods. He could then have filled up a good many blanks in his narrative, particularly as regards the older formations. He dwells on the artificiality of the subdivisions of the geological record, the necessity for constantly judging of their value by reference to analogous cases in operation at the present time, the value of a species in stratigraphy and in palæontology. Much of what he has to say on these subjects has long been familiar to working geologists in this country, and they will be pleased to see these sound notions gaining ground abroad, and displacing the systematic "cut and dry" measuring-rod style of subdivision and classification which looks so pretty in the pages of D'Orbigny, but which has no counterpart in nature. As a curious illustration of the want of wide reading we may notice that while discussing the nature and value of species as landmarks in the geological record the author seems unaware of Ramsay's important observations on "breaks in succession" among organic remains. We earnestly recommend him not to confine his studies to such foreign memoirs as may chance to find themselves honoured by translation into the *Revue des Cours Scientifiques*, but to seek out the original sources and learn what a vast amount of sound geological work bearing on the subject he has at heart has been accomplished in recent years outside of France, in which French geologists have taken no share, and of which it is to be suspected they remain to a large extent in wilful and perhaps happy ignorance.

Prof. Contjean's "Eléments de Géologie" is a singularly excellent work; in scope it travels over a vast range of subjects—astronomy, physical geography, meteorology, mineralogy, and other branches of Science, besides the two which specially appear on the title-page. So far as we have examined it, the book is careful, exact, and full. Prof. Contjean takes his readers first through planetary space, and having given them some notion of what it is he brings them down to Mother Earth, and proceeds to dissect her with great cleverness. At the outset he states the phenomena connected with the position of our globe as a planet, and then leads us through the physical characters of the surrounding atmosphere, the seas, and the solid crust, with its overlying plains, valleys, and mountains. Having in this way described the parts of the earth he proceeds to give a most clear and satisfactory account of the phenomena of which the earth is at present the theatre—those of the air, of water, whether solid, as snow and ice, or liquid, as rain, streams, and lakes; of the solid land, such as earthquakes and volcanoes; and, lastly, of the organic influences at work in producing changes on the earth's surface. On this solid foundation of knowledge as to what our globe is at the present time the author in the last part of his book builds his narrative of what that globe has been in past ages. He now gives a succinct and rather meagre account of rocks and minerals, followed up by a much better disquisition on sedimentation (a word, by the way which we might advantageously introduce into our English geological vocabulary). His paragraphs devoted to geological structure—faults, joints, cleavage, &c.—furnish a fresh example of how little the value of these parts of practical geology is understood abroad. What we ordinarily term stratigraphical or historical geology, that is the history of the various geological formations, occupies relatively but a small part of the book. It ought to have been fuller. The various formations for the sake of convenience might have been more sharply and clearly distinguished from each other in the printing. Above all information should have been given regarding the nature, succession, and geographical distribution of the several rocks or formations from which the story of the geological record is compiled. The palæontological *résumé* under each formation is good as far as it goes, and is well illustrated with good figures. Throughout the volume the illustrations are much above the average and have likewise the great redeeming feature of not being merely repetitions of the same old drawings which have done duty in text-books in almost every language under the sun for the last twenty or thirty years.

Prof. Contjean has produced a book which is likely to be in the highest degree useful to his countrymen. He not only gives a clear and intelligible digest of what is known regarding the several subjects on which he treats, but intersperses here and there original discussions of his own, which are full of interest, and give us a very favourable impression of his powers, both as a thinker and writer. We would especially cite his examination of M. Elie de Beaumont's theory of the elevation of mountain chains. In this country, where the theory of that distin-

guished French *savan* has never had any hold, it may seem superfluous now-a-days to take up time in the disproof of it. But those who know what a power Elie de Beaumont has been and still is in France, how with all his abilities and knowledge and the excellent service which he has rendered by his map and other publications, he has for many years been a kind of dark shadow on the progress of the newer geology in his country, will thank the Professor at Poitiers for taking such pains to demolish the *réseau pentagonal*.

OUR BOOK SHELF

Handbook of Natural Philosophy. By Dionysius Lardner, formerly Professor of Natural Philosophy and Astronomy in University College, London. "Hydrostatics and Pneumatics." New Edition, edited, and the greater part rewritten by Benjamin Loewy, F.R.A.S. (London: Lockwood and Co., 1874.)

DR. LARDNER'S treatise on Natural Philosophy is quite familiar to those who studied Science ten or fifteen years ago. Before Ganot and Privat-Deschanel were translated, Lardner was *the* book which everyone used. It was originally almost a translation of Pouillet's "Eléments de Physique," but was added to from time to time, and is still a valuable text-book, especially the new editions of it edited by Prof. G. C. Foster, and (as in the present instance) by Mr. Benjamin Loewy. The value of the book is indeed shown by the fact, that although first published many years ago, it is still deemed worthy of new editions, and of being edited by well-known men. The volume before us has been carefully edited, augmented to nearly twice the bulk of the former edition, and all the most recent matter has been added. The treatment is essentially experimental and elementary; a slight knowledge of mathematics is needful. It is to be regretted that Mr. Loewy has not introduced metrical weights and measures. A few omissions may be noticed: the *action latérale* of Venturi is scarcely alluded to; the theory of the trompe is omitted, as are also the hydrodynamic experiments of Plateau and Magnus, and the account of Dr. Guthrie's experiments on approach caused by vibration. But the book has in the main been carefully edited and improved.

Les explorations Sous-Marines. Par Jules Girard. (Paris: Libraire, F. Savy, 1874. London: Dulau and Co.)

NO nation surpasses the French in brilliant popular expositions of the various departments of Science. They already possess a large number of works of this kind, several of which have been translated into English, and the present work by M. Girard deserves to take its place among them as an extremely interesting and wonderfully full account of the numerous and valuable results which have of late years been obtained by deep-sea exploration. The two introductory chapters gives a rapid *résumé* of the history of deep-sea exploration, with a short description of the interior economy of the *Challenger*, and a clear and pretty full description of the various apparatus used in carrying on the explorations. The subsequent part of the work consists of four divisions, the first of which treats of the characteristics of the sea-bottom looked at in its geographical relations; the second treats of life in the depths of the sea, describing eloquently the various organisms which inhabit the ocean; the third division deals with the waters themselves, pointing out the chemical properties and the physical phenomena which take place in the midst of the ocean; in the last division an attempt is made to depict the seas of ancient geological epochs, and compare them with the discoveries which have been made by recent soundings. The author seems to have fairly mastered the literature of his subject, and has managed to write a book containing a vast deal of information conveyed in clear and eloquent language. The work is profusely illustrated with artistically executed, useful, and most attractive woodcuts. The work might well be translated into English.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

The Habits of various Insects

[The following letter on this subject, from Fritz Müller to Mr. Charles Darwin, F.R.S., has been forwarded to us for publication by the latter.—ED.]

I DELAYED answering your kind letter of January 1 till I should have had an opportunity of examining once more some nests of leaf-cutting ants, to which you had directed my attention. In the meantime I received Belt's "Nicaragua," which I have read with extraordinary interest, and for which I must express to you my hearty thanks.

I was much surprised to learn from Mr. Belt's book how closely the far-distant province of Chontales resembles by its vegetation and animal life our own of Sta. Catharina. I am thus enabled fully to appreciate the exactness of many of his statements; he is an excellent observer, and most of his theories are very seducing. As to leaf-cutting ants, I have always held the same view which is proposed by Mr. Belt, viz. that they feed upon the fungus growing on the leaves they carry into their nests, though I had not yet examined their stomachs. Now I find that the contents of the stomach are colourless, showing under the microscope some minute globules, probably the spores of the fungus. I could find no trace of vegetable tissue which might have been derived from the leaves they gather; and this, I think, confirms Mr. Belt's hypothesis. Here, as in Nicaragua, the Cecropiæ are always inhabited by ants, but, I think, by only a single species. I have cut down hundreds of them and never missed the ants. I wonder that it had never occurred to me that the trees are protected by the ants; but there can be no doubt that this is really the case, for young plants of Cecropiæ, not yet inhabited by ants, are often attacked by herbivorous insects.

A few days ago I caught on the flower of a Vernonia a female moth belonging to the Glaucopidæ, of which family there are here numerous species. When I seized it by the wings nearly the whole body became suddenly enveloped in a large cloud of snow-white wool, which came out of a sort of pouch on the ventral side of the abdomen, and consisted of very thin flexuous hairs 1—2 mm. long, three, four, or five of which used to proceed from the same point. I preserved the moth alive for some time, and as often as I seized her by the wings, by inflating the abdomen, a large naked membrane became visible, and somewhat protruded behind the first (white) segment of the ventral face of the abdomen (the rest of which is black), and a little more wool appeared under the posterior margin of this segment. I am at a loss as to the meaning of this curious contrivance. There is in the males of the same family an interesting secondary sexual character; they are able to protrude from near the end of the abdomen a pair of long hollow hairy retractile filaments, which in some species exceed the whole body in length. In the beautiful *Belemnia inaurata* there is a second pair of shorter filaments which are wanting in all the other species I examined (*Eunomia eagrus, Euchromia jucunda, Agyrta cærulea, Eudule invaria, Leucopsumis* sp., *Philoros* sp., &c., the names of which I owe to the kindness of Dr. A. Gerstäcker, of Berlin). In some species, most distinctly in *Belemnia inaurata*, I perceived a peculiar odour when the filaments were protruded; this, I think, may serve to allure the females, which in all our species appear to be much less numerous than the males.

I mentioned to you that with our stingless honey-bees wax is secreted on the dorsal side of the abdomen; now this is also the case with some of our solitary bees, for instance, *Anthophora fulvifrons* Sm., and with some species nearly allied to that genus. These solitary bees probably use the wax only to cement the materials with which they build their nests. Our species of Melipona and Trigona also never employ pure wax in the construction of their cells or of the large pots wherein they guard their provisions; they mix it with clay, resinous substances, &c., so that in some species wax forms hardly 10 per cent. of the material. The only case, as far as I know, in which pure wax is

used, is in the construction of a tube, which *Trigona jaty* Sm. builds at the entrance of its nest.

Among European Apidæ, Apis and Bombus are the only genera which wet with honey the pollen they are collecting, and in consequence of this habit the hairs on the outside of the tibiæ of the hind-legs have disappeared. This is also the case with our Meliponæ, Trigonæ, and Euglossæ. Now Centris, Tetrapediæ, Epicharis, and some other bees, collect pollen in the same way; but notwithstanding, in some species, the hairs on the tibiæ are developed in an extraordinary degree. This seemed to me rather perplexing, till I lately observed several species of Centris and a Tetrapedia gathering sand in the large hair-brushes of the hind-tibiæ, which accounts for the conservation and excessive development of the hairs.

With one of our smallest Trigonæ (*T. mirim* n.sp.), of which I have two hives in my garden, I have made a long series of observations on the construction of the combs, in which the young are raised. As in all other species the combs are horizontal and consist of a single layer of hexagonal cells, like those of wasps; but the cells are vertical. There is always in this species (other species behave differently) a set of cells constructed at the same time in the circumference of the two or three uppermost combs. When the cells are ready, they are filled with food, which the bees vomit from their mouths, the queen lays an egg into every cell and these are then immediately shut. The eggs at first lie horizontally; but in the course of the first or second day they assume a perpendicular position, with the thicker end turned upwards, dipping but slightly into the semi-fluid food. The combs are never used more than once; as soon as the young bees have left them (five to six weeks after the laying of the egg) they are destroyed and new ones built in their place.

Once I assisted at a curious contest, which took place between the queen and the worker bees in one of my hives, and which throws some light on the intellectual faculties of these animals. A set of 47 cells had been filled, 8 on a nearly completed comb, 35 on the following, and 4 around the first cell of a new comb. When the queen had laid eggs in all the cells of the two older combs she went several times round their circumference (as she always does in order to ascertain whether she has not forgotten any cell), and then prepared to retreat into the lower part of the breeding room. But as she had overlooked the four cells of the new comb the workers ran impatiently from this part to the queen, pushing her, in an odd manner, with their heads, as they did also other workers they met with. In consequence the queen began again to go around on the two older combs, but as she did not find any cell wanting an egg she tried to descend; but everywhere she was pushed back by the workers. This contest lasted for a rather long while, till at last the queen escaped without having completed her work. Thus the workers knew how to advise the queen that something was as yet to be done, but they knew not how to show her *where* it had to be done. In the same hive there appeared to be two political parties among the workers, dissenting about the construction of the combs, one destroying what the other had begun to build; but it would require a very long and tedious exposition to give you the details of the case.

Our several species of honey-bees differ as much in their mental dispositions as they do in external appearance and size (the smallest species, called *Trigona lilliput* by my brother, is only about 2·5 mm. long). Some rush furiously out of their nest, whenever an enemy approaches it, attacking and persecuting the offender; others are very tame, and permit close observation of all their work. In one large species I could even observe with a lens the act of their sucking a solution of sugar, which I had given them, and there was no doubt that at least these bees really suck, and do not lap, like dogs or cats, as Milne Edwards, Gerstäcker, and most entomologists think.

There is one species (*Trigona liomão* Sm., named for my brother by Mr. Frederick Smith himself) which never appears to collect honey or pollen from flowers, on which, at least, I have never seen it. It robs other species of their provisions and sometimes takes possession of their nests, killing or expelling the owners. The hives in my garden have often been invaded, and two of them destroyed, by these robbers, and I have seen in the forest several nests, formerly inhabited by other species, occupied by them.

Together with my brother at Lippstadt I intended to publish an essay on the natural history of our stingless honey-bees, but it will probably cost some years to give a tolerably complete account of them. FRITZ MÜLLER

Itajahy, Santa Catharina, Brazil, April 20

Eozoön canadense

I DESIRE permission to state, in your journal, my entire agreement with the explanation of the actual structure of this fossil given by Dr. Carpenter in the Ann. Nat. Hist. for April. Though it may not be necessary to corroborate, in any way, the decisions of so great an authority on *Foraminifera*, or to add to illustrations so clear and convincing, my testimony may not be without its value; since, in addition to work in micro-geology extended over more than thirty years, and some familiarity with modern *Foraminifera*, I have, in the original examination of *Eozoön*, undertaken at the request of Sir William Logan, studied larger suites of specimens of typical *Eozoön*, and of materials supposed to resemble it, not only from Canada, but from other localities, than any other person.

I have the more pleasure in bearing testimony to the "tubulated primitive chamber-wall," because this was not manifest in my original specimens, and was first made out by Dr. Carpenter in those submitted to him from *Petite Nation* after my original description was written. I did not, however, take it for granted even on Dr. C.'s testimony, but satisfied myself of the organic nature of the structure by careful examination and comparison with the Chrysotile and other fibrous minerals occurring in connection with some of the specimens.

Part of a Calcareous lamella of *Eozoon canadense*, showing at *a a* the tubulated structure of the proper wall of the chamber or "nummuline layer," perfectly differentiated from the serpentine chamber-cast on which it abuts, and at *a' a'* a line of flexure of the tubuli, corresponding with that often seen in dentine and other tubulated calcareous structures; *b*, origins of the "canal system" in irregular lacunæ of the "intermediate skeleton" on the exterior of the proper wall of the chamber, precisely as in *Calcarina*; *c, c*, "intermediate skeleton," traversed by cleavage-planes, whose extension into the "nummuline layer" proves it to be a part of the calcareous, not of the serpentinous, lamella.—From a figure given by Dr. Carpenter from the Ann. Nat. Hist. for June.

It is not surprising that *Eozoön* mets with some opponents. There are few naturalists who have sufficient familiarity with the structures of modern *Foraminifera*, and with those strange and gigantic representatives of the *Protozoa* found in the Primordial and Silurian rocks, to appreciate the importance of the structures it presents. Still fewer have added to this experience by the study of the structures of the fossils of the more ancient rocks as they appear under the microscope, and of the conditions of mineralisation of such fossils. The intelligent appreciation of the claims of *Eozoön* must, therefore, be of slow growth; and the controversies respecting it will be finally settled only when the other organisms of which traces exist in the Laurentian rocks are better understood, and when the *Protozoa* of the Cambrian and Silurian have been more thoroughly investigated. These desiderata are gradually being supplied; and I venture to predict that before many years have passed, palæontologists will be required to extend their belief to several other Laurentian and Primordial *Foraminifera* besides *Eozoön canadense* and *Eozoön bavaricum*. J. W. DAWSON

McGill College, Montreal, May 15

Proportionality of Cause and Effect

IT does not surprise me that Mr. Hayward gives up in despair the attempt to make Mr. Spencer conscious of the fallacies in his logic. But as from the first I have addressed myself to Mr. Spencer's readers, I must in justice to myself point out to them the true

nature of the controversy in order to counteract the effect of Mr. Spencer's endeavours to represent it as a controversy between those who think that forms of thought become hereditary and those who do not. The original attack centred upon the fallacious character of certain would-be *à priori* proofs of physical laws. Mr. Spencer has tried to parry the attack by maintaining that the writer misunderstood the sense in which the phrase *à priori* was used. That the new interpretation was not the one which it was at the time intended to bear is rendered as clear as the English language permits by his speaking of one of these truths as *not* resulting "from a long registry of experiences gradually organised into an irreversible mode of thought," and his using similar, or even stronger expressions of the others. But this is, after all, not the real issue. No definition of *à priori* would cure the fallacies in the proofs in question or in the subsequent attempts that he has made to support them. They are as illogical with the one definition as with the other; and the sole result of Mr. Spencer's change of front will be, I think, to supply the critics of his writings on Physics with another instance of his habit of changing the meanings of the terms he employs without perceiving that by so doing he forfeits the right to use previous conclusions, even though legitimately obtained, and destroys all connection between the bases and the later parts of his system.

As I have already said, I have been chiefly addressing myself to Mr. Spencer's readers. My aim has been to show that his writings on Physics are marred by superficial and inconsistent views of the subject-matter and fallacies in reasoning thereon. I have been accused of being too violent in my language, and some of my friends have urged, like Mr. Hayward, that it would have been better had I used expressions which less adequately conveyed my (and their) opinion of the magnitude of the errors I was attacking. As I have left the department of personal abuse wholly to Mr. Spencer, I do not think he has much right to complain, even though I have not hesitated to call absurdities by what seemed to me descriptive and suitable titles, and I will conclude this by calling attention to a last effort by Mr. Spencer to show that there is some excuse for expressive language on my part, provided always it is directed to the blunder rather than to the blunderer.

IN NATURE, vol. ix. p. 461, Mr. Spencer asserted that the second law of motion was a mere corollary from the general postulate that cause and effect are necessarily connected together, and in all cases by definite quantitative relations. As every mathematician will at once see that there is a great difference between asserting that there is *some* definite relation between cause and effect and asserting that this relation is the *particular one* of direct proportionality, it will be asked how he came to consider the one a mere deduction from the other? It will be seen, on examination of the passage, that he is misled by a couple of instances that he cites (and of course he might have cited countless others), where there is this simple relation between a prominent part of the cause and a prominent part of the effect. The fallacy of this was pointed out by a writer who signed himself "A Senior Wrangler" in the next number of NATURE, and to this Mr. Spencer replies in the number for May 7:—

"Nor should I care to discuss any question with my new anonymous assailant, who, when certain examples given *show the 'exact quantitative relations spoken of to be those of direct proportion,'* describes me as 'intensely unmathematical,' because I subsequently use the more general expression as equivalent to the more special—which, *in the case in question*, it is."

Now, in the first place, the phrase "certain examples show," amounts to admitting that the argument is inductive in its nature, which is inconsistent, to say the least, with the professions he makes, for the proof is not only not to be an inductive one, but is to render it clear that no such proof of the matter in question could possibly exist; but this is a trifle to that which follows it. Can anyone avoid admitting that the italicised words leave Mr. Spencer committed to at least one of the following propositions:—

1. That these (and similar) instances establish the proposition that the 'exact quantitative relations' between cause and effect are, *in all cases*, those of direct proportionality.

2. That in a proof (other than an inductive one) you may assume the result during the progress of the argument without invalidating the proof.

The first of these is saved from being pronounced contrary to fact by being discovered, on closer examination, to be meaningless; nothing but the most superficial notions of the meanings of the words cause and effect can prevent its being seen to be unmeaning. The second is too common a logical error to need exposing. What examiner in Euclid has not rejected attempts at the solution of geometrical deductions for this fallacy? If a boy has to prove a triangle to be equilateral, cruel mathematicians do not allow him to assume that it is so in the course of his proof. But Mr. Spencer would take a more lenient view of the matter, and would allow him to use "the more general expression (*i.e.* triangle) as equivalent to the more special (*i.e.* equilateral triangle), which, in *the case in question*, it is."

THE AUTHOR OF THE ARTICLE ON HERBERT SPENCER IN THE BRITISH QUARTERLY REVIEW.

MR. COLLIER, in his anxiety to "transfix" me on one of the horns of a dilemma, has shown himself strangely blind to the fact that he could only do so by thrusting at me through the body of his leader, Mr. Spencer. My wound is consequently but skin deep; but what of Mr. Spencer's?

As I have carefully avoided representing Mr. Spencer otherwise than by quoting his own words, the charge of "misrepresentation" (an ugly word, which, I think, Mr. Collier, on reconsideration, will regret having used) falls to the ground; and if, as Mr. Collier clearly enough shows, there be inconsistency in the phraseology used by Mr. Spencer at different times, the responsibility rests with Mr. Spencer and not with me.

The facts are briefly these:—Mr. Spencer first asserted the Second Law of Motion to be an "immediate *corollary of the preconception*," &c. I criticised the assertion. Mr. Spencer characterised my criticism as a proposal to "exemplify *unconsciously-formed preconceptions.*" I did not care for the moment to quarrel with this description lest I should multiply and thus "confuse the issues" between us; and so adopting the phrase under the safeguard (insufficient as it now appears to have been, at least for Mr. Collier) of the usual marks of quotation, I noted what appeared to me an admission, implied in Mr. Spencer's remarks, and important as bearing on the real issue between us, that the Second Law of Motion is a "*consciously-formed hypothesis.*" Mr. Collier has done well in calling attention to the discrepancy between the first two phrases italicised. He might also have noted the discrepancy between both of these and the third. But the phrases are Mr. Spencer's; and the only crime to which I can plead guilty is that of not having seen the necessity of more explicitly repudiating Mr. Spencer's characterisation of my criticism, and thus saved Mr. Collier from bringing charges against me of "confusing issues," &c., which I can only transfer to Mr. Spencer.

And now having cleared the path of the personal questions which Mr. Collier has raised, I would appeal to him to obtain for me and other perplexed readers of NATURE an authoritative statement as to what Mr. Spencer's latest views as to the Second Law of Motion are. Does Mr. Spencer regard it as an "unconsciously-formed preconception," or as a "corollary of a preconception," or as a "consciously formed hypothesis?" Each of these views seems to be deducible from Mr. Spencer's language, but I agree with Mr. Collier that they can hardly be regarded as one and the same thing.

I would also remind Mr Collier that no answer has yet been given to the difficulties which in my first note I showed to attach to the view of the Second Law of Motion as a "corollary of a particular preconception;" and that, unless Mr. Spencer, or Mr. Collier on his behalf, can show that these difficulties are imaginary, judgment will be recorded against them by default by all readers of NATURE who have had patience to follow the controversy thus far. ROBT. B. HAYWARD

Harrow, June 6

I OUGHT to thank Mr. Collier for the care with which he has explained his previous letter, but to assure him at the same time that I fully understood it before; his italics have only made plain what was accurately and lucidly expressed before, and have only served to convince me that I thoroughly understand his position, and that it is wholly untenable.

I will make one more effort to show this, by pointing out one of the fallacies in Mr. Collier's last letter. He says "Mr. Spencer alleges that this cognition of proportionality is *à priori*; his opponents affirm that this cognition is *à posteriori.*"

The "cognition" spoken of is not one, but two. Mr. Spencer alleges that a conviction of a quantitative relation of some kind between cause and effect, such that the greater cause produces the greater effect, grows in our minds from experiences which are antecedent to reasoning. No one denies it. But to call this a cognition of *proportionality* is so utterly inaccurate an expression as to astound me. And the consequences of the inaccuracy

are immediate and evident; it is believed that special cases of proportionality are involved in the general relation, and hence that Newton's Second Law is an *à priori* cognition.

But the cognition which his opponents affirm is a very different cognition, though this is an odd name to give to a mathematical doctrine. What his opponents affirm is that in certain cases forces measured in a certain way are proportional to their effects measured in a certain way; and by proportional they mean proportional and not something else. They affirm that experiment and observation are necessary to ascertain this proportionality; and that experiment and observation, and the method of verification, furnish overwhelming evidence in favour of the truth of Newton's laws. Their best proof is the *Nautical Almanac*, to those who can understand it and them.

I believe the *à priori* method to be as utterly barren in the future as it has been in the past. When a new truth has been discovered it is easy to say that it is evident *à priori*. Some day the laws of the actions of molecules and their relations to heat and electricity will be discovered by physicists; but I imagine they will be physicists of the type of Rumford and Faraday and Thomson and Maxwell. Meantime it is open to any *à priori* philosopher to anticipate the future.

And now, as far as I am concerned, this correspondence will cease. Mr. Collier is polite enough to say that my letter would have confirmed Sir W. Hamilton in his conviction that the narrow discipline of mathematics produces an incapacity for general reasoning; and he therefore cannot be anxious to continue a correspondence with one so contemptible, so stupid, and so ignorant as he plainly believes me to be.

A SENIOR WRANGLER

I SHALL be obliged if you will permit me to correct a verbal error, of some importance, in my letter (NATURE, vol. x. p. 84). The words "*finished conception*," in col. 2, line 26, should be "*finished pre-conception*." J. COLLIER

The Glacial Period

BOTH Mr. Belt and Mr. Bonney, have, I think, missed the one point on which the question under discussion turns. The shell-bearing drift-gravels are *well stratified*. I can speak to those in the neighbourhood of Macclesfield, which run up to 1,100 ft. above the sea, being also very delicately current-laminated. I am puzzled to imagine how this structure could be obtained if the gravels were brought to their present position in the way Mr. Belt supposes; indeed its presence seems to me fatal to his hypothesis. It is not the case moreover that all the shells are smashed and scratched. At Macclesfield most of the shells are broken, as one would expect to be the case if they had been tossed about on a shingle-beach; but entire specimens were not very rare. As for scratches, I never saw one on either the shells or the pebbles of these gravels; in the boulder clay, where the included stones are scratched, scratches are occasionally seen on the shells as well. A. H. GREEN

Cockermouth, June 6

VENUS'S FLY-TRAP (*Dionæa muscipula*) *

THERE are two ways of studying a plant or an animal. One of these consists in the mere contemplation and description of its external aspects and behaviour. Persons who occupy themselves with this sort of study are commonly called naturalists; for it is by them that by far the greater proportion of the facts we possess relating to natural objects has been gained.

But there is another and a much better sense in which a man may be said to be a naturalist. The true naturalist does not content himself with standing at one side and watching the proceedings of nature as a mere spectator. Animated by that insatiable scientific curiosity from which some shrink, in the fear lest it should carry them too far, while the greater part are indifferent, he occupies his whole life in seeking to lift the veil from all that is hidden in nature and in discovering and exposing the springs of every secret process. His restless spirit cannot content itself with contemplation of the mere external aspects of living beings nor even with the most minute and searching study of the forms and structure of organic life. For even if he begin as a botanist or zoographist, a mere describer of plants or animals, he is forced by the perception of that general adaptation of means to ends and ends to means which he sees everywhere, to become first an anatomist then a physiologist. The study of these external aspects leads him, if possessed of that curiosity which is his characteristic attribute, to study their minute structure, and this, the further he goes into it, stirs up in him the desire to penetrate further into the mysteries of their being. For the delight and interest with which the forms, colours, and structure of animals and plants fill us is derived from the conscious or unconscious perception by our minds of their *adaptation*—their fitness for the place they are intended to occupy. I would go further even than this, and maintain that our artistic perception of beauty in nature is, I believe, in great measure derived from the same source.

But to understand nature in the sense of the naturalist we must know not only those aspects which she is willing to present to us but those she is determined to hide. For this end, when we cannot get at what we want by persuasion, we are often obliged to use compulsion.

It is constantly happening to the naturalist, that he has a process, a contrivance before him, a series of phenomena the connection or evolution of which he cannot understand. He stands at one side and watches and learns but little, for nature refuses to tell *why* she does this, or *how* that. Under these circumstances, which recur, not once in a way, but daily and hourly in the study of plant and animal life, what is he to do? Is it his duty to sit down respectfully and wait, in the hope that what is now difficult and obscure may, by the light thrown upon it from right or left, become more or less clear and intelligible? No. This is not the spirit of the naturalist. If nature conceals the truth, we frankly deny her right to do so, and wrest it from her by force. If circumstances are unfavourable, we alter them to suit our ends. If, as repeatedly happens, a number of antecedents are seen to lead to one event, if a number of apparent causes conspire to one result, we proceed in our investigation by taking away first one, then others of these antecedents, until by a succession of trials (or as they are commonly called experiments) we find the true one, viz. that of which the removal or modification abolishes or alters the event. It is thus, and thus alone, that we compel nature to tell "that wherein her great strength lies."

It is my purpose in this lecture to illustrate to you if I can, by an example, that the systematic application of the method of experiment is the only method by which it is possible to become so acquainted with the forces of nature as eventually to be able to convert them to useful purposes (and this is one, though by no means the highest, end of natural knowledge). More particularly is it true of that branch of natural knowledge which *par excellence* we call physiology, that it is by experiment alone that progress has been or can be made; the whole subject being in its present state but a system of experimental results.

A while ago I applied the term forcible to this method because it is the plan by which, as Bacon said, we torture nature. But let us remember that this is a mere figure of speech. In disciplining nature to our ends, in forcing her to give up her secrets, we use no violence, but utmost gentleness. Plant or animal, to be made to tell its story, must be delicately handled, so delicately that, by association, the very care which the naturalist, for scientific ends, bestows on animals and plants, unavoidably engenders a love for them. However right and necessary it may be that we should to-night destroy and mangle these beautiful leaves for our own pleasure and instruction, let us not do so recklessly, for the life and beauty we destroy we cannot with all our science bring back again or imitate.

The name *Dionæa muscipula* was given to the plant when it was first imported from America. It belongs to the family Droseraceæ, a very natural one, *i.e.* one in

* Lecture by Dr. Burdon Sanderson, F.R.S., at the Royal Institution, Friday evening, June [illegible], 18[illegible]

which the family characteristics are so well marked that in no individual member of it can the signs of original relationship be mistaken.

In speaking of original relationship, I refer rather to that of descent or ancestry than to community of parentage. Thus in this order we have distinct evidence that in the Drosophyllums, Droseras, Dionæas, which constitute the family, the peculiarities which they have in common and by which they are distinguished from other plants are not possessed by them in equal development and completeness, so that here as elsewhere the more developed forms stand to the less perfect ones rather in the relation of descendants than in that of cousins.

In the Droseraceæ the most striking peculiarity is one which is entirely functional or even teleological. It consists in this, that each member of it possesses in one way or other adaptedness to one and the same end. This end is the catching of insects, and not only catching them but digesting them, using them as food in short, just as animals do. These animal endowments, which have for some years engaged the attention of our great naturalist, are possessed (as we hope he will some day show us) by each individual species in a degree which, in the main, corresponds to the general development of the plant; so that each advance from less to more perfect form and structure is accompanied by an improvement in its adaptedness to the function of preying upon insects.

Description of the Plant.—Of root and flowers I need say little or nothing. It is the leaf to which I have to ask your attention. It is of very peculiar form. The blade of the leaf consists of two nearly semicircular halves or lobes, which are united together along their straight borders by a strong mid-rib. On to this the two lobes are set in planes which are nearly at right angles to each other. The curved outer edge of each lobe is strengthened by a thickened border or hem. From the hem spring some twenty spikes on either side, which are directed upwards and inwards. The under surface is bright green, smooth and glistening, and is marked with parallel streaks. The upper surface is pink or red, and is beset with little red projections, which are called glands.

In addition to these glands there are on the upper surface of each lobe of the leaf three spines, which are of extreme delicacy and are always arranged as if at the angles of a triangle, about the middle of the lobe. The petiole or leaf-stalk is of the shape of the handle of a tea-spoon, the only difference being that its upper surface is channelled along the middle instead of being flat. At its end it is united to the leaf by a jointed isthmus, of about a line in length and breadth

The mechanism by which the leaf catches insects is strikingly like that of a rat trap. When it is open the lobes are, as I have said, at right angles to each other. When an insect comes into contact with either, at once they approach each other, but this does not occur with the suddenness and completeness that it occurs in the rat trap. The lobes begin to close sharply enough, but do not come quite together, remaining for some time *entr'ouvert*. When the leaf is in this state of half closure, it is easy to see what is the significance of the two sets of prongs already mentioned. You see that they are set on alternately along the opposite edges of the lobes, so that just like the teeth of the rat trap they fit into each other. It is not difficult to see why this is, *i.e.* why the spikes are arranged alternately. The leaf, being a trap, is made like a trap. But I should not have been able to tell you why the leaf does not at once close on its prey had not Mr. Darwin told me. After having partially closed, as I have said, one of two things may happen. The insect, having been caught, at once begins to think of escaping, and makes efforts to do so, which may or may not be successful. If it is small, it easily finds its way out through this wonderful grating formed by the crossing of the teeth; and in this case the leaf soon recovers, expands again, and is ready for the capture of another victim. If it is large all its efforts to regain its liberty are futile. Repelled by its prison bars, it is driven back upon the sensitive hairs, which stick into the interior of its cell, and again irritates them. By doing so, it occasions a second and more vigorous contraction of the lobes. The result is that the creature is not only captured, but crushed; not only swallowed, but, as I have already said, digested.

In all this we see a wonderful completeness of adaptation for a purpose; but I fancy that the purpose itself would be considered unworthy or even immoral by some persons. Just as in the "gentle craft" the small fry are rejected and thrown back again into the water to enjoy a little more life and to be better prepared for their future destiny, so the plant, not quite for the same reason, acts in a similar manner. The angler rejects the small fish with a view to their future and his own, for he wants them to grow larger that he may have the better sport out of them afterwards; but the plant lets the little insects go, because it would cost too much to keep them; and this leads me to the description of what happens to the leaf and to the poor fly when it is big enough for the leaf to find it worth while capturing, *i.e.* when it is too big to slip through the bars.

Digestion of Dionæa.—Even after slight irritation, such as that which is produced when a fly merely touches one of the sensitive hairs, or when they are touched with a dry camel-hair pencil, the leaf remains closed for some time, usually more than twenty-four hours. But if a fly is caught, or any other nutritious substance is introduced, the case is different. For a week or more the leaf remains closed on its prey, the two lobes being at first pressed flat against each other. The two lobes indeed close round the fly so completely that its body gives rise to two projections of the (outer) surface of each lobe, which correspond to it in form. The result of this is that the secreting glands on the part of the leaf against which the body of the fly presses are irritated, and begin to pour out a quantity of secretion. Gradually this effect extends to the rest of the leaf, and consequently its cavity becomes gradually extended.

The meaning of this bulging is that the fly is becoming digested. The liquid juice which the glands pour out has the property of so acting on the tissue of the fly's body that they at first become diffluent and then are absorbed.

When we call this process "digestion" we have a definite meaning. We mean that it is of the same nature as that by which we ourselves, and the higher animals in general, convert the food they have swallowed into a form and condition suitable to be absorbed, and thus available for the maintenance of bodily life.

The nature of animal digestion is best explained by examples. If I take some starch, which is not soluble, and put it into my mouth, and keep it there for a certain time, it has become first soluble, and finally transformed into a substance quite different in properties. If we examine into this process we find that the change of starch into sugar takes place, because there exists in saliva a ferment called ptyaline. We know that it is the ptyaline which does the work, because if we separate this substance in a solid state, then dissolve it in water in which starch is diffused, the starch is converted into sugar. We call it a ferment, for two reasons—first, because, like leaven, it acts in small quantity, a mere trace being sufficient; and secondly, because it does not itself take part in the transformation. This is one example, and a very simple one; but it is not with this that we compare the digestion of Dionæa, but with that which in man and animals we call digestion proper, the process by whch the nitrogenous constituents of food are rendered fit for absorption. This takes place, not in the mouth, but in the stomach. It also is a fermentation, *i.e.* a chemical change effected

by the agency of a leaven or ferment which is contained in the stomach-juice, and can be, like the ferment of saliva, easily separated and prepared. As so separated, it is called pepsin (the medicine called by that name is supposed to contain some of it, and indeed often does). Consequently, having the ferment, we can easily imitate digestion out of the body. For this experiment there are three things necessary—first, that our liquid should contain pepsin; secondly, that it should be slightly acid; and thirdly, that it should be kept at the temperature of incubation, *i.e.* about 97° F. We select for the experiment a substance which, although nutritious and containing nitrogen, is not easily digested—such, for example, as boiled white of egg. In water containing a small percentage of hydrochloric acid and a trace of pepsin, it is gradually dissolved; but chemical examination of the liquid shows us that it has not been destroyed, but merely transformed into a new substance, called peptone, which is afterwards absorbed, *i.e.* taken into the circulating blood.

Between this process and the digestion of the Dionæa leaf, the resemblance, as Mr. Darwin has found by a most elaborate comparative investigation, is complete. It digests exactly the same substances in exactly the same way, *i.e.* it digests the albuminous constituents of the bodies of animals just as we digest them. In both instances it is essential that the body to be digested should be steeped in a liquid, which in Dionæa is secreted by the red glands on the upper surface of the leaf; in the other case, by the glands of the mucous membrane. In both the act of secretion is excited by the presence of the substance to be digested. In the leaf, just as in the stomach, the secretion is not poured out unless there is something nutritious contained in it for it to act upon, and finally in both cases the secretion is acid. As regards the stomach, we know what the acid is: it is hydrochloric acid. As regards the leaf, we do not know precisely as yet, but Mr. Darwin has been able to arrive at very probable conclusions, the setting forth of which we look forward to in his expected work on the Droseraceæ.

(*To be continued.*)

REPORT OF PROF. PARKER'S HUNTERIAN LECTURES "ON THE STRUCTURE AND DEVELOPMENT OF THE VERTEBRATE SKULL" *

IV.

IN the Teleostei the jaws attain their maximum amount of mobility, and the articulation of the lower jaw is, consequently, brought to the farthest possible distance from the skull, by the disjointing of the mandibular arch from its original attachment. This arch consists of two cartilaginous bars (see Fig. 11, Pl.Pt and Mck) corresponding to the upper and lower jaws of the shark or ray, but containing certain important ossifications. The apex of the arch, corresponding to the spiracular cartilage of the ray, is formed by the meta-pterygoid (Fig. 7, M.Pt), below which, and separated from it by a broad synchondrosis, is the quadrate (Qu) bearing a rounded articular surface for the mandible. In the pterygo-palatine cartilage are three ossifications—the palatine (Pl), pterygoid (hidden in the figure by the maxilla and jugal), and mesopterygoid (Ms.Pt). The proximal portion of the originally cartilaginous lower jaw is ossified by the articular (Art), while its distal portion remains as the comparatively slender Meckel's cartilage, running on the inner side of the dentary, almost to the symphysis.

As in the Elamobranchs, the proximal part of the hyoid arch forms the suspensory apparatus for the jaws, but unlike the corresponding cartilage in those fish, contains two ossifications, the large and massive hyo-mandibular (H.M), articulating with a cartilaginous surface afforded to it by the sphenotic and pterotic (see Fig. 9), and the symplectic (Sy) below, which, fitting into a groove in the quadrate, firmly binds together the hyoid and mandibular arches. The free portion of the hyoid articulates with the cartilaginous space between the hyo-mandibular and symplectic, through the intermediation of a small bone (shown in Fig. 7 by dotted lines, being hidden by the pre-opercular), called by Cuvier the stylo-hyal, but better named inter-hyal, as it is not the homologue of the mammalian styloid process. The hyoid cornu is segmented as in the ray, except for the fact that there is a median basal piece, usually called, from the circumstance of its giving support to the tongue, glosso-hyal (G.Hy). All these segments are ossified and separated from one another by tracts of cartilage.

The branchial arches are much smaller in proportion to the mandibular and hyoid than in the shark and ray; they also lie almost entirely within the latter, instead of in a regular series behind it. Each of the first four bars is divided into pharyngo-, epi-, cerato-, hypo-, and basi-branchial; and each segment, with the exception of the last pharyngo-branchial, is ossified. The fifth arch (inferior pharyngeal bone) is much smaller than its predecessors, and consists simply of a tooth-bearing cerato-branchial. The pharyngo-branchials (superior pharyngeal bones) are not dentigerous.

The development of the salmon was described at far greater length than that of the shark or ray, the metamorphoses gone through being much more complex, and exhibiting in a most instructive manner the endless modifications which the facial arches may undergo in their modes of segmentation and coalescence.

Besides the adult, seven arbitrary stages of the skull were described; in the first three of which the embryo was still unhatched, and lying as a flat tape-like band about ¾ of an inch long coiled round the yelk-sac; in the fourth the head was just emerging from the chorion; the fifth consisted of salmon fry at the second week after hatching; those of the sixth stage were at the sixth week; and those of the seventh young salmon of the first summer, varying in length from 1½ to 2¼ inches, and having in all essential respects the cranial characters of the adult. The earliest stages are remarkable for their want of symmetry, the head being so twisted that only one eye is visible in an upper view.

The head of an embryo at the first of these stages is shown in Fig. 10; it resembles very closely the earliest conditions in the shark and ray (Figs. 3 and 6, vol. ix. p. 467), having, like them, prominent sense-capsules, a widely-open mouth, and simple, unsegmented facial arches, which latter, however, present very important differences to the homologous structures in the lower types. The trabeculæ (Tr) are seen in the roof of the mouth, where they lie, enclosing the pituitary body (Pty) like a pair of forceps, in the same plane as the investing mass and notochord, and not at right angles to them like the post-oral arches. Curving under the eye is a bar of somewhat thickened indifferent tissue (Pl.Pt) representing the pterygo-palatine arcade, but, even in this extremely early stage, so entirely distinct from the mandibular arch proper (Mn) as to have the appearance of a true, separate face-bar. It long remains, however, in a rudimentary state as regards histological development, not being converted into true hyaline cartilage until the fourth stage, when it unites with the main part of the mandibular arch.

In the second stage, a most noticeable change has taken place with regard to the hyoid. A lozenge-shaped basal piece, the glosso-hyal, has appeared between the bars of opposite sides, and the whole arch has split lengthwise from top to bottom, becoming divided into an anterior and posterior division, the former of which becomes the fixed hyo-mandibular and symplectic, the latter the free epi- and cerato-hyals.

In the third stage, this process has gone farther: the two divisions of the hyoid have become separated from

* Continued from p. 10.

one another below, and have grafted themselves above to the auditory capsule, thus approximating very closely to the state of things found in the ray, where, as in this early stage of the salmon, the two parts of the hyoid are nearly equal in size. The pterygo-palatine has not yet united to the mandibular arch, although it has joined anteriorly with a "conjugational process" sent out from the now flattened trabecula. Meckel's cartilage is entirely separated from the quadrate.

The chief point to be noted in the fourth stage is the assumption of an undoubted Teleostean character, by the slipping down of the posterior bar of the

Fig.10.

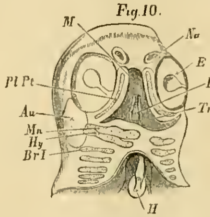


FIG. 10.—Head of Embryo Salmon, about ⅓ inch long (× 10 diam.). H, heart.

hyoid, which is now attached, not to the upper angle of the anterior bar, but to about its middle, a small nodule of cartilage, the inter-hyal, appearing between the two. This important change has advanced still farther in the fifth stage (Fig. 11), in which also the palato-pterygoid has united with the quadrate, and the membranous roof of the brain-case, beginning to chondrify, has formed the anterior part of the tegmen cranii (T.Cr), and sent back a supra-orbital bar (S.Or) to meet the ear capsule, leaving, however, a large membranous space or fontanelle (Fo) in the roof of the cranium. The trabeculæ, although flattened out and united in front, are completely separated behind, both from one another and from the investing mass, which

Fig.11.

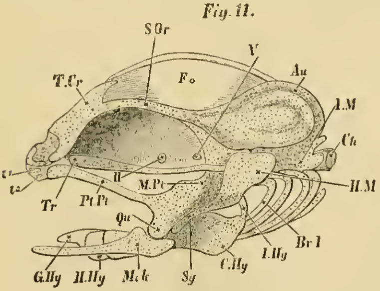


FIG. 11.—Skull of Young Salmon, the second week after hatching. (× 12 diam.) Fo, fontanelle; I.Hy, inter-hyal.

is merely overlapped by their slender inturned posterior ends (pharyngo-trabeculars). The jaws are constituted exclusively by the palato-pterygoid and Meckelian cartilages, and in many other points the skull now bears a very close resemblance to that of the shark or ray, and still more to that of certain recent Ganoids, such as Polypterus.

The sixth stage shows ossification to have set in at several points, and exhibits in an interesting manner the formation of the inter-orbital septum. The cartilage between the nasal sacs (mesethmoid) has sent backwards a triangular plate towards the orbito sphenoidal region, another plate has risen up from the middle line of the skull-floor or coalesced trabeculæ; and by the subsequent union of these two elements the partition so characteristic of bony fishes, as well as of reptiles and birds, is produced. It is the fissure left by the incomplete union of these elements which is shown at e.t.f in Fig 8 (p. 10). In the seventh stage all the ossifications have appeared, and the skull is fast taking on adult characters.

V. *Skull of the Axolotl* (Siredon pisciforme). The group of tailed Amphibia or Saurobratrachia is one of the most interesting in a craniological point of view, presenting, as it does, so great a variety of types, that while the highest, such as the salamander, approach nearly to the frogs and toads, the lowest, such as Proteus and Menobranchus, have a chondro-cranium actually lower than that of the lamprey. As a rule, indeed, the skulls of those Saurobratrachia which, like the Axolotl and the two genera mentioned above, retain their gills throughout life, have, when once the investing bones are removed, a simpler and more embryonic structure than that of any other adult animal.

The two chief roofing-bones of the brain-case—the parietals and frontals—are far more normal in their relative size than in the salmon, the parietals uniting in the mid-line, and sending off an unusually long anterior process to the ethmoidal region. The nasals are sepa-

Fig.12.

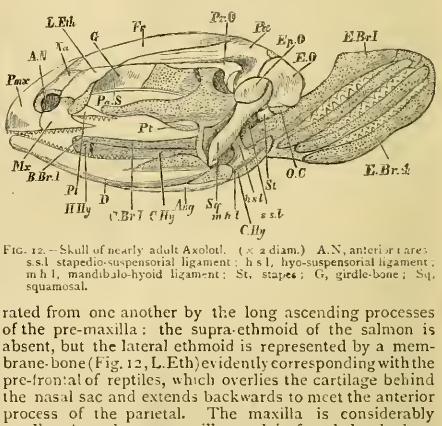


FIG. 12.—Skull of nearly adult Axolotl. (× 2 diam.) A.N, anterior nares; s.s.l stapedio-suspensorial ligament; h s l, hyo-suspensorial ligament; m h l, mandibulo-hyoid ligament; St, stapes; G, girdle-bone; Sq, squamosal.

rated from one another by the long ascending processes of the pre-maxilla: the supra-ethmoid of the salmon is absent, but the lateral ethmoid is represented by a membrane-bone (Fig. 12, L.Eth) evidently corresponding with the pre-frontal of reptiles, which overlies the cartilage behind the nasal sac and extends backwards to meet the anterior process of the parietal. The maxilla is considerably smaller than the pre-maxilla, and is free behind, there being no jugal or quadrato-jugal to unite it with the quadrate. On the under-surface of the skull is the large oblong para-sphenoid, and in front of it, bounding the inner side of the posterior nares, the well-developed tooth-bearing vomers, which together represent the single bone of that name in the salmon. All the opercular bones of the fish are absent, except the pre-opercular, now, as in all the high vertebrata, known as the squamosal (Sq), a flat ossification clamping the suspensory apparatus of the jaw, and extending upwards and backwards to the auditory region.

In the mandible three membrane-bones are developed, the two first of which bear teeth; the dentary has the same relations as in the salmon, the splenial lies as a flat splint on the inner side of each ramus, and the angular is also chiefly visible within, a small portion of it only (Ang) being seen externally.

The remaining bones will be described with the chondrocranium, of which they are ossifications.

(*To be continued.*)

ON SPECTRUM PHOTOGRAPHY*

THOSE of you who know best how the Society of Arts always places itself in the forefront of any movement which is likely to benefit mankind by the application of the various sciences to the practical affairs of life, may recollect that, as nearly as may be thirty years ago, the dawn of a new science was brought before an audience in this room. If I look, no longer to the Journal, but to the "Transactions," of the Society of Arts, Manufactures, and Commerce, as far back as the year 1843, † I find a paper there by the late Mr. Claudet, who then gave an account of the progress which had been made up to that time in an art and a science which is now pefectly familiar to all of you; I refer to photography. It is exceedingly curious that his lecture on the origin of this science, and my present lecture on the application of photography to spectrum analysis are complementary to each other, so much so that one may almost say that Mr. Claudet's lecture, admirable though it was, was incomplete, because he did not show in it, as of course he could not, how certain matters which he referred to in that lecture have been dealt with in the light of modern science.

If you carry yourselves back to the year 1839, some four years before the lecture to which I refer was delivered, you will recollect Mr. Niepce had at that time brought photography to a more practical realisation than it had been by any of his predecessors. He had then for some years allied himself with Daguerre, and the daguerrotype was already in existence. The action of iodine on silver, first discovered by Fox Talbot, had been fixed by the vapour of mercury. ‡ Now, in the daguerrotype we had not the action of light in its ordinary sense; and men's minds were very much exercised as to what could be the real cause of the effects which were then being revealed. Mr. Claudet, in his lecture, points this out in a most admirable way, and I will summarise, if you will allow me, some of the principal points to which he alludes. You had a beam of light falling on a plate. On this plate was a certain chemical compound. What part of the sunlight, or was it sunlight at all, which so acted upon this compound, that you got an image more or less permanent? What more natural than that this question should be investigated by means of various tinted glasses? The solar beam which the experimenters then used they made to pass through glass, now of one colour, and now of another. I can show you, by means of this electric lamp, nearly what they did. Imagine the lamp to be the sun; in the path of the beam differently coloured glasses are placed. We have now the action of a red glass; we now change the red glass for another one, and now we have the action of a green glass. There was an immense deal of difference of opinion concerning the action of light as investigated in this way. In fact, I shall have shortly to show that Mr. Claudet and a very distinguished French physicist, M. Becquerel, were considerably at variance with regard to one particular point which came out from this kind of investigation. But we had not long to wait. Sir J. Herschel, in the year 1839, pointed out that it was not a question of investigating these new qualities of light at all by means of coloured glasses; they should be investigated by means of the spectrum. In three papers, communicated to the Royal Society in the years 1839, 1840, and 1842, he showed that the only philosophic way of investigating this problem was really by obtaining a pure spectrum, such a one as I now throw upon the screen. You see that we have, at once, in different parts of this spectrum, exactly what we get at different times when we deal with red glass, yellow glass, orange glass, green glass, blue glass, and so on. And having such a spectrum as this to deal with, and supposing such a spectrum thrown on to the photographic plate, it is quite clear to all of you that if there were something magical or unknown in the red rays which gave us this new action on the molecules of the particular chemical compound employed, or whether this magic really resided in the blue rays, that we should at once have this pointed out to us in the most unmistakeable manner, by action in the part of the plate on which the red rays fell, or in the part of the plate on which the blue rays fell.

Now, although Sir John Herschel was the first, in this country, to point out the extreme importance of this point of view, he was by no means the only one. Then, as now, there were distinguished Americans who were well to the front, and among them was Dr. Draper, the father of another Dr. Draper whom I shall have to speak of by and by. Those of you who are familiar with the enormous step in advance which was taken in spectroscopic investigations by Wollaston, who substituted a slit for a round hole, will perhaps be somewhat surprised to find that the first observations were conducted by throwing a converging beam of sunlight, giving an achromatic image of the sun, on the plate, through a prism. This method of procedure of course did not go so far as a better one might have gone, but it went a considerable way. Sir J. Herschel, from his observations made in this manner, stated that he had found a new kind of light—a new prismatic colour, "lavender grey," altogether beyond the blue end of the spectrum, such as you have seen it on the screen—altogether beyond the *blue* end of the spectrum, not the *red* end. Prof. Draper, on his part, also came in the main to the same conclusion, stating that he had discovered a "latent light."

When we have come from the year 1839 to the years 1842 and 1843, we find a great advance—an advance, just the same as far as photography goes, as Wollaston's advance on Newton was with regard to spectroscopic observation. Both Becquerel and Draper introduced, instead of this achromatic image of the sun, the simple arrangement of throwing sunlight through a slit and a proper combination of lenses on to a plate. The result was that on June 13, 1842, Becquerel did what I may venture to call a stupendous feat.* He did what has never been done since, so far as I know. He photographed the whole solar spectrum with nearly all the lines registered by

FIG. 1.—Reduced copy of Becquerel's photograph of the complete solar spectrum taken in 1842.

the hand and eye of Fraunhofer. I do not mean merely the blue end of the spectrum, as you may imagine, but the complete spectrum, from the "latent light"—the ultra-violet rays of Draper—to the extreme red end. Draper also did something like the same thing, but not quite the same thing, in what he calls a "tithonographic representation" of the solar spectrum. He gives certain lines in the extreme visible blue part of the spectrum,§ certain other lines, which none but Becquerel had ever seen before (Draper's work being done nearly a year later), and in the extreme red—beyond the visible red of the spectrum—he gives other lines which even Becquerel had not photographed. This of course was such a tremendous revelation to both these men that as you can imagine a considerable discussion arose. Becquerel found, from an absolute comparison between the Fraunhofer lines which he had photographed and the Fraunhofer lines which Fraunhofer himself had registered, evidence in favour of the fact that this new chemical agent which was astonishing the world, whatever it was, was not something absolutely and completely independent of the visible rays. Draper, on the other hand, in his "tithonographic representation," had, for some photographic reason or other, not succeeded in registering the lines in the yellow, orange, and green part of the spectrum, although he had fixed the lines in the blue, in the extreme violet, and in the extreme red; and he considered himself justified by his experiments in coming to exactly the opposite conclusion to that at which Becquerel had arrived, namely, that the light, whatever kind of light it might be, which was at work in effecting this chemical change which rendered photography possible, was something absolutely and completely independent of the ordinary light which the retina receives.

This was in the year 1843. I need not tell you that by the year 1845, in which year Mr. Claudet read another paper before this Society, further investigations by means of the spectrum had

* A Cantor Lecture delivered at the Society of Arts, Nov 24, 1873, by J. Norman Lockyer, F.R.S.

† Vol. lv. p. 89.

‡ Fox Talbot, *Philosophical Magazine*, vol xxii. p. 97.

§ *Philosophical Magazine*, vol. xxii p. 360, 1843. For his earliest work see Journal of the Franklin Institute for the year 1837.

* "Bibliothèque universelle de Genève." t. xxxix.-xl., 1842, p. 341.

shown that Dr. Draper's idea was heretical, and at the present moment you know it is the general opinion of physicists, an opinion founded upon the work which has been done to advance photography, and other researches since that time, that the radiations which you get from any light source, from the extreme violet to the extreme red, differ only in the rate and in the magnitude of the vibrations which are at work, so that I claim for the application of photography to spectroscopy, as a first result, the establishment of a great fact, that the visible, the chemical, and the heat rays are really part and parcel of the same thing, that thing being a system of undulations varying in rate and wave-length from one end of the spectrum to the other, whether you consider the visible portion or the invisible rays—those outside the blue in one case, and outside the red in the other. But this is not all: I claim another thing for the application of photography to spectroscopy. Sir J. Herschel, so soon as he applied the prism, stated, in a communication to the Royal Society, that it was no longer possible to proceed with that branch of research under the best possible conditions, unless opticians would construct lenses which would bring the visible and the chemical rays into absolute coincidence. This is now done by our Rosses and Dallmeyers in the camera-lenses, and that is the second great feature which I claim for the application of photography to spectroscopy.

The next step brings us down to the year 1852. In this year a paper † was communicated to the Royal Society, by Prof. Stokes, who had already announced his discovery of what has since been called "fluorescence;" "on the long spectrum of the electric light." Prof. Stokes dealt in his first paper with the "change of refrangibility," or, as Sir William Thomson proposed to call it, "degradation of light," by virtue of which, light, which was generally invisible to us, could, under certain circumstances, be made visible. It is no part of my present purpose to go into this magnificent paper, one of the crowning glories of the work of this century, at any great length; but you will see in a moment that, if it were a question of the *degradation* of light, then the invisible light to which Prof. Stokes referred as being capable of being rendered visible, must have been light outside the blue end of the spectrum, and not outside the red. Prof. Stokes, in his investigations, in order to get at this invisible light under better conditions, if possible, than those with which he commenced operations, tested the transparency of the substances through which the light with which he experimented passed, and the transparency of glass was passed under review by him,* when he found that this invisible light, or whatever it was, could only get through glass with extreme difficulty. Continuing his investigations, he found that quartz on the other hand allowed this invisible light to pass. If you will allow me, I will read an extract from Prof. Stokes's paper of the extremest importance to our subject. After referring to these experiments on glass and quartz, he proceeds to say: †—"I have little doubt that the solar spectrum" (which you recollect had already been photographed to a certain extent both by Becquerel and Draper beyond the visible blue end of the spectrum), "would be prolonged, though to what extent I am unable to say, by using a complete optical train, in every member of which glass was replaced by quartz." He then adds that other substances which suggested themselves to him were not equally good. Then further, that if this invisible light does get through quartz, and does become visible to the eye, it does not at all follow that it will be capable of being photographed. Because already Prof. Stokes, in order to continue his researches in fluorescence, had been, as it were, driven to photograph some of the results which he had thus obtained. I am sorry to say that, so far as I can find out, none of those photographs have ever been published.

Before I go further, I think it will be convenient to throw on the screen some photographs of the solar spectrum, showing exactly what I mean by the "invisible rays;" and you will then see the enormous advance which Prof. Stokes made the moment he introduced his quartz train, and enabled both the eye and the photographer to take advantage of a new region of the spectrum in its entirety, in order to investigate it.

In a note to his paper communicated to the Royal Society, he shows that his anticipations, so far as the eye was concerned, were perfectly justified by the facts. ‡ He says:—"I have since ordered a complete train of quartz, of which a considerable portion, comprising, among other things, two very fine prisms, has been already executed for me by Mr. Darker; with these I have seen the lines of the solar spectrum to a distance beyond H, more than double that of *p*. So that the length of the spectrum, reckoned from H (the outside line in the portion originally visible), was more than double the length of the part previously known from photographic impressions." I will now throw on the screen the spectrum of the extreme part of the visible portion. The eye

H 2 H 1

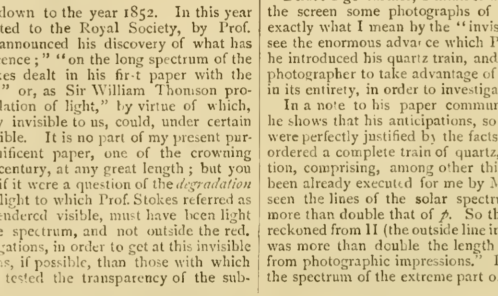


FIG. 2.—The H-lines in the blue end of the solar spectrum, from a photograph by the author.

generally can see the two dark bands which you see in the middle of the screen called H 1 and H 2. The least refrangible part of the spectrum lies to the right. When Prof. Stokes, therefore, stated that the solar spectrum was prolonged, he means that the part of the spectrum visible either to the unassisted eye or on a photographic plate after impression extends to a certain distance beyond these two dark lines. The part which Prof. Stokes rendered visible by means of his quartz train extended a considerable distance to the left beyond the part of the spectrum which you now see on the screen.

So much for the solar spectrum. Now let me carry you on another ten years, to the year 1862. Prof. Stokes, in a paper communicated to the Royal Society in this year,† refers to his former paper, and to what he had been enabled to do by means of it. He states: "A map of the new lines [the lines thus observed by him] was exhibited at an evening lecture before the British Association, at their meeting in Belfast in the autumn of the same year, and I then stated that I conceived we had obtained evidence that the limit of the solar spectrum in the more refrangible direction had been reached. In fact, the very same arrangement which revealed, by means of fluorescence, the existence of what were evidently rays of higher refrangibility coming from the electric spark, failed to show anything of the kind when applied to the solar spectrum;" and then he goes on to say that, in making observations by means of the electric spark, he had found that in the case of a spark taken between the poles of an induction coil like this on the table, or between the poles of an electric lamp such as you see there, that the visible spectrum which was revealed and rendered visible to him by means of fluorescence was no less than six or eight times longer than the whole of the visible part of the spectrum. That you see, was a revelation of the first order. He was so astonished at this, that he at first thought there was some mistake. "I could not help suspecting that it was a mistake, arising from the reflection of stray light." In fact, so astonished was he, so many methods did he try in order to break down the impossibility, if it existed, that he adds, in a subsequent part of the paper, "I tried different methods, without being able to satisfy myself as to the accuracy of the observations, and frequently thought of resorting to photography."

Prof. Stokes thought of resorting to photography, but at the moment that Prof. Stokes was thinking of this, Dr. Miller, of King's College (unknown to Prof. Stokes), was not only thinking of resorting to photography, but had actually resorted to it, and was taking photographs of the so-called invisible part of the spectrum, in which the spectrum in the case of some substances was

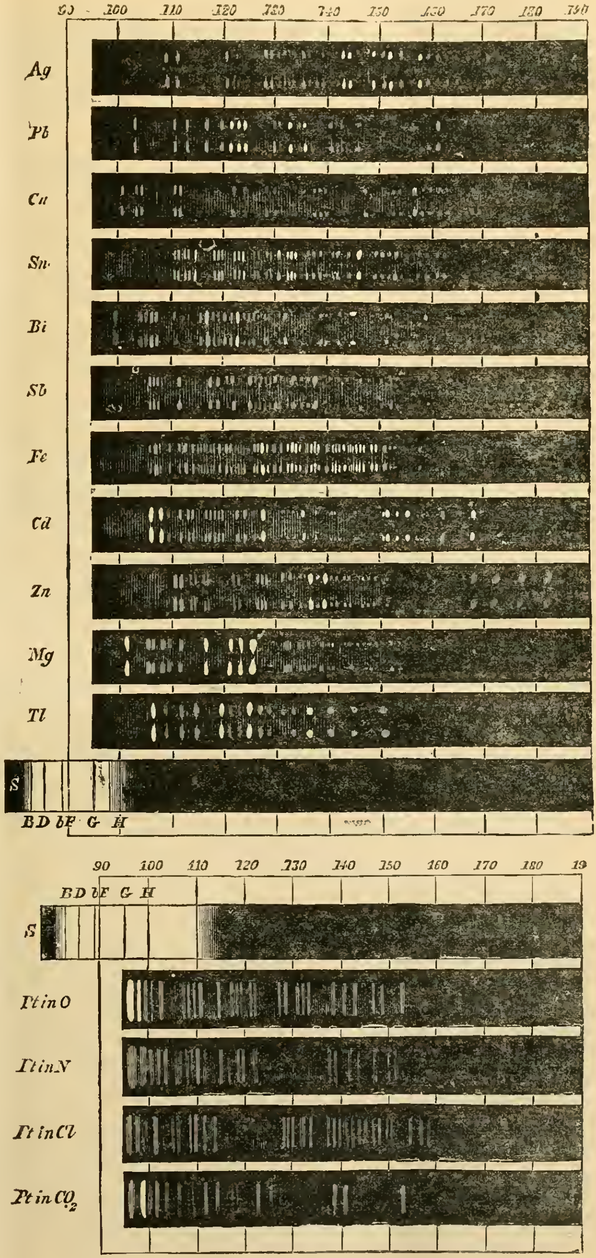
* *Philosophical Transactions*, vol. clxii., 1852.
† On the long spectrum of the electric light. Phil Trans, vol clii p. 599.

* Op. cit. Art. 202. † Art. 204. ‡ Page 559.

five or six times, and in the case of silver one might say almost seven times, as long as the spectrum ordinarily visible through glass prisms. Prof. Miller goes very nearly over the same ground that Prof. Stokes had done before him. He also investigated the transparency of quartz, and comes to the conclusion that quartz is almost the only substance that can be employed. Prof. Miller, in this paper, which you will find in the *Philosophical Transactions*,* also gives for the first time a detailed account of the way in which such work is done. Permit me to give you a rough notion of this method of work. We have here a spark from an induction coil, exactly such a spark as Dr. Miller wished to examine. He had a spectroscope something like this on the table, with two important differences. The first important difference was that instead of having two glass prisms he had prisms of quartz; and again, instead of having an observing telescope adapted for use by the eye, he inserted a camera, or what was to all intents and purposes a camera, in the same place. So that he had, first of all, a light source by which you get an intense illumination, due, as is generally imagined, to the extremely high temperature of the spark. Then you have a quartz lens, and quartz prisms, and then simply the photographic plate. Having therefore an entire absence of the non-transparency of glass, Prof. Miller was delighted to find that, on taking this spark in this way, between electrodes of different substances, he not only photographed what could be seen, namely, a spectrum ranging from red to blue, but one extending as a rule six times the length of the visible spectrum beyond the blue; although, in some cases, it is true it is only four times as long on the more refrangible side of H, as H is from the red end of the spectrum, that is to say the line which is generally called A. In this paper of Dr. Miller's we have the germ of all the applications of photography to spectroscopic inquiry which have been carried on since; and I am sorry to say that altogether too little has been carried on. Not only did Dr. Miller investigate in this way the radiation of different vapours, and give photographs for the first time of the bright lines of a very large number of chemical substances, but he went further than this, and dealt with the absorption of different substances.

He commences his paper with the absorption of chemical rays by transmission through different media,—through solids (transparent, of course), through liquids, and through gases and vapours, the only alteration he made in his general mode of experimentation being that in the case of the absorption of gases and vapours he placed the instrument farther from the light source, and in the path of the ray inserted a tube containing the gas or vapour to be experimented with, as I am doing now, so that the light which passed from the spark to the telescope was compelled to traverse a thickness of vapour according to the length of the tube employed. In that way he not only determined the absorption of equal lengths of different vapours amongst themselves, but the absorption of different lengths of the same vapour; his paper is thus one of the most important contributions to spectroscopic knowledge that I am acquainted with, and I hold that the chief importance of it is the application of

* Vol. cit. p. 801.



FIGS. 3 and 4*.—Copies of Dr. Miller's maps of the ultra-violet spectrum of the chemical elements showing the length of the visible and ultra-violet spectrum.

* These have been obligingly placed at my disposal by Messrs. Longmans.—J. N. L.

photography to spectroscopic observations. There are few things so difficult, I think, as to make a proper spectroscopic observation, while from the little experience I have had at present I should think there is nothing more easy than to produce passable spectroscopic photographs.

That, then, was in the year 1862. In the year 1863 we have another equally distinct advance to chronicle, but this time the work is done in France. M. Mascart—a name very well known to physicists—undertook a tremendous work, which he has not yet completed, namely, a complete investigation of the ultra violet solar spectrum.* Instead of using a quartz prism, as Dr. Miller had done before him, M. Mascart uses a diffraction

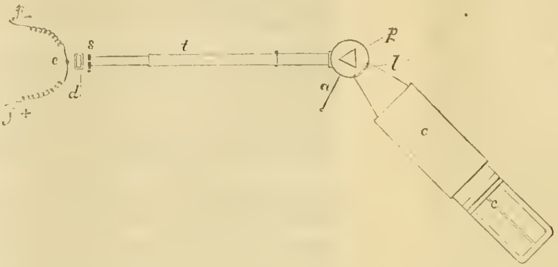


FIG. 5.—Dr. Miller's arrangements,—*s*, slit; *l*, quartz lens; *c*, camera; *p*, quartz prism; *t*, collimator.

grating, that is to say an instrument by means of which the light is not refracted, as in the case of the prism, but diffracted by an effect of interference of fine lines ruled on glass. M. Mascart has shown it to be possible, by means of reflecting light from the first surface of the diffraction gratings, to get light diffracted without its going through the glass at all. In this way, therefore, you avoid altogether the imperfect transparency of the glass. Prof. Mascart has gone on advancing every year, until now he has completed a photographic map, not only of the solar spectrum extending about as far as the line R., by means of photography, but he has been able to observe as far as the line called T. There he finds the solar spectrum ends; but in the

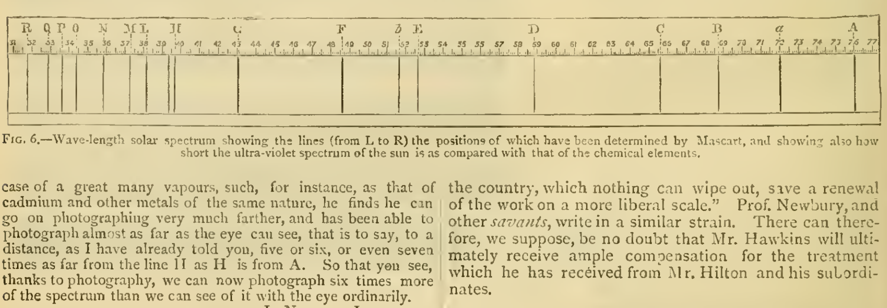


FIG. 6.—Wave-length solar spectrum showing the lines (from L to R) the positions of which have been determined by Mascart, and showing also how short the ultra-violet spectrum of the sun is as compared with that of the chemical elements.

case of a great many vapours, such, for instance, as that of cadmium and other metals of the same nature, he finds he can go on photographing very much farther, and has been able to photograph almost as far as the eye can see, that is to say, to a distance, as I have already told you, five or six, or even seven times as far from the line H as H is from A. So that you see, thanks to photography, we can now photograph six times more of the spectrum than we can see of it with the eye ordinarily.

J. NORMAN LOCKYER

(*To be continued.*)

THE CENTRAL PARK OF NEW YORK AND MR. WATERHOUSE HAWKINS

SOME time ago (NATURE, vol. vi. p. 70) we copied from the *American Naturalist* an account of the destruction "by order of Mr. Henry Hilton" of Mr. Waterhouse Hawkins' restorations of *Hadrosaurus* and other extinct animals, in the Central Park of New York. We have lately received some further correspondence on this subject, from which it appears that in April last Mr. Hawkins addressed to the Board of Commissioners of the Central Park a memorial, setting forth the manner in which he had been treated, and claiming compensation for his losses. It is not very easy to understand the origin of the affair, which appears to have occurred through some change in the government of the city of New York, produced by the notorious "Ring." But it is quite evident that Mr. Hawkins has the sentiments of all the leading scientific men of the United States in his favour.

Prof. Henry, of the Smithsonian Institution, speaks of the destruction of Mr. Hawkins' models as a "disgrace to the country, which nothing can wipe out, save a renewal of the work on a more liberal scale." Prof. Newbury, and other *savants*, write in a similar strain. There can therefore, we suppose, be no doubt that Mr. Hawkins will ultimately receive ample compensation for the treatment which he has received from Mr. Hilton and his subordinates.

EUCALYPTUS GLOBULUS IN MAURITIUS

THE subject of the introduction of the Eucalyptus as a sanitary agency in fever-stricken countries has of late been so much talked about that some authoritative preliminary inquiries have been made with the view of planting *Eucalyptus globulus* on a large scale in the Mauritius. From these inquiries, directed chiefly as to the possible success of the plant in the island, it appears that it does not thrive in any part, and still less in the warmer parts. The tree, moreover, is unsuited to resist the violent winds or hurricanes with which the Mauritius is so frequently visited. In 1865 twelve plants were planted in the Botanic Gardens at Pampelmousses, and though they were secured to strong stakes, eleven of them were destroyed in the hurricane of 1868; the remaining one also was blown over, but met with some support by falling into the branches of another tree, where it still remains.

Though it appears at one time thousands of young plants were planted in the lower parts of the island very few at the present time exist; there are, however, several

* "Annales scientifiques de l'Ecole normale Supérieure." Vol. for 1864, p. 219.

specimens growing in the higher districts, at Vacoa and Moka; and a number of young trees were planted at Curepipe, of the success or failure of which, however, nothing can yet be said. Besides the frequent occurrence of devastating gales, the drought exercises an evil influence on the *Eucalyptus*, which is proved from the fact of the failure from this cause alone of 200 young trees that were planted and a quantity of seed that was sown last year on the signal mountains above Port Louis. As avenue trees to be planted on each side of the streets they are said to be the most unsuited of all the trees known in the island. The streets of Port Louis are, moreover, too narrow or too much crowded with traffic to admit of such planting.

Above and beyond all these considerations it is the opinion that no system of planting, whether of groups or avenues, in the midst of the town, or of whole forests in the outskirts, nor yet a system of sewers and surface drains, would suffice to make Port Louis a healthy town. A perfect system of subsoil drainage throughout is considered the only possible means of a permanent improvement. The evil lies in the water, which soaks into the heavy clay subsoil, and having no means of escape becomes stagnant and putrefies.

JOHN R. JACKSON

COGGIA'S COMET

THE following position of this comet was obtained here this evening by micrometrical comparisons with a star in the Bonn Catalogue. It should be pretty exact:—

June 9, at 10h. 23m. 34s. mean time at Twickenham.

R.A. . . . . 6h. 58m. 31·19s.

Decl. . . . . + 69° 2′ 3″·1

The comet is rather brighter than Argelander's stars of 6th magnitude, and the tail may be traced about 2° from the nucleus, which still presents a very stellar appearance.

The following orbit is the best I have yet seen, and was calculated by myself from the Marseilles observation of April 17, and two made at Mr. Bishop's observatory on May 9 and June 1; all the small corrections taken into account:

Perihelion Passage, July, 8·2110 Greenwich mean time.

	° ′ ″	
Longitude of Perihelion ...	270 47 13	Mean Equinox,
,, Ascending Node ...	118 24 33	July 0.
Inclination to Ecliptic ...	65 51 31	
Perihelion distance	0·67437 (the earth's mean distance = 1)	
Heliocentric motion	Direct.	

The comet is steadily increasing in brightness, as indicated by theory.

J. R. HIND

Mr. Bishop's Observatory,
Twickenham, Tuesday night

NOTES

WE are informed that the whole of the large and valuable collection of Natural History specimens procured by Signor D'Albertis during his recent travels in New Guinea has been purchased by the Italian Government, and that Signor D'Albertis himself will shortly return to the same island to continue his researches, which have already proved so important.

AT the last meeting of the Royal Geographical Society, held on Monday, June 1, Dr. Carpenter delivered a discourse entitled "Further Researches in Oceanic Circulation," in continuation of the communication he made to the Society on this subject four years ago. We understand that this lecture will be published in the Journal of the Society in full detail and with ample illustrations, and that it will contain a complete discussion of the results of the *Challenger* Temperature-Survey of the Atlantic.

MR. CLEMENTS R. MARKHAM, C.B., F.R.S., has been created a Knight Commander of the Portuguese Order of Jesus Christ.

THE Swedish Order of the Pole Star has been conferred upon Mr. Leigh Smith, the arctic voyager.

AT a Convocation of Durham University, held on June 2, certain alterations in the regulations were moved, the object o which was to prescribe the standing and exercises requisite for the academical rank of Associate in Physical Science, and of Mechanical, Mining, and Civil Engineers, which would enable students who had obtained the academical rank of Associate in Physical Science to become admissible to the degree of Bachelor of Science, provided not less than two years had intervened from the time of their being made Associates, after passing an examination in not less than six of the following subjects:—1. Mathematics (pure and applied); 2. Physics; 3. Chemistry; 4. Geology; 5. Engineering; 6. Biology; 7. Either Latin or Greek; 8. Either French or German; the two last of these subjects being compulsory. In title 8, sec. 1. of the regulations, it was proposed to add the following clause:—"That students of the Durham University College of Medicine, or of the Durham University College of Physical Science at Newcastle-on-Tyne, may petition the University that terms kept by them at either of these colleges, equivalent in duration to three terms kept by students in Arts at Durham, may count towards the degree of B.A., provided that they shall have passed the first examination appointed for students in Arts, which really takes place at the beginning of the second year, and that they shall not be admitted to the final examination for the degree of B.A. unless they have kept three terms at least by residence as students in Arts at Durham." The alterations were assented to.

THERE will be an election at Merton College, Oxford, in October next to two postmasterships, value 80*l*. per annum, tenable for five years from election, or so long as the holder does not accept any appointment incompatible with the full pursuance of his University studies. In the examination for these postmasterships papers will be set in algebra, pure geometry, trigonometry, theory of equations, and analytical geometry of two dimensions. Candidates must not have exceeded four terms of University standing. There is no limit of age. The examination will commence on Tuesday, Oct. 13, at 9 A.M. in Merton College Hall. Candidates are required to call on the Warden on the same day between 4 and 5 P.M.

AT the election to Mathematical and Physical Science Postmasterships in October, at Merton College, Oxford, an election will be made to two Physical Science Postmasterships, each of the value of 80*l*. a year, and tenable for five years from election, provided that the person elected do not accept any appointment interfering with the full course of University studies. There is no limit of age, but candidates, if already members of the University, must not have exceeded six terms from matriculation. The persons elected, if not members of the University, will be required to pass the University examination for responsions within a year of election. The subjects of examination will be Chemistry and Physics. There will be a practical examination in Chemistry. Candidates will have opportunities of giving evidence of a knowledge of Biology; but it must be borne in mind, that in such cases the examiners will look for evidence of an acquaintance with the principles of Chemistry and Physics equal in extent to that which is required in the Preliminary Honour Examination in the Physical Science School. A paper will be set in Algebra and Elementary Geometry, which, *cæteris paribus*, will be of weight in the election to the postmasterships. The examination will commence on Tuesday, Oct. 13, at 9 A.M. in Merton College Hall. Candidates are required to call on the Warden on the same day between 4 and 5 P.M. Further information may be obtained from the Tutor in Physical Science.

THE annual *conversazione* of the Society of Arts will be held on the 19th inst. at the South Kensington Museum.

MR. WILLETT, the hon. secretary to the Sub-Wealden exploration, reports that up to the end of the week before last a total depth of 967 ft. 8 in. had been attained, so that the present contract to bore 1,000 ft. may be taken as virtually complete. A continuation of the work will require an immediate expenditure of 500*l.* for lining tubes, and every additional foot bored to 1,500 ft. or 2,000 ft. will cost at least 2*l.* Thus, to enable another 500 ft. to be bored, subscriptions to the amount of 1,500*l.* must be forthcoming. The boring continues in the Kimmeridge clay. At a depth of 883 ft. the core contained a shell of the Arca species, which is entirely new to Science. At a meeting of the central committee it was moved and carried unanimously:— "That, as such important economic and scientific questions are awaiting their solution by the completion of this undertaking, it is most desirable that the work should be continued, and that a sub-committee be appointed to draw up a statement and an appeal for pecuniary support, and that such sub-committee consist of Prof. Ramsay, F.R.S., Director-General of the Geological Survey of England; Mr. John Evans, F.R.S., President of the Geological Society; and Mr. J. Prestwich, F.R.S., ex-President of the Geological Society." These gentlemen having consented to act, the hon. secretary solicits subscriptions, that the desired result may be attained.

Les Mondes announces the death of Mme. Liais, the wife of the director of the Observatory of Rio de Janeiro, who acted as the secretary of and co-worker with her husband in all his labours. She accompanied him in his dangerous expeditions into the centre of Brazil, and died in consequence of the sufferings she endured during her travels with her husband.

M. A. L. A. FÉE, the well-known French botanist, died on the 21st ult., in his 86th year.

M. FORTIN, who recently died, has left all his fortune, amounting to 36,000*l.*, to the city of Paris, on condition that it will be employed in building schools for children of both sexes.

Allen's Indian Mail learns from Calcutta that the Indian Government proposes before long to resume the surveys of the Indian coast line on an extensive scale. The work will be taken in hand next cold season under the supervision of Capt. A. D. Taylor, late of the Indian Navy. The operations will be generally directed by Col. Thuillier, Surveyor-General.

AT a Cambridge congregation held on June 4, an additional grant of 300*l.* was voted for the maintenance of the new Museums and Lecture rooms. The Vice-Chancellor, Dr. Power, Dr. Phear, Dr. Humphry, Professors Stokes, Liveing, and Hughes, Mr. Bonney, St. John's, and Mr. Hart, Emmanuel, were appointed a syndicate to collect information as to the space and accommodation required for a new Geological Museum, and were ordered to report before the end of next Michaelmas Term. The seal of the University was affixed to a letter of thanks to the Chancellor, the Duke of Devonshire, for his munificent gift of the Cavendish laboratory of Experimental Physics.

IN the last article on The Coming Transit, it was mentioned that the Royal Society had appointed three naturalists to accompany the Transit Expedition to Rodriguez. This Natural Science Staff will consist of Mr. Henry Slater, B.A., as geologist, Mr. Balfour, son of Prof. Balfour of Edinburgh, as botanist, and Mr. George Gulliver, B.A., as zoologist.

PREPARATIONS are being made for holding a national festival to commemorate the discovery and colonisation of Iceland by the Norsemen 1,000 years ago.

ONE of the principal points to note in Dr. Acland's Report to the Radcliffe Trustees for 1873, is the grant made by the trustees of 100*l.* to be expended in the promotion of higher medical science in connection with Oxford University. Of this twenty-five guineas were granted to Messrs. C. C. Pode and E. Ray Lankester to aid them in their researches concerning Bacteria. Mr. Pode unfortunately died, but the research is being carried on by others.

WE take the following extract from an article in the New York *Nation*, entitled, "Who shall direct the National Surveys?":— "It is little short of absurd that scientific work should be voted a military matter, to be carried on only under the oversight of men who have military education. Unless, indeed, experience had already shown, or should show hereafter, that scientific men are not to be found who are capable of directing surveys as well as of doing the work required upon them; or that the methods of military topography are the best basis for the complete geographical and geological exploration of a region; or that civilians work more happily and effectively under the government of military men—and there are facts in abundance to disprove each and every one of these hypotheses. It would seem a little less unnatural that the Navy Department should claim to undertake the management of the foreign diplomatic service because it has well-educated officers lying idle and ships to carry them to their destinations. Army and navy are often good initiators; but there comes a time when, in all the proper arts of peace, *arma cedunt togæ*. And if the country has more educated military talent than it needs for military purposes, profitable occupation can surely be found for it without putting it in authority over scientific men engaged in carrying on the work for which they have been trained and to which they have devoted their lives."

WE are glad to see that a British Bee-keepers' Association has been formed "for the encouragement, improvement, and advancement of bee-culture in the United Kingdom." Its first exhibition will be held at the Crystal Palace on Sept. 8, 9, and 10, when a large number of prizes will be offered. The hon. secretary is Mr. John Hunter, Eaton Rise, Ealing.

THE *Linguist, and Educational Review*, "a cheerful, instructive, and interesting periodical on languages, anthropology, antiquarian research, literature, education, science, and the fine arts," is the name of a new monthly journal to be published on July 1, by Thomas Cook and Son and Hodder and Stoughton.

SYMONS' *British Rainfall* for 1873 has come to hand, and for the immense amount of labour involved in sifting and arranging the vast mass of material, all meteorologists ought to be grateful to Mr. Symons. He has many difficulties to struggle with, including 200 lazy correspondents, who are usually months behind in sending in their statistics. We regret to see that Mr. Symons' request, that one or two gentlemen in each county would have the kindness to volunteer to assist in seeing that their county is not neglected, has been acted on in only a very few cases. It is possible that many who would be willing to comply with the request are ignorant of it; we hope Mr. Symons will have a better report to give in this respect next year. Mr. Stow's paper, On Scotch mist, is worthy of attention.

A SUPPLEMENTARY part of Petermann's *Mittheilungen* contains four lectures On the Caucasus, by Dr. G. Radde. Lecture I. treats of the configuration of the Caucasus; II. Of the organic world of the region; III. Of the inorganic world in its relation to the wants of man; and IV. Of the present inhabitants of the Caucasus, their condition, industries and prospects. Three good maps accompany the lectures; one a general map of the country, another showing the extent of forest, and a third the density of population.

COUNT WILCZEK, the Austrian traveller, the *Geographical*

Magazine informs us, is preparing for a second arctic voyage during the season to Novaya Zemlya. He intends to launch provision-laden balloons in various directions in the hope of succouring the Austro-Hungarian *Tegethoff* expedition.

We learn from the *Geographical Magazine* that the surveys in connection with the European measurement of a degree have been resumed, under the direction of Col. Granbal of the Austrian and General de Vecchi of the Italian Engineers, who are now measuring a base-line in the neighbourhood of Udine.

On Saturday last the foundation-stone of a fine new museum in connection with the Torquay Natural History Society was laid by the president, the Rev. T. R. R. Stebbing. The Society was founded in 1844, by a few gentlemen of Torquay, among whom was Mr. Pengelly, and has had a most prosperous career in all respects. The contents of the Museum, wholly Devonian, are of high scientific value. Among the contents of the bottle placed in the cavity of the foundation-stone, was a copy of the last number of Nature, containing a portrait of Mr. Darwin.

An extract from a letter by Mr. Dunn, the geologist, now on a special exploring expedition to the Transvaal, published in the *Cape Argus* of May 5, gives a description of a thunder and hail-storm which he experienced at Pietermaritzburg, on April 17:—"Hail-stones, liberally mingled with great masses of ice of very irregular forms, poured down with great violence. The hail-stones were seldom less than 1 in. in diameter; the average was from 1½ in. to 2 in. in diameter. These were of very regular spherical form, and consisted of a nucleus of white snow, with an envelope of hard transparent ice. Sometimes they presented, when broken through, a concentric arrangement of zones, alternately white and opaque and transparent. The irregular masses were formed of a nucleus generally longer in one direction than the others, from 2 in. to 4 in. in diameter; projecting all over were stalactites, each one about the thickness of a little finger, and presenting, when broken across, an agate-like structure, as though segregation had built them up. Of these masses I weighed a few with the following results:—Three weighed over 8 oz., two over 6 oz., and one over 4 oz. The mischief done will not be covered by 2,000*l*. or anything like that sum."

M. W. de Fonvielle made a balloon ascent on May 27, in the "Guillaume Tell." He ascertained the existence of an aerial stream 2,000 ft. thick, blowing with a velocity of 4 yards per second, in a south-east direction. From that current up to 10,000 ft. the air was running in a southerly direction, with nearly the same velocity. The temperature was only 42° F. at 8,000 ft., and rapidly increased when nearing the earth, where it was 77°. The lower part of the northern current for 1,800 ft. was limpid air. At an immense height were floating strata of cirrhus, almost parallel. The landing took place after having run 42 miles in only 40 minutes. Several experiments on sound were made, and others will be made shortly.

The additions to the Zoological Society's Gardens during the last week include a Great Anteater (*Myrmecophaga jubata*) from the Argentine Republic, presented by Mr. J. Mendez; a Temminck's Snapper (*Macroclemmys temmincki*), a North American Trionyx (*Trionyx ferox*) and other Chelonia, presented by the Smithsonian Institution of Washington; a Red Deer (*Cervus elaphus*), European, presented by Lord H. Russell; a Vervet Monkey (*Cercopithecus lalandii*) from West Africa, presented by Commander J. H. Smith; a Pig-tailed Monkey (*Macacus nemestrinus*) from Java, presented by Mr. J. E. Kincaid; a Griffon Vulture (*Gyps fulvus*), European, presented by Mr. S. Reid; a Stanley Crane (*Tetrapteryx paradisea*) from South Africa, purchased.

SCIENTIFIC SERIALS

The current number of the *Quarterly Journal of Microscopic Science* contains several articles of interest, most being condensed accounts of longer papers from British and foreign sources. The first memoir is by Mr. Francis Darwin, entitled "Contributions to the Anatomy of the Sympathetic Ganglia of the Bladder in their Relation to the Vascular System." The author's object is to show that there is a reflex mechanism effected by peripheral ganglion cells, through which the coats of the arteries are placed under nervous control, independent of the central nervous system; so that the statement of Cohnheim to the contrary in his "New Researches on Inflammation" does not hold. Mr. Darwin illustrates his views by two excellent plates, which demonstrate that in the bladder at least the ganglionic nerve fibre or fibres (for there are generally two) which accompany each small artery, send branches which are partly distributed to the coats of the vessel, and are partly lost on its outer covering.—This paper is followed by a further *résumé* of recent observations on the Gonidia question, by Mr. W. Archer, which commences with the adverse comments of Fries and J. Müller on Schweindener's peculiar theory respecting the relation borne by the gonidia to the lichen-thallus, and is followed by an abstract of the researches of Bornet in the same direction, but favourable to the parasitic hypothesis.—Mr. W. Hatchett Jackson proposes a new method for preserving magenta-stained microscopic sections which he has found successful. Magenta being a trianime, its triacid salts colourless, and nearly all of them soluble in most preservative solutions, it was desirable to obtain a stable mon-acid salt and a suitable preservative fluid. These conditions are fulfilled by employing as the staining agent the monotannate of magenta, and as the preservative fluid syrup, with 3 or 4 per cent. of calcium chloride. Specimens prepared and mounted by this method have been kept for more than a year, the sugar making them very transparent.—A translation is given by Mr. Perceval Wright of part of Prof. Haeckel's now well-known Gastraea theory, the phylogenetic classification of the animal kingdom, and the homology of the germ lamina. The gastraea theory, which is very similar to one published shortly before it by Mr. E. Ray Lankester, divides the animal kingdom into two chief divisions, the Protozoa and the Metazoa, the former of which never form germ laminæ, never possess a true intestinal canal, and, especially, never develop a differentiated tissue; whilst the latter always form two primary germ laminæ, always possess a true intestinal canal, and always develope differentiated tissues. The Metazoa are further divisible into the Zoophyta (or Coelenterata) and the Bilateria (or bilaterally symmetrical animals).—The last article in the number is an account of Dr. Cunningham's report on the microscopical examination of air, from experiments prosecuted at Calcutta, undertaken with the view of throwing light on the origin of cholera and other eastern epidemics.

Journal of the Chemical Society, April.—This part contains the following papers:—On the products of decomposition of castor oil. No. I. Sebacic acid, by E. Neison. The author prepares the acid by mixing equal weights of castor oil and sodium hydrate with sufficient water to form a pasty mass, and then heating this mass till it solidifies. The product thus obtained is quickly distilled in a copper flask (200 grms. at a charge), the residue dissolved out of the flask by boiling water, and the sebacic acid precipitated from the solution by hydrochloric acid, the precise method of precipitation being varied according to the stage to which the distillation has been carried. The yield is small, 1 kilog. of oil giving only about 50 grms. of the acid. Analyses of numerous salts are given.—Action of benzyl chloride on laurel camphor (*Laurus camphora*). Preliminary notice, by Donato Tommasi. The reaction is performed in presence of powdered zinc, and the chief product appears to be toluene.—On the action of trichloracetyl chloride upon amines. I. Action upon aniline, by D. Tommasi and R. Meldola. The result of the reaction is phenyl-trichloracetamide $N\left\{\begin{array}{l}C_6H_5\\C_2Cl_3O\\H\end{array}\right.$. This by treatment with fuming nitric acid yields a dinitro derivative $N\left\{\begin{array}{l}C_6H_3(NO_3)_2\\C_2Cl_3O\\H\end{array}\right.$—Isomeric terpenes and their derivatives. Part III. On the essential oils of wormwood and citronella, by C. R. A. Wright. The author has studied the action of zinc chloride, and of phosphorus pentasulphide upon absinthol and citronellol; also the

action of phosphorus pentachloride and of bromine on this latter substance. The cymene obtained from absinthol and citronellol yields terephthalic and acetic acids on oxidation.—On the perbromates. Preliminary notice, by M. M. Pattison Muir. The author has undertaken the preparation of a number of these salts.—On two coals from Cape Breton, their cokes and ashes, with some comparative analyses, by Henry How. The remainder of the journal is devoted to abstracts from British and foreign journals.

THE *Geographical Magazine*, June.—This number opens with a valuable article by Mr. C. R. Markham, on the Railways of Peru.—The longest and most important paper, from a scientific point of view, is by Mr. H. P. Malet on Bone Caves, in which the author's conclusions differ in several points from those generally accepted.—Other articles are on Singapore, and on the British colonial wool trade, by Mr. W. Robinson.—In connection with the American Geographical Society, letters are given from Capt. Buddington, and three other officers of the *Polaris* expedition, in which all but Buddington agree in stating that had Hall lived the ship would have pushed much further north, and that there would be no difficulty in some future properly equipped expedition doing so.

THE *Geological Magazine*, June.—The original papers in this number are the following:—Description of *Cycloptychius*, a coal measure fish, by Dr. R. H. Traquair, with a plate; Physical changes preceding deposition of cretaceous strata, by C. E. de Rance, F.G.S.; On *Columnopora*, a new tabulated coral, by Prof. H. A. Nicholson, F.R.S.E., with a woodcut; Glaciation of West Somerset, by W. C. Lucy, F.G.S.; On the South of England ice-sheet, by James Croll, of the Geological Survey of Scotland; On *Polypora tuberculata* in Scotland, by Prof. J. Young, M.D., and Mr. John Young, Hunterian Museum, Glasgow; Landslips and Sinkings in Cheshire, by J. M.

Journal of the Society of Telegraphic Engineers, No 5.—The principal original papers in this part are the following:—On a method of testing short lengths of highly insulated wire in submarine cables, by Prof. Fleeming Jenkin, F.R.S.; On the mechanical testing of telegraph wires, by R. S. Culley; On the strength of cylindrical wrought-iron telegraph poles, by F. C. Webb; On the percentage of averages, by W. H. Preeece; On lightning protectors, by John Fletcher; On equations connected with telegraph wire, by H. Mallock; Tables to facilitate the calculation of strains of overhead line wires, by Robert Sabine.

Transactions of the Glasgow Society of Field Naturalists. Part II. Session 1873-74.—This Society was established in 1871, and seems to be in a prosperous condition so far as members are concerned, and, to judge from the brief reports of the meetings, is doing good work. The Society meets all the year over, specimens being exhibited and papers read at all the meetings; the papers contain the results of observation as well as occasionally of speculation, and show that the members can observe and think to good purpose. In summer the Society makes excursions to various places in Scotland, an account of the results of these excursions being read at the meetings. The paper of greatest novelty in this publication is Contributions to a knowledge of the Scotch Cynipidæ, by Mr. P. Cameron.

Astronomische Nachrichten, Nos. 1,989, 1,990.—In these numbers is contained a long paper by J. G. Galle on a method of calculating the paths of bright meteors, and he gives the orbits of the meteors of July 11 and 19, 1873. The elements of Planet (127) are given by Henry Renan. The elements of Coggia's comet are given by A. C. Dunér as follows:—

$$T = 1874, \text{ July } 20{\cdot}1670 \text{ Berlin time}$$
$$\omega = 150^\circ\ 3'\ 16''$$
$$\Omega = 123^\circ\ 1'\ 55''$$
$$i = 72^\circ\ 52'\ 53''$$
$$\log. q = 9{\cdot}86894$$

The ephemeris for this comet is added, going up to Aug. 11.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti: t. vii. Fasc. v.—In this number M. Celoria has a note On the extremes of temperature observed in Milan since the year 1763. It appears rom his table that the minimum temperatures of the several years occurred 63 times in January, 27 in December, 19 in February, once in March (1785), and once in November (1866). The maximum temperatures occurred 62 times in July, 33 in August, 13 in June, once in May (1786). It is further observed that the minimum temperature in Milan is, on an average, $-9^\circ{\cdot}57$ (oscillating between $-2^\circ{\cdot}8$ and $-17^\circ{\cdot}2$); while the maximum temperature is, on an average, $34^\circ{\cdot}38$ (oscillating between $31^\circ{\cdot}5$ and $37^\circ{\cdot}7$). The average mutability of temperature is thus $43^\circ{\cdot}9$. The author also furnishes some data as to days of frost at Milan in 1838-73. The average number of these is found to be about 58; there was a minimum of 17 in 1872, and in the two years 1848 and 1858 the number rose to 85.—Prof. Mantegazza contributes a paper On the expression of pain. He groups all modes of painful expression in three categories; viz. expressions of reaction, expressions of paralysis, and mixed expressions of pain and of different sentiments.—Prof. Garvaglio has a paper in vegetal pathology, treating of a parasitic fungus which produces a form of blight in rice.—Prof. Sayno describes some applications of the spiral of Archimedes to graphic calculation.—In the section of moral and political science, Prof. Cossa contributes a paper On political economy of people and states.

Annali di Chimica applicata alla Medicina. Nos. 3 and 4, March and April, 1874.—Under the heading of "Pharmacy" we notice in these numbers a paper by Carlo Pavesi on the compound of chloral hydrate with glycerine.—One by Giovanni Ruspini on the metallurgy and applications of bismuth.—F. Mayer contributes a note on the assay of alkaloids, and Leger one on metatartrate of magnesia.—Bultot writes on an alteration of bichloride of mercury.—Prof. G. Bizio contributes a paper on protosulphide of phosphorus.—In hygiene there is a paper on the disinfection of drains, by Prof. S. Zinno.—In toxicology C. Méniere d'Angers contributes a paper on the toxical properties of *salmoja*, the residue obtained in salting meat and fish for exportation; N. Zuntz on the nature of the compound of carbonic oxide with hæmoglobulin; Huseman on antidotes for phenic acid.—From the *Journal de Pharmacologie* two papers are translated, one on a case of arsenical poisoning, and one on the frequency of phenol poisoning in England.—In physiology there is a paper by Engel on metals and the human body; and a paper by G. Gallo on a new fact favouring heterogenesis. We notice also an account of experiments on the production of bacteria in organic infusions, by E. R. Lankester, and a paper on the physiological and therapeutic effects of the active principle of ipecacuanha, by A. E. d'Orenellas.—In therapeutics S. Cadet has a paper on the efficacy of black sulphide of mercury in cholera; Dr. Gimbert on the application of *Eucalyptus globulus*; Prof. Binz on the action of bromide of potassium on the animal organism; L. Tassinari on the transfusion of blood; Prof. de Renzi on the use of sulphites in intermittent fever; and on the injection of water and saline solutions into the veins in cholera, by Dr. Dujardin-Beaumetz.

Gazetta Chimica Italiana. Fasciolo iii. contains but two original communications, the first of which is by E. Paterno, On the identity of cymene from camphor and from essence of terebenthene. The cymene was prepared from camphor by a modification of Pott's process, enabling more than a kilog. of this substance to be acted on at once. 100 grm. of red phosphorus, 265 grm. of sulphur, and 780 grm. of camphor are well mixed in a suitable vessel, and then heated over a gas burner till cymene ceases to pass over. Analyses and descriptions of the calcium, barium, lead, potassium, sodium salts of cymene-sulphonic acid, from camphor cymene, as well as of the acid itself, are given.—Cymene from essence of terebenthene was prepared by Riban's method, and the same salts of the sulpho-acid studied.—The other paper is by Ugo Schiff on chromic peroxide and acid, being observations and experiments relating to a paper by E. Hintz (under the direction of Prof. L. Meyer) on these substances. The remainder of this part is occupied by abstracts from other journals.

Cosmos, May.—The principal papers in this number of the Italian geographical journal are an account of N. M. Prjewalsky's exploration of eastern Mongolia, the present contribution relating to his travels in the southern confines of Mongolia from Dala-Noor to Ala-Shan; On the gold-bearing regions between the Limpopo and Zambesi, with a map; and a continuation of the paper on recent expeditions into New Guinea.

SOCIETIES AND ACADEMIES

LONDON

Geological Society, May 27.—John Evans, F.R.S., president, in the chair.—The following communications were read:—On the last stage of the Glacial period in North Britain, by T. F. Jamieson. In this paper the author arranged the Glacial phenomena of Scotland under the three following heads:—(1) The

great early glaciation by land-ice (maximum effects of glaciation). (2) The period of Glacial marine beds containing remains of arctic mollusca, when most of the country was covered by the sea. (3) The time of the late glaciers, the special subject of the paper. After expressing himself in opposition to the hypothesis of a great polar ice-cap, the author described this last period as one not of mere local glaciers, but as characterised by a return of a great ice-sheet over nearly the whole of Scotland and Ireland; but he stated that this ice-sheet was probably neither so thick, so extensive, nor so enduring as that of the first period of glaciation, which cleared away everything in the shape of superficial deposits, down to the hard rock. He believed, however, that in the last period the mountains of Scotland and Wales, as well as the Penine range and the rest of the north of England as far as Derby, were covered with thick ice, which in most parts reached down to the sea, and that extensive snow-beds prevailed over the rest of England. In the summer months the melting of these would give rise to streams of muddy water, and produce the superficial deposits of brick-earth, warp, and loess; whilst when the currents were stronger, perhaps from the thaw being unusually rapid, deposits of gravel would be formed. This second ice-sheet would gradually become less and break up into valley-glaciers, which in their retreat would leave kaims and eskers at low levels, and moraines in the mountain-glens. During this time no new great submergence of the country took place; and the last great modifications of the surface were sub-aërial, and not submarine, the work having been done by frost, rain, and glaciers.—Notes on the Upper Engadine and the Italian valleys of Monte Rosa, and their relation to the glacier-erosion theory of lake-basins, by the Rev. T. G. Bonney. The author stated that he had examined (1) the small lakes on the summit of the Bernina Pass. These were situated in a position very favourable to glacier-erosion, and he thought might be attributed to that cause. (2) The lakes on the upper part of the Maloya Pass. These lay in three rock-basins, and at first sight seemed favourable to the glacier-erosion theory; but further examination showed that they were in no way connected with the Glacial system of the neighbourhood, and were probably Preglacial. (3) The Val Bregaglia to the Lake of Como. The presence of barriers in the valley, its frequent V-like form, and the signs of Glacial action to near the present level of the stream, seemed to indicate that the glacier had had but slight erosive power. (4) The Como arm of the lake. It was shown that the glacier, which was supposed to have excavated the lake, had passed over the ridge of Nagelfluhe and Molasse that encloses it, and had not been able to grind away its remarkably sharp crest. (5) Similar evidence was produced with regard to the Lake of Orta. (6) The Italian valleys east of Monte Rosa. These were shown to offer difficulties precisely similar to those of the Val Bregaglia. The author therefore argued that these cases showed how superficial the action of the glaciers had been; and that they must have been wholly inadequate to excavate the greater lake-basins, since no approach to this form, no U-like trough, was found in the valleys down which the glaciers had flowed on their way to the lakes. As then the principal features of the district appeared to be Preglacial, he contended that disturbances of beds of the valleys along lines transverse to their direction were more likely to have produced the lakes.

Zoological Society, June 2.—Arthur Grote in the chair.—A letter was read from Mr. T. D. Forsyth containing an account of some of the animals met with in the vicinity of Kashgar.—An extract was read from a letter received from Mr. E. P. Ramsay, relating to a living cassowary (*Casuarius australis*), which he was proposing to send to the Society's collection.—Prof. Owen, F.R.S., read the fifth part of his series of memoirs on the "Osteology of the Marsupialia." This portion contained a general account of the osseous structure of the kangaroos.—Lieut.-Col. H. Irby exhibited specimens of apparently a new species of raven, which he had lately obtained in the vicinity of Tangier, Morocco, and which he was intending to describe under the name of *Corvus tingitanus*.—A communication was read from the Rev. O. P. Cambridge, on some new species of the Arachnidean family of *Drassides*, from various localities.—A communication was read from Dr. E. Grube, containing descriptions of new Annulata collected by Mr. E. W. H. Holdsworth on the coasts of Ceylon.—A communication was read from Mr. W. Nation on the habits of *Spermophila simplex*, as observed in the vicinity of Lima.—A communication was read from A. G. Butler containing a list of the butterflies of Costa Rica, with descriptions of new species.

Chemical Society, June 4.—Prof. Odling, F.R.S., president, in the chair.—The following papers were read:—1. Dendritic spots in paper, by H. Adrian. These he finds to consist of sulphide of copper, formed from particles of gun metal, derived from the machinery employed in manufacturing the paper; they are far more usually found in common paper than in the better classes. 2. The acidity of normal urine, by J. Resch, M.A. 3. On a simple method of estimating urea in urine, by Dr. Russell and Mr. West. The apparatus employed for this purpose was exhibited, and a practical illustration given by Mr. West. 4. On ipomæic acid, by E. Neison and J. Bayne. This acid, prepared by the action of nitric acid on jalapin, the authors find to be identical with sebacic acid. 5. On certain compounds of albumin with the acids, by G. S. Johnson. 6. On sulphide of acetyl, and 7. On a new method of preparing toluene: both by Dr. D. Tommasi. 8. Note on New Zealand Kauri gum, by M. M. P. Muir.

Royal Horticultural Society, May 27.—Scientific Committee.—R. M'Lachlan, F.L.S., in the chair.—The Rev. M. J. Berkeley remarked with respect to the Thread Blight of the tea in Assam:—"I have carefully examined the thread blight in company with Mr. Broome. We could find not the slightest trace of fruit, and therefore we are unable to say to what genus its perfect state belongs. It seems to run indifferently over plants belonging to very different natural orders. The leaves of *Andrachne trifoliata*, a plant which it also attacks, are very much damaged by minute lichens belonging to the genus *Strigula*. In one perfect asci were discovered with minute sausage-shaped sporidia, in the other only stylospores were found, but of a very peculiar character. They were staff-shaped, hollowed out on either side, septate, and seated on very long pedicels." Mr. Berkeley also placed before the committee a curious fungus from New Jersey, which affects *Cupressus thujoides*. Mr. J. B. Ellis, who sent it him, remarks, "It grows from the same matrix yearly, generally at the extremities of the branches, which it causes to swell and branch in a brush-like or digitate manner." It appeared to agree with *Podisoma* except in possessing no gelatinous investment, and would appear to constitute a new genus.—Mr. M'Lachlan remarked, with reference to the *Termes* exhibited at the last meeting from the wood of Zanzibar copal (*Trachylobium*), that he had ascertained that it did not belong to the sub-genus *Eutermes*, but to *Calotermes*. It seems to be an undescribed species, allied to *Calotermes solidus* Hagen, but differing slightly. The original locality for that species is unknown. Hagen, in his monograph of the family, speaks of having seen two specimens of *C. brevis*, a species from Central and South America, inclosed in copal. It would not be expected to find an American species under these conditions, and the individuals in question may possibly have been the same as those from Kew. In the south of France two small indigenous species (one belonging to *Calotermes*) do considerable damage, and a small North American species (*Eutermes flavipes*) had at one time established itself in the hot-houses of the gardens of Schönbrunn, at Vienna, principally infesting the tubs in which plants were growing.—Mr. Andrew Murray sent a note on the section of a stem of *Macrozamia spiralis*, exhibited at the last meeting, and which was completely riddled by the borings of a weevil, described by Mr. Pascoe under the name of *Tranes internatus*.—Prof. Thiselton Dyer read the following extract from a letter addressed by Mr. W. H. Tillett to Dr. Hooker:—"April 26.—*Philodendron selloum* is now in bloom again. Last night I fancied it was emitting heat, and in testing this with a thermometer found it was so. The heat in the house was 58° F., and the thermometer rose at once to 68° F. I have tested it again this evening, and the thermometer rises from 58° F. to 74° F. April 27.—Testing the *Philodendron* last night, I found it was 35° F. above the temperature of the house. The house was 56°, and the flower—one newly opened—91°."—Dr. Voelcker thought the committee would like to know the results of his investigation of the soil of a London square in which Messrs. Veitch had twice planted planes, which in each case had died. He found, on examining the clear watery solution from treating the soil with distilled water, that the soil contained one-tenth per cent. of common salt and two-tenths per cent. of nitrates. Now it was obvious that this was really a considerable quantity, when it was considered that one-tenth per cent. of common salt would amount to a ton mixed with 6 in. of soil over an acre. He might say parenthetically that whenever the amount of chlorine in soil reached anything like an appreciable quantity, it exercised an injurious influence.

General Meeting.—Henry Webb in the chair.—The Rev

M. J. Berkeley commented on the injury done to pears by a species of *Cecidomyia* and also by a fungus *Helminthosporium pyrorum* which produced the unsightly cracking of the surface.

Royal Microscopical Society, June 3.—Charles Brooke, F.R.S., president, in the chair.—Mr. Slack called attention to a slide exhibited under one of the Society's microscopes, as being a remarkable specimen of Herr Müller's technical skill in diatom mounting. The slide had photographed upon it, in an extremely beautiful and perfect manner, eighty spaces with the names of diatoms below each, and a diatom of corresponding species was mounted in every space.—Mr. Charles Stewart described and figured on the blackboard the peculiar position of the touch corpuscles in the skin of the hand; he also exhibited and described a section of an Ascidian, and explained the method of preparation.

BOSTON, U.S.

Society of Natural History, Jan. 7.—Dr. T. Sterry Hunt read a paper on the stratification of rock-masses. The crystalline rocks are commonly divided into stratified and unstratified. These two classes correspond to what the author has designated indigenous and exotic rocks, but a third class must be distinguished, which he has called endogenous rocks, and which appear to have been deposited from solutions, not in open basins, but in fissures at greater or less depths from the surface, and under peculiar conditions of temperature and pressure. To these crystalline deposits belong the various veinstones, including many of the so-called granites, especially those containing the rarer mineral species. The speaker desired to call attention to the fact that a stratiform or layer-like arrangement of the constituent parts is often met with, both in exotic and endogenous rocks, and cannot be regarded as characteristic of indigenous rocks, nor as a proof of aqueous deposition at the earth's surface. While admitting the frequent occurrence of the banded structure in eruptive rock, and the necessity in many cases of a careful geognostical study to determine to which class a stratiform rock should be referred, the speaker maintained the truly indigenous character of the great formations of gneissic rocks, such as, for example, the Laurentian, which from their wide extent, and from the mode of their association with layers of quartzite, limestone and iron-oxides, were clearly deposited in horizontal layers at the earth's surface.

Feb. 4.—Mr. J. A. Allen read a paper on geographical variation in colour among North American squirrels, exhibiting many specimens in illustration of his remarks. The law of geographical variation in size, that representatives of the same species decrease in size with decrease in latitude or altitude of their range, was established by Prof. Baird in 1857-58, in respect to both mammals and birds, who also noticed the occurrence of variation with locality in some other respects. Laws have been found to govern these variations as well, and are as follows:—(1) enlargement of peripheral parts towards the southward; (2) increase in depth, intensity, and extent of dark colours towards the southwards, and (3) increase of colour with increase of humidity, or the correlation of intensity of colour and the mean annual rainfall. Mr. Allen then proceeded to notice the application of these laws to the family of squirrels.—Prof. C. H. Hitchcock spoke of his studies of the Helderberg rocks of New Hampshire. He also described in detail the geology of the northern part of Grafton County, New Hampshire, where the Helderberg Rocks can be best studied.

PARIS

Academy of Sciences, June 1.—M. Bertrand in the chair.—M. Jamin presented the following paper in continuation of his researches on magnetism:—On the part played by the mean section, the polar surfaces, and the armatures of a magnet. The author concludes that the mean section determines the quantity, and the surface the distribution, of the magnetism.—Presentation of an ingot of 250 kilogrs. of platinum iridium alloy, cast at the Conservatoire des Arts et Métiers, May 13, 1874, by M. le Gen. Morin. This enormous ingot is more than 1 metre in length, and contains about 10·3 per cent. of iridium. It was fused in a furnace of limestone by means of an oxyhydrogen blow-pipe with seven jets, the fusion being completed in from 65 to 70 minutes.—M. Chevreul communicated a paper containing observations on M. Boussingault's paper on the transformation of iron into steel.—M. Boussingault made some remarks in reply, and MM. Dumas and Pasteur added some observations.—Observations on the dwarf African races, *à propos* of the photographs of Akkas sent by Prof. Panceri, by M. de Quatrefages.—Researches on the simultaneous diffusion of certain salts, by M. C. Marignac.—Probable decrease in the water supply from the Seine basin in the summer and autumn of 1874, by MM. E. Belgrand and G. Lemoine. The authors predict that the water supply will fall very low from now to the middle of October.—Memoir on the bay of St. Jean de Luz, by M. Bouquet de la Grye.—New process for engraving on copper, by the same author. The plate is first coated with a thin layer of silver, on which is spread a coloured varnish, and the design is then engraved with a dry point. The tracing is finally etched by a solution of ferric chloride.—Note on magnetism, by M. J. M. Gaugain. The present researches relate to the magnetisation of hardened steel.—On the motion of the air in pipes (fourth note), by M. Ch. Bontemps.—On the adulteration of bee's-wax with Japanese wax, by M. Ch. Mène. The author has determined the densities of the pure substances and of mixtures containing the two kinds of wax in varying proportions.—On the integrals of the differential equations of curves of which the locus of the centres of the intersecting ellipsoids, similar and similarly placed, is a given curve, by M. l'Abbé Aoust.—On a mechanical problem, by M. H. Durrande.—On the principles of correspondence of the plane and of space, by M. Zeuthen.—On the flatness of the planet Mars, by M. Amigues. The author arrives at the conclusion that the planet was formed in two or more stages and that the mean density of the superficial layers is 1·54 of the mean density of the nucleus.—On the shock of bodies (second note), by M. G. Darboux.—Perfection of electric chronographs, and researches on electro-magnets, by M. Marcel Deprez.—Study of the products formed by the action of hydrochloric acid on cast-iron and steel, by M. S. Cloëz. The author has separated and made analyses of several hydrocarbons.—On the new triangulation of the Isle of Corsica, by M. F. Perrier.—Of the spectrum of muscle, by M. L. Ranvier. The author has devised an instrument called a *myospectroscope*, of which the action depends on the fact that striated muscular fibre when properly prepared acts as a natural diffraction grating.—On certain particulars of the history of casein and albumen *à propos* of a recent note by M. Commaille, by M. A. Béchamp.—Experiments which explain the difference of opinion on the constitution of the iron in the blood, by MM. Paguelin and L. Jolly.—On the *Tyroglyphus* of the vine, by M. A. Fumouze. This Acarus (*T. echinopus*) is stated by Planchon to destroy Phylloxera, but the author of the present communication does not speak of it hopefully as an agent of destruction of the vine scourge.—On a new indigenous genus of terrestrial Lombricians (*Pontodrilus marionis*), by M. E. Perrier.—On the mode of contagion of cholera, by M. Ch. Pellarin.

CONTENTS

THURSDAY, JUNE 18, 1874

PLATEAU ON SOAP-BUBBLES

Statique expérimentale et théorique des Liquides soumis aux seules Forces moléculaires. Par J. Plateau, Professeur à l'Université de Gand, &c. (Paris, Gauthier-Villars; London, Trübner & Co.; Gand et Leipzig, F. Clemm. 1873.)

ON an Etruscan vase in the Louvre figures of children are seen blowing bubbles. Those children probably enjoyed their occupation just as modern children do. Our admiration of the beautiful and delicate forms, growing and developing themselves, the feeling that it is *our* breath which is turning dirty soap-suds into spheres of splendour, the fear lest by an irreverent touch we may cause the gorgeous vision to vanish with a sputter of soapy water in our eyes, our wistful gaze as we watch the perfected bubble when it sails away from the pipe's mouth to join, somewhere in the sky, all the other beautiful things that have vanished be fore it, assure us that, whatever our nominal age may be—we are of the same family as those Etruscan children.

Here, for instance, we have a book, in two volumes, octavo, written by a distinguished man of science, and occupied for the most part with the theory and practice of bubble-blowing. Can the poetry of bubbles survive this? Will not the lovely visions which have floated before the eyes of untold generations collapse at the rude touch of Science, and "yield their place to cold material laws"? No, we need go no further than this book and its author to learn that the beauty and mystery of natural phenomena may make such an impression on a fresh and open mind that no physical obstacle can ever check the course of thought and study which it has once called forth.

M. Plateau in all his researches seems to have selected for his study those phenomena which exhibit some remarkable beauty of form or colour. In the zeal with which he devoted himself to the investigation of the laws of the subjective impressions of colour, he exposed his eyes to an excess of light, and has ever since been blind. But in spite of this great loss he has continued for many years to carry on experiments such as those described in this book, on the forms of liquid masses and films, which he himself can never either see or handle, but from which he gathers the materials of science as they are furnished to him by the hands, eyes, and minds of devoted friends.

So perfect has been the co-operation with which these experiments have been carried out, that there is hardly a single expression in the book to indicate that the measures which he took and the colours with which he was charmed were observed by him, not in the ordinary way, but through the mediation of other persons.

Which, now, is the more poetical idea—the Etruscan boy blowing bubbles for himself, or the blind man of science teaching his friends how to blow them, and making out by a tedious process of question and answer the conditions of the forms and tints which he can never see?

But we must now attempt to follow our author as he passes from phenomena to ideas, from experiment to theory.

The surface which forms the boundary between a liquid and its vapour is the seat of phenomena on the careful study of which depends much of our future progress in the knowledge of the constitution of bodies. To take the simplest case, that of a liquid, say water, placed in a vessel which it does not fill, but which contains nothing else. The water lies at the bottom of the vessel, and the upper part, originally empty, becomes rapidly filled with the vapour of water. The temperature and the pressure—the quantities on which the thermal and statical relations of any body to external bodies depend—are the same for the water and its vapour, but the energy of a milligramme of the vapour greatly exceeds that of a milligramme of the water. Hence the energy of a milligramme of water-substance is much greater when it happens to be in the upper part of the vessel in the state of vapour, than when it happens to be in the lower part of the vessel in the state of water.

Now we find by experiment that there is no difference between the phenomena in one part of the liquid and those in another part except in a region close to the surface and not more than a thousandth or perhaps a millionth of a millimetre thick. In the vapour also, everything is the same, except perhaps in a very thin stratum close to the surface. The change in the value of the energy takes place in the very narrow region between water and vapour. Hence the energy of a milligramme of water is the same all through the mass of the water except in a thin stratum close to the surface, where it is somewhat greater; and the energy of a milligramme of vapour is the same all through the mass of vapour except close to the surface, where it is probably less.

The whole energy of the water is therefore, in the first place, that due to so many milligrammes of water; but besides this, since the water close to the surface has an excess of energy, a correction, depending on this excess, must be added. Thus we have, besides the energy of the water reckoned per milligramme, an additional energy to be reckoned per square millimetre of surface.

The energy of the vapour may be calculated in the same way at so much per milligramme, with a deduction of so much per square millimetre of surface. The quantity of vapour, however, which lies within the region in which the energy is beginning to change its value is so small that this deduction per square millimetre is always much smaller than the addition which has to be made on account of the liquid. Hence the whole energy of the system may be divided into three parts, one proportional to the mass of liquid, one to the mass of vapour, and the third proportional to the area of the surface which separates the liquid from the vapour.

If the system is displaced by an external agent in such a way that the area of the surface of the liquid is increased, the energy of the system is increased, and the only source of this increase of energy is the work done by the external agent. There is therefore a resistance to any motion which causes the extension of the surface of a liquid.

On the other hand, if the liquid moves in such a way that its surface diminishes, the energy of the system diminishes, and the diminution of energy appears in the form of work done on the external agent which allows the surface to diminish. Now a surface which tends to diminish in area, and which thus tends to draw together

any solid framework which forms its boundary, is said to have surface-tension. Surface-tension is measured by the force acting on one millimetre of the boundary edge. In the case of water at 20° C., the tension is, according to M. Quincke, a force of 8·253 milligrammes weight per millimetre.

M. Plateau hardly enters into the theoretical deduction of the surface-tension from hypotheses respecting the constitution of bodies. We have therefore thought it desirable to point out how the fact of surface-tension may be deduced from the known fact that there is a difference in energy between a liquid and its vapour, combined with the hypothesis, that as a milligramme of the substance passes from the state of a liquid within the liquid mass, to that of a vapour outside it, the change of its energy takes place, not instantaneously, but in a continuous manner.

M. van der Waals, whose academic thesis, "Over de Continuiteit van den Gas- en Vloeistoftoestand,"* is a most valuable contribution to molecular physics, has attempted to calculate approximately the thickness of the stratum within which this continuous change of energy is accomplished, and finds it for water about 0·0000003 millimetre.

Whatever we may think of these calculations, it is at least manifest that the only path in which we may hope to arrive at a knowledge of the size of the molecules of ordinary matter is to be traced among those phenomena which come into prominence when the dimensions of bodies are greatly reduced, as in the superficial layer of a liquid.

But it is in the experimental investigation of the effects of surface-tension on the form of the surface of a liquid that the value of M. Plateau's book is to be found. He uses two distinct methods. In the first he prepares a mixture of alcohol and water which has the same density as olive oil, then introducing some oil into the mixture and waiting till it has, by absorption of a small portion of alcohol into itself, become accommodated to its position, he obtains a mass of oil no longer under the action of gravity, but subject only to the surface-tension of its boundary. Its form is therefore, when undisturbed, spherical, but by means of rings, disks, &c., of iron, he draws out or compresses his mass of oil into a number of different figures, the equilibrium and stability of which are here investigated, both experimentally and theoretically.

The other method is the old one of blowing soap-bubbles. M. Plateau, however, has improved the art, first by finding out the best kind of soap and the best proportion of water, and then by mixing his soapy water with glycerine. Bubbles formed of this liquid will last for hours, and even days.

By forming a frame of iron wire and dipping it into this liquid he forms a film, the figure of which is that of the surface of minimum area which has the frame for its boundary. This is the case when the air is free on both sides of the film. If, however, the portions of air on the two sides of the film are not in continuous communication, the film is no longer the surface of absolute minimum area, but the surface which, with the given boundary, and inclosing a given volume, has a minimum area.

M. Plateau has gone at great length into the interesting but difficult question of the conditions of the persistence of liquid films. He shows that the surface of certain liquids has a species of viscosity distinct from the interior viscosity of the mass. This surface-viscosity is very remarkable in a solution of saponine. There can be no doubt that a property of this kind plays an important part in determining the persistence or collapse of liquid films. M. Plateau, however, considers that one of the agents of destruction is the surface-tension, and that the persistence mainly depends on the degree in which the surface-viscosity counteracts the surface-tension. It is plain, however, that it is rather the inequality of the surface-tension than the surface-tension itself which acts as a destroying force.

It has not yet been experimentally ascertained whether the tension varies according to the thickness of the film. The variation of tension is certainly insensible in those cases which have been observed.

If, as the theory seems to indicate, the tension diminishes when the thickness of the film diminishes, the film must be unstable, and its actual persistence would be unaccountable. On the other hand, the theory has not as yet been able to account for the tension increasing as the thickness diminishes.

One of the most remarkable phenomena of liquid films is undoubtedly the formation of the black spots, which were described in 1672 by Hooke, under the name of holes.

Fusinieri has given a very exact account of this phenomenon as he observed it in a vertical film protected from currents of air. As the film becomes thinner, owing to the gradual descent of the liquid of which it is formed, certain portions become thinner than the rest, and begin to show the colours of thin plates. These little spots of colour immediately begin to ascend, dragging after them a sort of train like the tail of a tadpole. These tadpoles, as Fusinieri calls them, soon begin to accumulate near the top of the film, and to range themselves in horizontal bands according to their colours, those which have the colour corresponding to the smallest thickness ascending highest.

In this way the colours become arranged in horizontal bands in beautiful gradation, exhibiting all the colours of Newton's scale. When the frame of the film is made to oscillate, these bands oscillate like the strata formed by a series of liquids of different densities. This shows that the film is subject to dynamical conditions similar to those of such a liquid system. The liquid is subject to the condition that the volume of each portion of it is invariable, and the motion arises from the fact that by the descent of the denser portions (which is necessarily accompanied by the rise of the rarer portions) the gravitational potential energy of the system is diminished. In the case of the film, the condition which determines that the descent of the thicker portions shall entail the rise of the thinner portions must be that each portion of the film offers a special resistance to an increase or diminution of area This resistance probably forms a large part of the superficial viscosity investigated by M. Plateau, which retards the motion of his magnetic needle, and evidently is far greater than the viscosity of figure, in virtue of which the film resists a shearing motion.

The coloured bands gradually descend from the top of the film, presenting at first a continuous gradation of

* Leiden, A. W. Sijthoff, 1873.

colour, but soon a remarkable black, or nearly black, band begins to form at the top of the film, and gradually to extend itself downwards. The lower boundary of this black band is sharply defined. There is not a continuous gradation of colour according to the arrangement in Newton's table, but the black appears in immediate contact with the white or even the yellow of the first order, and M. Fusinieri has even observed it in contact with bands of the third order.

Nothing can show more distinctly that there is some remarkable change in the physical properties of the film, when it is of a thickness somewhat greater than that of the black portion. And in fact the black part of the film is in many other respects different from the rest. It is easy, as Leidenfrost tells us, to pass a solid point through the thicker part of the film, and to withdraw it, without bursting the film, but if anything touches the black part, the film is shattered at once. The black portion does not appear to possess the mobility which is so apparent in the coloured parts. It behaves more like a brittle solid, such as a Prince Rupert's drop, than a fluid. Its edges are often very irregular, and when the curvature of the film is made to vary, the black portions sometimes seem to resist the change, so that their surface has no longer the same continuous curvature as the rest of the bubble. We have thus numerous indications of the great assistance which molecular science is likely to derive from the study of liquid films of extreme tenuity.

We have no time or inclination to discuss M. Plateau's work in a critical spirit. The directions for making the experiments are very precise, and if sometimes they appear tedious on account of repetitions, we must remember that it is by words, and words alone, that the author can learn the details of the experiment which he is performing by means of the hands of his friends, and that the repetition of phrases must in his case take the place of the ordinary routine of a careful experimenter. The description of the results of mathematical investigation, which is a most difficult but at the same time most useful species of literary composition, is a notable feature of this book, and could hardly be better done. The mathematical researches of Lindelöf, Lamarle, Scherk, Riemann, &c., on surfaces of minimum area, deserve to be known to others besides professed mathematicians, and M. Plateau deserves our thanks for giving us an intelligible account of them, and still more for showing us how to make them visible with his improved soap-suds.

In the speculative part of the book, where the author treats of the causes of the phenomena, there is of course more room for improvement, as there always must be when a physicist is pushing his way into the unknown regions of molecular science. In such matters everything human, at least in our century, must be very imperfect, but for the same reason any real progress, however small, is of the greater value. J. CLERK MAXWELL

HINTON'S PRACTICAL PHYSIOLOGY

Physiology for Practical Use. By various writers. Edited by James Hinton. 2 vols. (Henry S. King & Co.)

THIS work consists of a series of independent essays by different writers, on points in physiology which are likely to prove interesting and instructive to the general public. No attempt is made to give more than the best known facts of the science, together with the most approved theories by which they are, at the present day, connected. The thoroughness of the knowledge of the authors, the largeness of the view they take of the subject, and the easiness of the style they adopt add greatly to the interest of the book.

Those who are accustomed to regard the living body as an arrangement of organs which is quite peculiar and whose mechanism is altogether inexplicable upon the ordinary principles of mechanics and chemistry, will, after having carefully studied this work, be convinced how subject it is to the same influences that affect the inanimate world, and that in fact it is nothing more than a very complex machine, with the detailed mechanism of which we are daily becoming more and more acquainted. There are peculiarities however in the living frame which fail to be represented in working out the analogy with the steam engine. "The latter, after being constructed, daily wastes. Every day it becomes worse, for each stroke of its piston, to say nothing of the motion of its other parts, implies a waste of the piston itself, and of the cylinder in which it is inclosed, and in which it works. Now when we get these out of order, the whole machine has to be stopped, that the engineer may repair the deteriorated portions." Such is not the case in the living body, which differs from any machine yet constructed in that it is "constantly working, constantly wasting, and *constantly repairing its own deficiencies*." This is a most important difference between the two engines; and it is almost certain, that as our knowledge of machine-construction increases, but little improvement will ever be made in this direction, on account of the nature of the materials employed, so that the difference will not be diminished. The cell of a Daniel's battery may be instanced as an example of an engine in which a partial repair of its structure is continually being effected, for by the gradual solution of the crystals of sulphate of copper that are always placed in one of the compartments, the power of the battery, and therefore the constancy of the current it developes, is rendered more perfect.

There is an excellent chapter on alcohol, in which the principle of its action is most clearly explained. The author prefaces his subject by clearly stating his views on its social relations. For instance, he remarks:—"We are not in the ranks of those who would remove the tax on spirits, a tax whereby the poor as well as the rich are made to contribute to the expenses of Government, by paying a price above its production-cost for an article of luxury; and very far are we from siding with those who misinterpret the liberty of the subject—we mean the right of any man to wrong his neighbour, to sell him fictitious goods—poison, perchance for food." . . . "We are not abstainers ourselves, and we are not about to advocate teetotalism under the banner of physiological instruction."

There is a paragraph which quite represents the generally accepted doctrine of the relation of mental activity to work done, but to which we think all physiologists ought now-a-days to take exception. It is remarked that "energy, the manifestation of power, or the conversion of force into action, involves no expenditure of life or loss of power. Thinking or lifting a weight is but a function of

tissues provided to issue thoughts or actions. The tissues do not suffer by reason of their employment, so long as their nutrition is maintained. Brain and muscle can be very fairly likened to machinery." From this it is evident that the author considers that both mental and muscular activity involve a consumption of nutriment material according to their amount. Of muscular action this is no doubt correct, for the amount of work performed can be measured by foot-pounds without difficulty; but as it is inconceivable that we should be able to say that one pound falling through one foot is equivalent to so much thought, or so much of an argument, not because of the difficulty in measuring, but because of the total absence of relation between the one and the other; so it is necessary to believe that thought is not a mode of motion, is not capable of being correlated with the other physical forces, and does not involve the consumption of nutrient fluid. If the brains of different individuals are compared to running streams, in which the waters exhibit different degrees of clearness, as brains give evidences of differences in quality, their thoughts may be compared to the reflections of surrounding objects on the surfaces of the streams, different in intensity according to the clearness of the water or the quality of the brain cells. Upon this analogy it is evident that the relative intensity of different reflections is not dependent at all on the stream itself, but on the illuminating power of the objects reflected; in like manner we cannot conceive that the amount of nerve tissue disintegrated by the greatest minds at the time that they are evolving their mightiest thoughts is in excess of that which is wasted during the same time by the most commonplace member of every community. Thought is as intimately connected with the reception of external impressions by the healthy human brain as reflections from water are with the illumination of the surrounding objects; they are involuntary when cause for their development is present.

The chapters on headache and on sleep are amongst those which show how backward is our knowledge of some of the simplest of the phenomena of life. We may be able to recognise that "sick headache" and nightmare have something to do with the presence of indigestible matter in the stomach, but as to the true relation between the two we are still completely in the dark. In speaking of "taking cold" the author tells us that "cold contracts almost all substances, and when the skin is exposed to its influence the contraction becomes visible to the eye, and the appearance it presents is called *goose-skin*, from its resemblance to the natural condition of the skin of the goose." This will, we fear, mislead those readers who are pure physicists as to what is the index of expansion of skin for heat, the fact being that the cold, by stimulating the small arteries of the corium, causes them to contract, and so prevents the blood from entering its substance, which gives it the shrunken, plucked-bird-like appearance that it presents. We are told also that "no danger need ever be apprehended from the application of cold water . . . to the naked body, if it be made immediately after remaining some time exposed to a high temperature." With this it is difficult to agree, for the epistaxis, or nose-bleeding, which sometimes occurs on entering the cold plunge of the Turkish bath shows that the blood-pressure is thereby suddenly augmented to a degree which cannot but be dangerous in some cases, especially when the walls of the arterial system are not as strong as they might be.

In conclusion we strongly recommend this work to non-professional readers, from the lucid and logical manner in which the physiological problems of everyday life are stated. The public cannot be too forcibly impressed with the importance of removing causes rather than combating effects by direct means, and on these points the authors lay considerable stress. The principles of such subjects as ventilation and gymnastics cannot be too frequently taught, and when expounded by writers so capable as those of the work before us they are doubly impressive.

OUR BOOK SHELF

Annual Record of Science and Industry for 1873. Edited by Spencer F. Baird, with the assistance of eminent men of Science.—(New York: Harper and Brothers, 1874.)

The Year Book of Facts in Science and Art: exhibiting the most important discoveries of the past year. By John Timbs.—(London: Lockwood and Co., 1874.)

THESE books, like M. Figuier's "L'Année scientifique,' give a fair general idea of the progress of Science and the mechanical arts during the year. They are scarcely sufficiently comprehensive and exact for the man of Science, but are decidedly useful for the ordinary well-educated reader, who takes an interest in the discoveries of Science. Mr. Baird's book is perhaps something more than this: it is carefully arranged, and enters into detail in most cases; it is also preceded by a "General Summary of Scientific Progress," of somewhat more than a hundred pages. From this we learn that five new planets were discovered during 1873—the last "Sophrosyne" being the 134th in order, starting from "Ceres," which was discovered in 1801. Seven comets were seen during last year, three of them new ones; five out of the seven were first seen in Marseilles by those indefatigable observers, Stephan, Coggia, and Borelli. In Physics there appears to have been no discovery of any particular note. In Chemistry the copper-zinc couple of Dr. Gladstone and Mr. Tribe, and its results are described as among the most interesting work of the year. Further on we find an account of the cruise of the *Challenger*, and favourable mention of Sir William Thomson's suggestions that' steel pianoforte-wire should be used for a sounding line in place of the usual hempen cord, which offers far greater resistance, and requires a heavy weight at the bottom. Under the head of "Mechanics and Engineering," we find some interesting statistics of American iron-industry. The production of pig-iron in the United States is estimated (for 1873) at 2,406,637 gross tons. The total number of furnaces is 636, and their estimated capacity 4,371,277 net tons. There are eight Bessemer works in the country, with a total capacity of 170,000 tons. The great Hoosac tunnel, 4¾ miles long, was completed during the year. In Timbs' "Year Book" we find too many evidences of careless compilation, and great want of method in grouping the different subjects. We read, "Dr. Odling, President of the Chemical Society, read a paper On the preparation of the Standard Trial plates to be used in verifying the composition of the coinage:'"—the paper was by Mr. Roberts, not Dr. Odling. Among the so-called chemical subjects, we find "Sunlight for the sick," "Transparent paper," and "Opium-smoking in New York." It is unfortunate also that non-scientific journals are so often made to guarantee scientific facts.

The *Illustrated London News* is quoted, and the *Hampshire Telegraph* is made to paraphrase the *Philosophical Magazine*.

Reprint of Boddaert's Table aes Planches Enluminecz d'Histoire Naturelle. Edited by W. B. Tegetmeier, F.Z.S.

MR. TEGETMEIER has done a service to ornithology by increasing the facilities for precise avian nomenclature, in reprinting, with an accuracy in typography which does him much credit, a catalogue compiled by Dr. Boddaert, printed in 1783, which contains the names of a large number of birds, given on the then novel binomial system of Linnæus. The original work is extremely scarce, only two copies being known in the United Kingdom; and as so much stress has to be laid on priority in naming, a book published so soon after the tenth edition of the "Systema Naturæ" ought to be available to all working ornithologists.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Molecular Motion

IN Prof. Maxwell's communication, NATURE, vol. viii., p. 537, on this subject, he assumes that if n_1 represent the number of molecules of a particular kind in a given element of space with a velocity given in direction and magnitude, which we will call v_1; and if n_2 represent the particles of another kind in the same element with the velocity v_2, then the number of encounters of these particles is proportional to $n_1 \times n_2$, and if out of these we select the particular encounters which give rise to a given set of resultant velocities v_1' and v_2', then we may assume that if the number of particles in the element which originally had the velocities v_1' and v_2' be called n_1' and n_2', then

$$n_1 n_2 = n_1' n_2'$$

This reasoning does not seem convincing. Assuming that in an element of space the average number of particles having a given velocity is the same, so that n_1 and n_2 are *not* functions of v_1 and v_2, then Mr. Maxwell's statement might be admitted; but if the number of particles in a given element is a function of its velocity in direction and magnitude, then although the average of the numbers in each direction is maintained, it does not follow that the average numbers of particles having the velocities v_1 and v_2 are directly restored from the particles having the velocities v_1' and v_2'. All that can be assumed is, that the average number of particles in a given element of space is maintained from the particles in that and the remaining elements. Just as in the case of an equilibrium of trade, the average course of exchange with respect to a given country is at par; but we cannot therefore safely assume that the same is the case relatively to any other individual country.

There are several other points in Mr. Maxwell's communication which seem to me to require fortification, but the subject has already assumed so technical a form that it would perhaps be uninteresting to your readers to point them out. My impression is that the whole subject is still somewhat beyond the grasp of strict mathematical reasoning, and is still open to experimental investigation. F. GUTHRIE

Graaff Reinet College, Feb. 7

[This question is treated at length in my paper On the dynamical theory of gases (Phil. Trans., 1866). It is there shown that if the average course of exchange is in a cycle from A to B, B to C, C to A, an equal reason may be given why it should be in the opposite cycle A to C, C to B, B to A., and thus it is shown that the exchange is at par between each pair of states separately. For a far more elaborate theoretical treatment of the subject Prof. Guthrie is referred to the papers of Prof. Ludwig Boltzmann in the Vienna Transactions since 1868. I fear we must delay the experimental investigation for some time, till we are able to count the molecules in a given space, to observe their velocities, and to repeat these operations millions of times in a second.—J. CLERK MAXWELL.]

The Germans and Physical Axioms

ALTHOUGH the *à priori* origin of the fundamental principles of Mechanics has been lucidly demonstrated by the reasoning of Herbert Spencer, it is presumable that his antagonists, who evidently pay great deference to authority, will not be convinced of its truth except by the opposition of acknowledged authorities. Kant, in Germany, one of the first and most assiduous students of Newton's *Principia*, from which he derived the nebular hypothesis subsequently developed by Laplace, thus delivers himself respecting the matter under discussion:—

"The science of Natural Philosophy (Physics) contains in itself synthetical judgments *à priori as principles*. For instance, the proposition, 'in all changes of the material world, the quantity of matter remains unchanged;' or, that 'in all communication of motion, action and reaction must always be equal.' In both of these, not only is the *necessity, and therefore their origin à priori clear*. . . . And so it is with regard to the other propositions of the pure part of Natural Philosophy."—"Critique of Pure Reason," Bohn's edition, page 11 of Introduction:—

This is explicit and incontrovertible. Yet those with whom precedents are omnipotent may argue that, since Kant was preeminent as a metaphysician rather than as a physicist, his deliverances must fall before the contrariety of such a man as Prof. Tait. Read then, the declaration of Helmholz:—

"In mathematics the general propositions which, under the name of axioms, stand at the head of the reasoning, are so few in number, so comprehensive, and so immediately obvious, that no proof whatever is needed for them. Let me remind you that the whole of algebra and arithmetic is developed out of the three axioms—

'Things which are equal to the same things are equal to one another.'

'If equals be added to equals, the wholes are equal.'

'If unequals be added to equals, the wholes are unequal.'

"And the axioms of geometry and *mechanics* are not more numerous. The sciences we have named are developed out of these few axioms by a continual process of deduction from them in more and more complicated cases."—Lecture "On the Relation of Natural Science to General Science."

Of course neither of these attestations is elucidatory, but they suffice to show that in Germany, at least, the axiomatic nature of physical principles is beyond controversy.

Waterbury, Conn., U.S. CHAS. G. ROOT

The Long Peruvian Skull

A KIND correspondent has called my attention to a communication from Dr. Daniel Wilson, of Toronto, in NATURE, vol. x. p. 46, to which my friend considers it incumbent upon me to reply. The communication in question has now reached me, although so late, but I can hardly regard it as requiring any answer, since I am quite satisfied my friend Dr. Wilson in it answers himself. As to his logical arguments, based upon Prof. Wyman's suggestion, that in Dr. Wilson's estimation *the skulls are natural because they are symmetrical*, no one can doubt that Dr. Wilson is fully acquainted with the want of symmetry in a large number of crania of all races. Of this it was scarcely needful for Dr. Wilson to reassure us.

But in reply to the real question at issue, had the ancient Peruvians dolichocephalic or long skulls, as well as brachycephalic, or short skulls? This question I must regard as fully solved, and I look upon it that craniologists consider this race to be brachycephalic. How is it, then, that Dr. Wilson, who has paid great attention to the study of craniology, maintains that there were among the ancient Peruvians two distinct types, a dolichocephalic and a brachycephalic section? A reference to his "Prehistoric Man," the two editions of which lie before me on the table, will suffice to indicate the source of error. I will refer to the figures which are unequivocal. In the first edition of this work, Dr. Wilson gives, Fig. 59, p. 240, vol. ii., the wood-cut of a Peruvian dolichocephalic skull, as an instance of the long skull type natural to the ancient Peruvians. At p. 242 he gives, "Fig. 60.—A Peruvian Child's Skull, Normal." This is the woodcut repeated in NATURE, vol. x. p. 48, Fig. 3. Seeing that both these skulls bore unequivocal marks of artificial distortion, years ago I acquainted Dr. Wilson with this fact, when I understood him to reply that the printer had not put the proper figures in the right places. When the second edition of "Prehistoric Man" reached me I looked to see if the right cuts had got put into their proper places,

but was surprised to find that at p. 446 the former figure is repeated with the description, "Fig. 58.—Peruvian Depressed Skull." This is quite correct, for it is not only depressed, but depressed by art; therefore it cannot be an instance of a natural Peruvian dolichocephalic skull. But at p. 451 the latter woodcut is repeated as "Fig. 60.—Peruvian Child's Skull, Normal," and described as such. Indeed it is not necessary to go beyond Dr. Wilson's communication to NATURE. His Fig. 3, p. 48, is the identical woodcut, as "Peruvian Child's Skull Normal." This woodcut is quite conclusive as to what I have asserted, that Dr. Wilson has answered himself. For it is the calvarium of a child which has been artificially distorted and thereby elongated. And in truth it is only necessary to cast the eye on the figures upon the same page in NATURE to see that all the skulls, Figs. 1, 3, and 4, have all been distorted, and distorted in the same manner, viz. by a figure of 8 bandage, which has left its distinct impressions upon the frontal, parietal, and occipital bones. This distortion has necessarily converted them into dolichocephalic or long skulls, in contradistinction to their natural form, which is exhibited in Fig. 2, on the same page of NATURE. This bandage has been the instrument of distortion, and all three have been deformed in what I call the *cylindroidal* manner, resulting in the lengthening out of the calvarium. It may be observed that this mode of distortion is the most generally diffused of any among human races, both of the old world and the new. The figures differ only in the degree of deformation, the "Fig. 3.—Peruvian Child's Skull, Normal," having been less tightly compressed than the other two. I conclude that it is quite unquestionable that this Peruvian skull cannot be looked upon as a natural Peruvian skull, cannot be adduced as evidence that there was a second type of cranium among the ancient Peruvians. The best inspection I am able to give the figures proves this unequivocally, and I am bound to affirm, with the utmost respect to Dr. Daniel Wilson, that he has fully answered himself, and proved that the asserted long Peruvian skulls are simply crania artificially contorted into dolichocephalic ones. After this it may be very safely said that craniologists, beginning with Morton, and going on to that eminent and accurate anatomist, Prof. J. Wyman, are agreed that the ancient Peruvian race was distinguished by having brachycephalic skulls, as is shown in Dr. Wilson's "Fig. 2.—Peruvian Child's Skull, Santa," NATURE, vol. x. p. 48, which is simply an undistorted and natural example.

Having said this, which is a plain statement of what I believe to be the truth, I may add that I regret to find scientific questions are by some even who have acquired a reputation treated as a source of wrangling (I do not at all allude to Dr. Wilson), which I observe with much regret; but such course I most certainly shall not imitate. If a plain statement of facts does not convince, I shall not try any other method. When Dr. D. Wilson shall produce half a score of ancient Peruvian dolichocephalic skulls, the appearance of which totally precludes the possibility of interference by art or other deforming accident, then the question he introduces will be open for discussion, but, until then, I hold that there is no valid reason to doubt that the ancient Peruvians were a decidedly brachycephalic race.

J. BARNARD DAVIS

IN NATURE, (vol. x. p. 46), Prof. Daniel Wilson replies to criticisms by Dr. J. Barnard Davis and myself, of his conclusion that certain skulls, described and figured in "Prehistoric Man," and belonging to the collections of Dr. Warren, of Boston, had natural and not artificial forms. As far as I am concerned, he quotes from a letter of mine to Dr. Davis the following sentence:—

"The upshot of the whole is the crania do not confirm Dr. Wilson's statement. One of Dr. Wilson's chief points—in fact it is his chief point—is, that the skulls are natural because they are symmetrical, and it is next to impossible that a distorted skull should be symmetrical."

In this sentence he says I misrepresent him, and appeals to his published views with regard to asymmetry in skulls in general, about which I had said nothing. I was writing only of those particular ones represented in Figs. 1 and 3 of Prof. Wilson's article in NATURE, and Figs 59 and 60 in "Prehistoric Man." In justification of the paragraph from my letter given above, and to which he objects as unfair, I quote the following sentence from "Prehistoric Man," pp. 449-50:—

"Few who have had extensive opportunities of minutely examining and comparing normal and artificially formed crania will, I think, be prepared to dispute the fact *that the latter are rarely if ever symmetrical.* The application of pressure on the head of the living child can easily be made to change its natural contour, *but it cannot give to its artificial proportions that harmonious repetition of corresponding developments on opposite sides* which may be assumed as the normal condition of the unmodified cranium. But in so extreme a case as the conversion of a brachycephalic head averaging about 6·3 in longitudinal diameter, *the retention of anything like normal symmetrical proportions is impossible.* Yet the dolichocephalic Peruvian crania present no such abnormal irregularities as could give countenance to the theory of their form being an artificial one."

I will only add, that in several distorted dolichocephalic Peruvian crania in the collections of the Peabody Museum at Cambridge, the symmetry is as complete as in any ordinary undistorted crania.

JEFFRIES WYMAN

Cambridge, Mass., U.S.

Lakes with two Outfalls

FIFTY miles south of Denver, Colorado Territory, on the Denver and Rio Grandé R.R., there is a little lake with two outfalls, which I have myself seen. This lake is on an east and west "divide" and is 8,000 ft. above sea-level; the outfall to the north, Plum Creek, goes to the Platte River, while Monument Creek, to the south, flows into the Arkansas.

EDWARD S. HOLDEN

Naval Observatory, Washington, U.S., June 2

CAPT. J. D. COCHRANE, R.N., in his "Narrative of a Pedestrian Journey through Russia and Siberian Tartary, &c., in the years 1820-23," has the following reference. I quote from the American edition (1824), p. 235:—

"In the evening we reached a fertile spot, and halted on the banks of a lake, from which, it is said, the rivers Okota and Koudousou, running in counter directions, have their source, a circumstance which recalled to my recollection those words in an able work by Mr. Barrow upon rivers, wherein it is said that, although it is not a physical impossibility that two rivers should flow in opposite, or indeed in any direction out of the same lake, yet the contrary approaches so near to an axiom in geography that no instance is perhaps known of such an occurrence."

The rivers named flow respectively into the Sea of Okhotsk and the Arctic Sea. Perhaps a reference to other and later works may settle the question whether this lake has two outlets.

Chicago, U.S., June 2 S. W. BURNHAM

Palæotherium magnum

THE *Palæotherium magnum*, an account of the discovery of which appeared in NATURE, vol. ix. p. 285, differs in so many respects from that which was restored by Cuvier, that it may be well, if possible, to try and reconcile these two accounts.

Cuvier, in his "Ossemens fossiles" (1825) after taking the individual bones of the *Palæotherium* one by one, and considering their affinities, places them together, and restores from them as far as possible the animals to which they belonged.

In vol. ii. p. 163, he says: "Hence we see in our environs of Paris, and elsewhere, the genus *Palæotherium*, which resembles the tapirs by its incisor and canine teeth, and in that the nasal bones are so arranged as to carry a trunk, whilst the molars more nearly approximate to those of the rhinoceros and deer."

In vol. iii. p. 53, *et seq.* he commences with a description of the skull, and passes on to the other bones in order.

Having considered separately the various bones of the eight species which he describes, he passes on at p. 243 to the restoration of the whole skeleton, considering first that one of which he had the most perfect remains, viz. *Palæotherium minus*, *vide* vol. iii., pl. 34. This skeleton is a more perfect specimen in many ways than that which was discovered the other day, though a good part of the lower extremities are wanting.

Speaking of this specimen Cuvier says (vol. iii., p. 244): "If only we could bring this animal to life as easily as we have put together its bones, we should see running about a tapir smaller than a roebuck, with thin and slender legs." And again, "Its height to the withers would be from 16 to 18 in."

This skeleton, it will be seen, resembles to a great extent that of *Palæotherium magnum*, which was figured in NATURE, vol. ix. p. 286. Having completed the smaller animal, *P. magnum* is next considered, of which Cuvier says: "We have the head and four extremities of this animal; by supplying it with a body like that of its predecessor, it will be very easy to restore its skeleton. Its head and limbs may be seen at pl. 49, 50, and 60, and its restoration at pl. 66, resembling almost exactly that of

P. minus, though the former is much the larger. Such then are the facts as they appear from Cuvier's writings. The fact that this one skeleton of *P. minus* was found with the neck in the erect position may have been considered by Cuvier as hardly a sufficient reason for placing the neck of his restored specimen, which showed so many tapiroid peculiarities, in the same position. Now, however, that a second skeleton of a *Palæotherium* has been found, with the neck in a similar position, the probability that such a position is the natural one is immensely enhanced.

Two points, however, remain somewhat involved in obscurity; first, how is it that the skeleton of *P. magnum*, as found at Vitry-sur-Seine the other day, differs so much in the length of its leg-bones from the *P. magnum* of Cuvier, which it undoubtedly does if the drawings and descriptions of both are correct? and secondly, how was it that Cuvier, with such a perfect skeleton as that in the accompanying figure, should restore an animal with such short and comparatively stout legs?

Someone perhaps may be able to throw some light upon these points. W. BRUCE-CLARKE

The Telegraph in Storm-warnings

THE idea of using the electric telegraph to give warning of cyclones approaching from a distance is generally supposed to have first occurred to Prof. Henry of the Smithsonian Institution in 1847 (NATURE, vol. iv. p. 390). This however is not the fact, for the same thing had been recommended in India fully five years before by the late Mr. Henry Piddington, in his sixth "Memoir on the Law of Storms," published in the Journal of the Asiatic Society of Bengal in 1842. Referring to a storm which was tracked from Macao to Shih-poo, and its estimated rate of travelling, he says (p. 703):—"If China was a country under European dominion, a telegraph might, when these storms strike the eastern coast, warn those on the southern that they were coming, and in India we might often attain the same advantage. *Our children may see this done.*" In 1849, when he published the first edition of his "Sailor's Horn-Book for the Law of Storms," he had not yet heard of the fulfilment in America of his prophecy, which however he has duly noticed in subsequent editions. FRED. NORGATE

Corydalis claviculata

A SHORT additional note on *Corydalis claviculata* may be of interest. A sprig placed in a glass of water and out of the way of insects continues to grow and to bear flowers and fruit with nearly as much regularity as if still rooted to its native bank. The flowers do not gape spontaneously; and, as most of the older ones that I have examined in a state of nature have their lips depressed, I think it certain evidence of the agency of insects, though I have not yet been so fortunate as to witness their operations. All the flowers that I have seen are of a greenish white, but dried specimens acquire the yellow tint described in systematic works, a fact which may help to throw light on the somewhat parallel behaviour of *Fumaria pallidiflora*.

Kilderry, co. Donegal W. E. HART

POLARISATION OF LIGHT*

IX.

THE results of combining two or more colours of the spectrum have been studied by Helmholtz, Clerk Maxwell, Lord Rayleigh, and others. And the combinations have been effected sometimes by causing two spectra at right angles to one another to overlap, and sometimes by bringing images of various parts of a spectrum simultaneously upon the retina. Latterly also W. von Bezold has successfully applied the method of binocular combination to the same problem (*Poggendorff*, Jubelband, p. 585). Some effects, approximating more or less to these, may be produced by chromatic polarisation.

Complementary Colours.—First, as regards complementary colours. If we use a Nicol's prism N as polariser, a plate of quartz Q cut perpendicularly to the axis, and a double-image prism P as analyser, we shall, as is well known, obtain two images whose colours are complementary. If we analyse these images with a prism, we shall find when the quartz is of suitable thickness, that each spectrum contains a dark band indicating the extinction of a certain narrow portion of its length. These bands will simultaneously shift their position when the Nicol N is turned round. Now, since the colours remaining in each spectrum are complementary to those in the other, and the portion of the spectrum extinguished in each is complementary to that which remains, it follows that the portion extinguished in one spectrum is complementary to that extinguished in the other. And in order to determine what portion of the spectrum is complementary to the portion suppressed by a band in any position we please, we have only to turn the Nicol N until the band in one spectrum occupies the position in question, and then to observe the position of the band in the other spectrum. The combinations considered in former experiments are those of simple colours; the present combinations are those of mixed tints, viz. of the parts of the spectrum suppressed in the bands. But the mixture consists of a prevailing colour corresponding to the centre of the band, together with a slight admixture of the spectral colours immediately adjacent to it on each side.

The following results given by Helmholtz, may be approximately verified:—

	Complementary Colours
Red	Green-blue
Orange	Cyanic blue
Yellow	Indigo-blue
Yellow-green	Violet

When in one spectrum the band enters the green, in the other a band will be seen on the outer margin of the red, and a second at the opposite end of the violet; showing that to the green there does not correspond one complementary colour, but a mixture of violet and red, *i.e.* a reddish purple.

Combination of two Colours.—Next as to the combination of two parts of the spectrum, or of the tints which represent those parts. If, in addition to the apparatus described above, we use a second quartz plate Q_1 and a second double-image prism P_1, we shall form four images, say O O, O E, E O, E E. And if A, A′ be the complementary tints extinguished by the first combination Q P alone, and B, B′ those extinguished by the second Q_1 P_1 alone, then it will be found that the following pairs of tints are extinguished in the various images.

Image	Tints extinguished
O O	B, A
O E	B′, A′
E O	B′, A
E E	B, A′

It is to be noticed that in the image O E the combination Q_1 P_1 has extinguished the tint B′ instead of B, because the vibrations in the image E were perpendicular to those in the image O formed by the combination Q P. A similar remark applies to the image E E.

The total number of tints which can be produced by this double combination Q P, Q_1 P_1 is as follows:—

4 single images
6 overlaps of two
4 overlaps of three
1 overlap of four
—
Total, 15

Collateral Combinations.—The tints extinguished in the overlap O O + E O will be B, A, B′, A; but since B and B′ are complementary, their suppression will not affect the resulting tint except as to intensity, and the overlap will be effectively deprived of A alone; in other words, it will be of the same tint as the image O would be if the combination Q_1 P_1 were removed. Similarly the overlap O E + E E will be deprived effectually of A′ alone; in other words, it will be of the same tint as E, if Q_1 P_1 were removed. If therefore the Nicol N be turned round, these two overlaps will behave in respect of colour exactly as did the images O and E when Q P was alone used. We may, in fact, form a table thus:—

* Continued from vol. ix. p. 508.

Image	Colours extinguished
O O + E O	B + A + B′ + A = B + B′ + A = A
O E + E E	B′ + A′ + B + A′ = B + B′ + A′ = A′

And since the tints B, B′ have disappeared from each of these formulæ, it follows that the second analyser P may be turned round in any direction without altering the tints of the overlaps in question.

In like manner we may form the Table—

O O + E E	B + A + B + A′ = B + A + A′ = B
O E + E O	B′ + A′ + B′ + A = B′ + A + A′ = B′

Hence if the Nicol N be turned round, these overlaps will retain their tints; while if the analyser P_1 be turned, their tints will vary, although always remaining complementary to one another.

There remains the other pair of overlaps, viz.:—

O O + O E	B + A + B′ + A
E O + E E	B′ + A + B + A′

Each of these is deprived of the pair of complementaries A, A′, B, B′; and therefore each, as it would seem, ought to appear white of low illumination, *i.e.* grey. This effect is, however, partially masked by the fact that the dark bands are not sharply defined like the Fraunhofer lines, but have a core of minimum or zero illumination, and are shaded off gradually on either side until a short distance from the core the colours appear in their full intensity. Suppose, for instance, that B′ and A′ were bright tints, the tints resulting from their suppression would be bright. On the other hand, the complementary tints A and B would be generally dim, and the image B + A bright, and the overlap B + A + B′ + A′ would have as its predominating tint that of B + A. And similarly in other cases.

There are two cases worth remarking in detail, viz. first, that in which

$$B = A',\ B' = A$$

i.e. when the same tints are extinguished by the combination Q P and by $Q_1 P_1$. This may be verified by either using two similar quartz plates Q, Q_1; or by so turning the prism P_1 that the combination $Q_1 P_1$ used alone shall give the same complementary tints as Q P when used alone. In this case the images have for their formulæ the following:—

O O	O E	E O	E E
A + A′	A + A′	2A	2A′

in other words, O O and E O will show similar tints, and E O, E E complementary. A similar result will ensue if B = A, B′ = A′.

Again, even when neither of the foregoing conditions are fulfilled, we may still, owing to the breadth of the interference bands, have such an effect produced that sensibly to the eye

$$B + A = B' + A'$$

and in that case

$$B' + A = B + A - A' + A$$
$$= B + A' + 2A - 2A'$$

which imply that the images O O and O E may have the same tint; but that E O and E E need not on that account be complementary. They will differ in tint in this, that E E, having lost the same tints as E O, will have lost also the tint A, and will have received besides the addition of two measures of the tint A′.

Effect of Combination of two Colours.—A similar train of reasoning might be applied to the triple overlaps. But the main interest of these parts of the figure consists in this, that each of the triple overlaps is complementary to the fourth single image; since the recombination of all four must reproduce white light. Hence the tint of each triple overlap is the same to the eye as the mixture of the two tints suppressed in the remaining image. And since by suitably turning the Nicol N or the prism P_1, or both, we can give any required position to the two bands of extinction, we have the means of exhibiting to the eye the results of the mixture of tints due to any two bands at pleasure.

Effect of Combinations of three Colours.—A further step may be made in the combination of colours by using a third quartz Q_2 and a third double-image prism P_2, which will give rise to eight images. And if C C′ be the complementaries extinguished by the combination $Q_2 P_2$, the formulæ for the eight images may be thus written:—

O O O	C + B + A
O O E	C + B′ + A′
O E O	C′ + B′ + A
O E E	C′ + B + A′
E O O	C′ + B + A
E O E	C′ + B′ + A′
E E O	C + B′ + A
E E E	C + B + A′

The total number of combinations of tint given by the compartments of the complete figure will be

$\frac{8}{1}$	= 8 single images		
$\frac{8.7}{1.2}$	= 28 overlaps of two		
$\frac{8.7.6}{1.2.3}$	= 56	„	three
$\frac{8.7.6.5}{1.2.3.4}$	= 70	„	four
$\frac{8.7.6}{1.2.3}$	= 56	„	five
$\frac{8.7}{1.2}$	= 28	„	six
$\frac{8}{1}$	= 8	„	seven
1	= 1	„	eight
Total . .	255		

The most interesting features of the figure consists in this, that the subjoined pairs are complementary to one another, viz.:—

O O O C + B + A	E O E C′ + B′ + A′
E O O C′ + B + A	O O E C + B′ + A′
E E O C + B′ + A	O E E C′ + B + A′
E E E C + B + A′	O E O C′ + B′ + A

And if the prisms P, P_1, P_2 are so arranged that the separations due to them respectively are directed parallel to the sides of an equilateral triangle, the images will be disposed thus:—

	O E O	O O O	
E E O	E O O	O E E	O O E
	E E E	E O E	

The complementary pairs can then be read off, two horizontally and two vertically, by taking alternate pairs, one in each of the two vertical, and two in the one horizontal row. And each image will then represent the mixture of the three tints suppressed in the complementary image.

Low-tint Colours.—A slight modification of the arrangement above described furnishes an illustration of the conclusions stated by Helmholtz, viz. that the low-tint colours (couleurs degradées), such as russet, brown, olive-green, peacock-blue, &c., are the result of relatively low illumination. He mentioned that he obtained these effects by diminishing the intensity of the light in the colours to be

examined, and by at the same time maintaining a brilliantly illuminated patch in an adjoining part of the field of view. If therefore we use the combination N, Q, P, P_1 (*i.e.* if we remove the second quartz plate), we can, by turning the prism round, diminish to any required extent the intensity of the light in one pair of the complementary images, and at the same time increase that in the other pair. This is equivalent to the conditions of Helmholtz's experiments; and the tints in question will be found to be produced.

W. SPOTTISWOODE

VENUS'S FLY-TRAP (*Dionæa muscipula*) *

II.

Contractility of Dionæa.—I have given you a general view of our plant and of its behaviour. We next proceed to examine more particularly that property of contracting when irritated to which the plant owes its faculty of catching insects, and to which my own investigations have been directed. Before beginning the experimental demonstration of the facts, I wish to lay before you some considerations relating to the nature of this property as it manifests itself in living beings belonging to both kingdoms.

We have to do here not merely with contractility but with irrito-contractility. The fact that the property requires two words to express it implies that there are two things to express, viz. (1) that contraction takes place, and (2) that it takes place in answer to irritation. As this is the case not only here, but in all other instances of animal or vegetable active motion, we recognise in physiology these two properties as fundamental: irritability, or *excitability*, and *contractility*, the former designating the property possessed by every living structure whatsoever of being excited to action (*i.e.* of having its stored-up force discharged) by some motion or disturbance from outside; the latter, that kind of discharge or action which results in change of form, and usually declares itself in the doing of mechanical work. This property of excitability, which, let me repeat, is common to all living structures, is, as we have seen, comparable in its simplest manifestations to that possessed by many chemical compounds (of explosiveness) and many mechanical contrivances (of going off or discharging when meddled with, as in the case of the rattrap already referred to).

In physiology, as in the other sciences of observation, the process of investigation is, throughout, one of comparison. Not only do we proceed from first to last from the known towards the unknown, but what we speak of as our knowledge or understanding of any new fact consists simply in our being able to bring it into relation with other facts previously well ascertained and familiar, just as the geographer determines the position of a new locality by ascertaining its topographical relation to others already on the chart.

The comparison we have to make this evening is between the contractility displayed by the leaf of Dionæa and the contractility of muscle. I choose muscle as the standard of comparison, not merely because it is best known and has been investigated by the best physicists of our time, but because its properties are easily illustrated and understood. I shall be able to show that the resemblance between the contraction of muscle and that of the leaf is so wonderfully complete that the further we pursue the inquiry the more striking does it appear. Whether we bring the microscope to bear on the structural changes which accompany contraction, or employ the still more delicate instruments of research which you have before you this evening, in order to determine and measure the electrical changes which take place in connection with it, we find that the two processes correspond in every essential particular so closely, that we can have no doubt of their identity.

* Continued from p. 107.

Muscle, like every other living tissue, is the seat, so long as it lives, of chemical changes, which, if the tissue is mature, consist entirely in the disintegration of chemical compounds and the dissipation of the force stored up in these compounds, in the form of heat or some other kind of motion. This happens when the muscle is at rest, but much more actively when it is contracting, in which condition it not only produces more heat than it produces at other times, but also may do—and, under ordinary circumstances, does—mechanical work; these effects of contraction of muscle are, of course, dependent in quantity on the chemical disintegration which goes on in its interior.

Again, muscle so long as it is in the living state is electromotive. This property it probably possesses in common with other living tissues, for it is very likely that every vital act is connected with electrical change in the living part. But in muscle, as well as other irritable and contractile tissues in animals, the manifestation of electromotive force is inseparably connected with the special function of the tissue, *i.e.* with contraction, the connection being of such a nature that the electromotive force expresses, not the work actually done at any given moment, but the capacity for work. Thus, so long as the muscle lives, its electromotive force is found to be on the whole proportional to its vigour. As it gradually loses its vitality, its power of contracting and its electromotive force disappear *pari passu*. When it contracts, the manifestation of electromotive force diminishes in proportion to the degree of contraction. But it is to be borne in mind that, although when the muscle or the leaf contracts electromotive force disappears and work is done, there is no reason for supposing that there is any conversion of the one effect into the other, or that the source of the force exercised by the organ in contracting is electrical.

The lecturer then proceeded to demonstrate the correspondence between the electrical phenomena which accompany muscular contraction, and those which are associated with the closing of the Dionæa leaf, by a series of experiments.*

1. The form of the gastrocnemius muscle of the frog, in the uncontracted state, was projected on the screen with the aid of the electric light. A contraction was then determined by passing through it a single opening induction shock. It was seen to shorten and to become proportionately broader.

[In contraction, the bulk of a muscle remains unaltered. Further, the change of shape of the whole muscle depends on an exactly similar change of shape of every particle of which it is composed. This might be inferred from the consideration that a muscle is not an apparatus made up of parts differing from each other in structure, but a mass of substance equally instinct with life in every part. We know it to be the case by direct observation, for if we observe living muscle in the act of contraction under the microscope (as can easily be done in the muscles of insects), † we see that each minutest fibre participates in the change of form. The same holds good as regards the plant. The agent in the contraction is, without doubt, the protoplasm of the cells of the contractile organs. In Dionæa this has not as yet been sufficiently investigated, but in Drosera Mr. Darwin has shown that when the hairs which project from the upper surface of the leaf, become "incurved" under the exciting influence of appropriate stimuli, the contents of the cells undergo a most peculiar

* The statements contained in the first part of this lecture, especially those relating to the mechanism of the closure of the Dionæa leaf and its digestion, are founded almost entirely on information which I owe to Mr. Darwin. The experiments which led to the discovery of the "leaf current" and its "negative variation" were made last autumn, Mr. Darwin having kindly furnished me with plants for the purpose.—J. B. S.

† See Schäfer "On the Contraction of the Muscles of the Water-beetle." Phil. Trans., vol. clxiii. p. 429, 1873.

change of form and arrangement, which Mr. Darwin has described as "aggregation."]

2. The image reflected by the mirror of a Thomson's galvanometer having been thrown on the screen near its right edge, it was first shown that when a fraction of a voltaic current passed through the electrodes in a direction from the lecturer's right hand towards his left, the spot on the screen moved towards the left of his audience. The galvanometer having been shut off, a muscle was placed on the electrodes with its cut surface against the left (e') electrode, and its natural surface against the right (e). On again connecting the electrodes with the galvanometer the spot flew off in the same direction as before.

3. The nerve of the muscle having been placed across two wires in connection with the ends of the secondary coil of a Du Bois' induction apparatus, was excited by induced currents, the muscle remaining on the electrodes. The spot returned towards its original position.

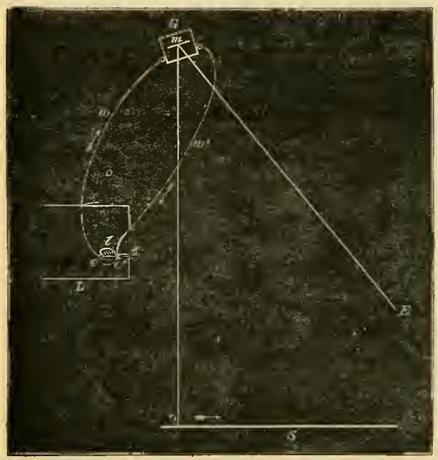


FIG. 1.—Diagram of the experiments.—S, screen facing the audience; E, position of electric light; G, reflecting galvanometer; *m* indicates the direction of the needle and of the mirror fixed to it; O, position of the bright image on the screen when no current exists in the galvanometer; L, end of the lecturer's table to his right; *e e'* his electrodes, on which the blade of the leaf *l* rests, with its stalk *s* towards the lecturer's right; *w w'*, wires leading to the galvanometer. The arrows show the direction in which the current flows through the galvanometer when the leaf is in the position shown. The arrow near O indicates the direction in which the spot of light moves under the influence of such a current.

[In both of these experiments only one-tenth of the muscle-current was allowed to pass through the galvanometer. The electrodes used, which are constructed on the same principle as those of Du Bois-Reymond, are shown in Fig. 2. The glass U-tubes A A' are half filled with saturated solution of sulphate of zinc. The zinc rods B B' are in metallic connection with the galvanometer ends by the wires W W'. The ends by which they dip into the solution are carefully amalgamated. The straight tubes C C' are of such width that they slip easily into the mouths of the U-tubes: they are prevented from going too far by rims of sealing-wax. These tubes are filled with a paste made by rubbing up modelling-clay with one per cent. solution of common salt. The electrodes are so supported that their distance and relative position can be varied with great facility.]

4. The heart of a frog was then placed with its apex against the left electrode (e') and its base on the right (e). The spot moved in the same direction as before, but each heart-beat was marked by a sudden return of the needle towards its original position, indicating the instantaneous disappearance of electromotive force in the act of contraction. The effect corresponding to the contraction of the auricles could even be distinguished from that of the ventricular contraction which succeeded it.

5. A leaf of Dionæa, with its leaf-stalk still attached, was placed with its stalk end on the left electrode and its point on the right, as in Fig. 1. The direction of movement was the same.

6. The spot having assumed a fixed position on the screen, the leaf was excited by touching the sensitive hairs with a camel-hair pencil. The spot flew back towards the right edge of the screen, immediately afterwards returning to its original position. This effect was repeated several times.

7. The leaf-stalk was cut off, the leaf remaining as before on the electrodes. The deflection was increased

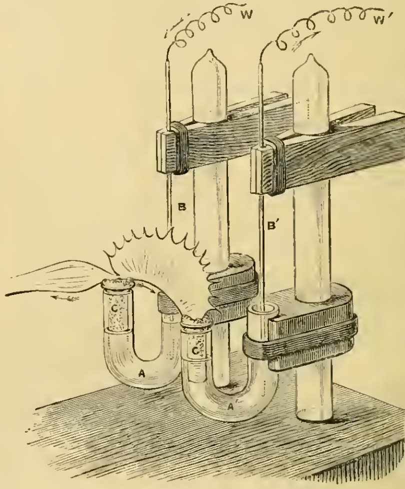


FIG. 2.—Non-polarisable electrodes employed in experiments on the Dionæa leaf.

(more than doubled). It was then explained that when the leaf-stalk is itself placed on the electrodes, the galvanometer indicates the existence of a current opposed in direction to that of the leaf, showing that the electrical conditions on opposite sides of the joint between stalk and leaf are antagonistic to each other. Consequently, so long as leaf and stalk are united, each prevents or diminishes the manifestation of electromotive force by the other. This is completely in accordance with what is observed with reference to nerve, and is known as "electrotonic variation of the nerve current."

8. Two fine pointed electrodes, each in connection with one end of the secondary coil of the induction apparatus, were thrust into the centre of the external surface of a leaf, the ends of which rested on the electrodes of the galvanometer. On thus exciting the leaf the spot of light shot to the left, but it was observed that there was an obvious interval of time between the excitation and the effect. This period, though of much greater duration, corresponds to the so-called "period of latent stimulation" in muscle.

The plants exhibited and used for the experiments were provided by the kindness of the Director of the Royal Gardens, Kew.

*FERTILISATION OF FLOWERS BY INSECTS**

VI.

Different Modes of Self-fertilisation where Visits of Insects are wanting

THE two functions of cross-fertilisation and self-fertilisation, which in the previous articles we have seen to occur in different forms of the same species or genus, are in most cases successively presented by the same form of flower; and the modifications by which self-fertilisation is attained by different plants, where visits of insects are wanting, are almost as various as the

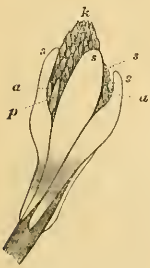


FIG. 32.

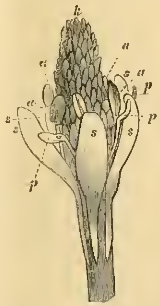


FIG. 33.

FIG. 32.—Side view of flower of *Myosurus minimus* before opening. FIG. 33.—Side view of a flower just open.

contrivances by which cross-fertilisation by insects is secured. Of these various modes I shall here speak only of some not yet referred to in my book on fertilisation.†

Myosurus minimus is as remarkable for the great variability in the size of its flower (compare Figs. 35 and 38) and in the number of its parts,‡ as for the enormous growth of the cone of pistils, which affords no other benefit to the plant but the self-fertilisation of the greater

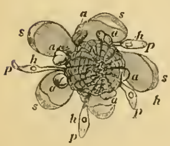


FIG. 34.

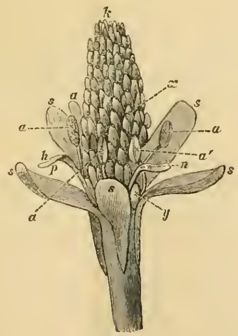


FIG. 35.

FIG. 34.—The same flower viewed from above. FIG. 35.—Side view of a somewhat older flower.

part of the numerous stigmas by the small number of anthers, in case it is not visited by insects.

* Continued from vol. ix. p. 166.
† "Die Befruchtung der Blumen durch Insecten," Leipsig, 1873.
‡ I examined a hundred flowers as to the number of sepals, petals, and anthers, and found the number of sepals in 3 flowers = 4, in 94 flowers = 5, in 3 flowers = 6; petals in 2 flowers = 2, in 20 flowers = 3, in 3 flowers = 4, in 35 flowers = 5: anthers in 2 flowers = 3, in 2 flowers = 4, in 11 flowers = 5, in 22 flowers = 6, in 31 flowers = 7, in 46 flowers = 8, in 5 flowers = 9, in 1 flower = 11.

When the flower opens, it stretches forth its small petals (p), which serve as nectaries (n), and offer a small drop of honey (h), by which very minute insects are attracted in sunny weather. These visitors are for the most part Diptera not exceeding 1-1½ mm. in length, belonging to the genera Sciara, Chironomus,* Hydrellia,* Scatopse,† Phora, Cecidomyia, Oscinis, and Microphorus. I observed also a single specimen of *Melanostoma mellina* (Syrphidæ), some Anthomyia (Muscidæ), a small Haltica, some Pteromalidæ, and small Ichneumonidæ. These minute visitors licking up the drops of honey, and

FIG. 36.

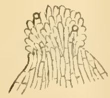


FIG. 37.

FIG. 38.

FIG. 36.—Stigma of the ovary x, Fig. 35, provided with pollen-grains from the anther a', which have already emitted their pollen-tubes. FIG. 37.—Stigma of the ovary y, Fig. 35, more developed than the stigma, Fig. 36, provided with two pollen-grains fallen down from the anther a'. FIG. 38.—One of the smallest flowers: s, sepal, p, petal, n, nectary, h, honey, k, cone of ovaries. FIGS. 32–35 and 38, seven times natural size.

walking round the cones of ovaries, stop many seconds in a single flower before visiting another. The anthers, lying close round the cone of ovaries, open by two lateral slits, and are soon afterwards covered with pollen on their whole outside; consequently, insects walking round the ovaries may easily be charged with pollen, and flying to another flower effect cross-fertilisation. But, upon the whole, the flowers, because of their being scentless and very inconspicuous, are so scantily visited by insects, that, after repeated careful examinations, I believe that even in sunny weather more than 90 per cent. of the flowers remain without any visit. This deficiency of secured cross-fertilisation is supplied by regular self-fertilisation in the following manner. The axis of the flower, extending gradually during the blooming-time into

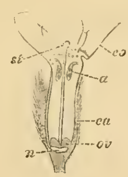


FIG. 39.

FIG. 40.

FIG. 39.—Flower of *Myosotis versicolor* when just opened, dissected longitudinally. FIG. 40.—An older flower, with full-grown corolla (seven times natural size): ca calyx, co corolla, a anthers, st stigma, n nectary, ov ovary.

a long cone, brings a great part of the stigmas into contact with the lateral pollen-grains of the anthers; those ovaries which now are in contact with the anthers soon afterwards overgrowing them, and others now below the anthers reaching them.‡ Thus a number of styles grazing the anthers during the growth of the long cone are self-fertilised by about five or more pollen-grains (Fig. 36); besides, also, the lowest stigmas of the flowe are fertilised by their own pollen, many pollen-grains falling down from the anthers (Fig. 35 y, Fig. 37). Consequently, only those ovaries are never self-fertilised which

* For instance, *Chironomus byssinus* Schrk., *Hydrellia chrysostoma* Meig., and *griseola* Fall., after Prof. Mik's (of Vienna) examination.
† *Scatopse brevicornis* Löw.
‡ This is easy to be seen by marking some of the ovaries with a spot of ink.

are already situated above the anthers before the opening of the flower.

Whilst in *Myosurus minimus* self-fertilisation is effected by a number of stigmas passing along each of the anthers, *Myosotis versicolor* attains the same effect in the contrary way, all five anthers of the flower passing along the single stigma.

The corolla, when opening, is not only still of a pale yellowish colour, like the buds of other species of Myosotis, but even when not yet fully developed the anthers and pistils are mature at the same time and the stigma slightly overtops the corolla. Hence when insects visit the flowers in this state, their probosces always touch the stigma sooner than the anthers, and consequently, when flying to another flower, always cross-fertilise it.

But by the gradual lengthening of the corolla-tube the anthers affixed to its inner side are raised till they surround and self-fertilise the stigma now enclosed in the corolla (Fig. 40). Thus also in this inconspicuous flower the defective cross-fertilisation by insects * is largely supplied by regular self-fertilisation.

HERMANN MÜLLER

INTERNATIONAL METRIC COMMISSION AT PARIS

Melting of the Metal for the new Metric Standards

AT the meeting of the Executive Committee of the International Metric Commission in October last, the fusion of the large single ingot of platinum-iridium, weighing 250 kilogrammes, out of which all the new metric standards were to be constructed, was fixed for the end of the following April, but the completion of the operation was delayed by accidental circumstances until the middle of the following month. As this was the first occasion on which any attempt had ever been made to melt together more than a few kilogrammes of platinum or of platinum alloyed with iridium, it was necessary to make a great number of experimental meltings during the intermediate time in order to secure success in the great operation.

All the actual meltings of the platinum and iridium have been made at the Conservatoire des Arts et Métiers, in a building erected for the purpose. The work has been carried out under the superintendence of M. Tresca, the Sous-Directeur of the Conservatoire, who is also honorary secretary of the Commission, and more immediately intrusted with the technical operations of constructing the new standards. He has had the advantage of the cordial assistance of Mr. George Matthey, of the firm of Johnson and Matthey, Hatton Garden, from whom the large mass of platinum and iridium was obtained. Mr. G. Matthey has had large personal experience in melting platinum, and he remained at Paris from the beginning of April assisting in the work.

It was necessary that the whole of the platinum and iridium should be separately assayed and purified previously to their being melted together. This process was entrusted to M. Henri Sainte-Claire Deville, and carried out at the Ecole Normale, of which he is director. The greatest difficulty in the purification consisted in getting rid of the osmium, which is found in the natural ore in combination with platinum and with iridium. But the chemical difficulty was satisfactorily overcome by M. Deville after many experiments made by him.

The whole of the platinum and iridium had thus been ascertained to be perfectly pure when delivered to M. Tresca for melting. The first process was to melt portions of the pure platinum, its melting point being about 1,900° C., and considerably lower than that of iridium, which is about 2,400° C. Portions of the platinum were then remelted together with iridium, in the proportions fixed upon of 90 per cent. of platinum and 10 per cent. of iridium. Quantities of from 10 to 15 kilogrammes of platinum-iridium were, in the first instance, melted together. Several of these smaller ingots were then remelted into larger ingots of rather more than 80 kilogrammes each, and the final operation was to remelt three of these larger ingots into a single ingot of 250 kilogrammes.

Each of the meltings was made as nearly as possible of uniform form in a furnace heated with oxy-hydrogen gas. The furnace was made of a block of the ordinary sandy limestone used for buildings in Paris. For the smaller ingots a square block of stone was employed with a hemispherical cavity about 6 in. (15 centimetres) in diameter, for containing the metal. This small block had a cover of similar form, and through its middle was a vertical hole, about $\frac{3}{4}$ in. in diameter, in which the tube for conveying the gas was fixed with mortar. When the metal was placed in the furnace, and the jet of lighted gas directed upon it, sufficient mortar was placed on the joining of the upper and lower blocks of stone to make it air-tight. For the three larger ingots a long oblong furnace was used, with a cavity of the same breadth, but a little deeper and much longer, and three gas-tubes were used. The largest furnace required for the whole quantity of metal had six gas-tubes, each about 1 in. in diameter, inserted in the upper block. The ordinary illuminating gas was used, mixed with the requisite proportion of oxygen gas, made on the premises and stored in a large gasometer placed near the furnace-room. For obtaining a sufficient blast the power of a 15-horse steam-engine was employed.

In order to facilitate the melting, it was necessary first to divide the larger ingots into small pieces. About half the quantity for a single melting, thus divided into small lumps, was placed in the mould, and when this was completely melted the remainder, which had been drawn out into long thin bars, was introduced gradually through two small holes opposite each other in the furnace. These holes also enabled the interior of the furnace to be seen, together with the progress of the melting, and they could be closed by stone plugs when requisite. The division of the ingots was a difficult operation, as this alloy of platinum and iridium is harder than ordinary steel. A V cut, about $\frac{1}{8}$ in. deep, was made around the ingot with a cold chisel, though not without splintering the edges of a considerable number of the best-tempered chisels. The ingot was then placed under a hydraulic press, supported upon the rounded tops of two strong iron bars, a sufficient distance apart. The rounded part of a third bar was placed upon the ingot, in the line of the cut, and the power of the press being applied, the ingot was broken in half, presenting in every instance a regular crystallised grain.

The melted metal was not cast into a separate mould, but was allowed to cool in the furnace. During the melting a portion of the interior of the stone, to the depth of about half an inch, became coloured by the excessive heat and formed into lime in a powdery state, which floated on the surface of the melted metal. When the metal was sufficiently cool, the stone mould was broken and the ingot removed to a bath of hydrochloric acid, which dissolved every portion of lime or other foreign matter upon the surface of the ingot, but does not act upon platinum-iridium. The ingot was then left quite clean and pure.

The first of the larger ingots of 80 kilogrammes was successfully melted on April 25. The second was melted on May 1, when Marshal MacMahon, the President of the

* After having repeatedly watched in vain the flowers of *Myosotis versicolor*, I succeeded twice in seeing it fertilised by insects, viz.—May 15, 1873, I observed *Bombus agrorum* F. ♀, and June 2, 1873, *Halictus sexnotatus* K. ♀, *H. zonulus* Sm. ♀, *Rhingia rostrata* L., and *Syritta pipiens* L., all of them successively sucking flowers of different stems. But certainly by far the greatest part of all the flower remains without any visit of insects.

Republic, accompanied by M. Deseilligny, the Minister of Commerce, were present unofficially, and remained during the whole process, appearing to take great interest in the operations. The third of the larger ingots was melted on May 7.

The melting of the great ingot of 250 kilogrammes took place on May 13, in presence of nearly every member of the French Section of the Commission, of M. Struve from St. Petersburg, MM. Stas and Heusschen from Brussels, M. Bosscha from Holland, Prof. Miller and Mr. Chisholm, delegates from Great Britain, and other foreign commissioners. It was successfully accomplished with the greatest facility and regularity, and without the slightest hitch or accident.

The dimensions of the cavity in the furnace, and consequently of the large ingots produced, were as follows :—

	Mètre		Inch
Length	1·24,	or about	44·9
Breadth	0·15,	„	5·9
Depth	0·07,	„	2·8
Thickness of stone above the cavity	0·15	„	5·9

The time occupied in the process was as follows :—

2.10 P.M.—Furnace heated and lighted by degrees.
2.24 „ —Furnace thoroughly heated.
3.4 „ —Contents of metal (130 kilogrammes) melted and bars begun to be introduced.
3.27 „ —All the metal melted.
4.15 „ —Metal entirely solid, but still at white heat ; lid lifted.

In about half an hour the mould was broken and the ingot removed to the hydrochloric bath. When taken out it was examined, and found, to all appearance, perfect.

The stone used is so remarkably slow a conductor of heat, that when the whole mass of metal was in a melted state the upper surface of the stone was hardly warm, as was tested by the hands of several of the persons present being placed upon it.

Portions of the three large ingots had been previously tested and found to be very nearly indeed of pure platinum and pure iridium in the proportions of 9 to 1. The large ingot will also be assayed, and, if deemed necessary, again melted, in order that the requisite homogeneity may be attained.

The work of constructing all the new line-standard metres from this single ingot will at once be proceeded with, and there will be sufficient surplus metal for making first all the new standard kilogrammes, and then such number of end-standard metres as may be required.

H. W. CHISHOLM

SOUNDINGS IN THE PACIFIC

THE voyages of the U.S. steamer *Tuscarora*, Capt. Belknap, engaged in soundings for a cable from America to Japan, have been already described between Cape Flattery and Oonalaska Island (vol. ix. p. 150), and between California and the Sandwich Islands. They have now been extended from the last-named station to the coast of Japan. Sixty casts were taken at intervals of about 50 miles. In the first 95 miles from Honolulu, the depth increased at nearly 162 ft. to a mile, reaching 2,418 fathoms in lat. 21° N., long. 159° 20′ W. The average depth of all the casts taken during this voyage was 2,450 fathoms. Between the mountains (all but one of which are entirely submarine) the bed of the ocean was very level ; the greatest depth was found at lat. 22° 44′ N., long. 168° 23′ E., 3,262 fathoms. These mountains were as follows :—(1) Summit about lat. 20° 41′ N., long. 171° 33′ W. ; height 5,160 ft. ; eastern slope 40 ft. and western 128 ft. to the mile. (2) Summit, lat. 21° 41′ N., long. 176° 54′ E. ; height 12,000 ft. ; eastern slope 37 ft. for about 127 miles and 51 ft. thence to summit ; western slope 55 ft. (3) Summit 23° 45′ N., long. 160° 56′ E. ; height 9,600 ft. ; eastern slope 192 ft. ; western 204 ft. (4) Summit, lat. 23° 55′ N., long. 158° 7′ E. ; height 6,000 ft. ; eastern slope 60 ft. ; western, inappreciable for 45 miles from summit, afterwards 90 ft. per mile to its base. (5) Summit above water, known as Marcus Island, lat. 24° 12′ N., long. 153° 57′ E. Soundings 7 miles to northward, lat. 24° 20′ N., long. 154° 6′ E., gave 1,500 fathoms depth ; northern slope to this point 1,284 ft. to the mile ; eastern slope thence, 200 ft. ; western 157 ft. (6) Summit, lat. 25° 42′ N., long. 148° 39′ E. ; height 7,800 ft. ; eastern slope 163 ft. ; western 59 ft. From the base of the last mountain to Port Lloyd, Peele Island, the upward slope was 86 ft. to the mile. All the slopes are estimated at a minimum.

All specimens brought up from summits of mountains or ridges were white coral or pieces of lava, and indicated otherwise a hard and rocky bottom : all from the level bed were of soft brownish-yellow mud. It will be noticed that the position of Marcus Island has been hitherto incorrectly indicated on the charts—too much to the north and west. It is about 4 miles in length from east to west and is thickly wooded and frequented by large flocks of birds. Another island laid down on the charts as somewhat to the southward of Marcus Island has no existence, and the facts are similar in regard to several reported shoals and rocks indicated on the charts ; the *Tuscarora* sailed over their alleged positions, and found from 1,500 to 3,000 fathoms of water.

Bottom temperatures, as in other parts of the Pacific, range from 33°·2 F. to 34°·6 below 1,800 fathoms, whatever the additional depth. Between 1,200 and 1,800 fathoms the temperature rises slowly to about 35° at the former depth. From 1,200 fathoms to the surface the thermometer rose steadily ; surface temperatures ranging from 70° to 76° F.

Observations on currents are made from a boat when the sea is moderately smooth. For investigating deep currents the sinker of the apparatus is of about 10 lbs. weight ; it consists of four rectangular pieces of doubled tin soldered at right angles to each other, each 6 in. square, and with the requisite quantity of lead attached in strips through holes punched in the lower edges of the sheets. A small silk fishing-line supports the sinker, running through the float, which is a wooden cube 5 in. square at the surface by 4 in. in depth ; the line runs to a reel in the boat, having a toggle placed on it just above the float. For observing surface currents a similar sinker is constructed of wood weighted to sink about 2 fathoms. The line attached to it is marked in tenths of knots by small corks, which also prevent errors that would otherwise accrue by the line sinking.

A fixed point of departure is obtained by lowering the sounding apparatus and bringing the sounding wire in a vertical position after bottom is reached. From this point the current-measuring apparatus is thrown overboard, and its rate and direction of progress measured at frequent intervals of time. The small errors due to friction are easily eliminated, and the elements of calculation are exceedingly simple. An approximate method of obtaining the surface current when dredging is by anchoring the boat to the dredge lines as a fixed point. In deep currents the float is vertical over the sinker.

The voyage occupied twenty-eight days, and the weather was exceptionally favourable. There are only sixty-five inhabitants on Peele Island, and the *Tuscarora* was the first visit of a naval vessel for more than seventeen years ; Commodore Perry stopped at the island in 1853. A Mr. Savory, formerly a whaler, from Massachusetts, had exercised the functions of governor, consisting principally of presiding over marriages and funerals, for many years, and died last March at the age of eighty, a Mr. Thomas Webb succeeding to the position and honours. In 1827 Capt. Beechy, R.N., took possession of the island

in the name of George II., but the Japanese claim it by right of prior discovery and occupation. It is principally frequented by whalers, for supplies. There are no notable features in the sea-bed between this island and the coast of Japan.

COGGIA'S COMET

THE latest observations taken here give the following position of this comet, which, compared with that of June, published in NATURE, vol. x. p. 113, shows the present direction of the motion.

June 14, at 10h. 42m. 30s. mean time at Twickenham.

R.A. . . . . . 7h. 7m. 24·56s.

D. . . . . . $+68° 56' 31''·5$

The comet on this evening was distinctly visible to the naked eye, sensibly brighter than 43 Camelopardi, and therefore rather higher than the fifth magnitude. Towards midnight it was possible to detect a difference between its appearance, without the telescope, and that of neighbouring stars.

There appears a decided similarity between the elements of this comet and those of the second comet of 1737 observed by the French Missionaries in China. For the latter body I have calculated the following orbit, from the observations, or rather the estimated places, published by the Baron de Zach (Mon. Corresp. xxi. p. 318).

Perihelion passage 1737, June 2·230 Greenwich M.T.

	° ′
Longitude of perihelion	261 58
Ascending node	132 5
Inclination of orbit	61 52
Perihelion distance	0·8348

Motion—Direct.

Daussy's elements of this comet which appear in our catalogues are certainly defective.

The present comet was detected when the true anomaly before perihelion exceeded 100°, and there is every probability that Mr. Stone at the Cape of Good Hope may be able to furnish a good normal place at a large arc of anomaly after perihelion. Hence the period of the comet may be determined directly from the observations. In another week's time we shall doubtless know very nearly the course which it will take when near the earth and sun in the first half of July; but so far, the determination of the elements has been one of no ordinary difficulty, as I find the continental computers have remarked as well as myself.

J. R. HIND

Mr. Bishop's Observatory, Twickenham,
June 16

NOTES

WE need not say much on Monday night's debate as to the appointment of a minister of Education; as we have already often referred to the subject our ideas must be known. Mr. Lyon Playfair's appeal was certainly strong, unanswerable we think, but it referred too much to education and too little to science. Our scientific administration ought to be as strong as that of our law, and we are confident that it ultimately will be. Sir John Lubbock's speech was admirable. He said it was surely a great mistake to suppose that the business of an Education Minister would be confined to questions relating to elementary schools. We must, he thought, take a broader view of the question. "We had," he said, "large educational endowments, but a system which was not even now in harmony with the present state of things, and which consequently does not produce the results which might reasonably be expected. If there had been a Minister of Education the Endowed Schools would not have been allowed to fall into the condition in which too many of them were when the Endowed Schools Act was passed." Speaking of the Fellowships of Oxford and Cambridge, numbering 720, he said, "Out of the whole number he believed that not above a dozen had been given for proficiency in Natural Science, while even as regarded the Scholarships those offered for Natural Science are only a small fraction of the whole. But then the Colleges said, and said with some force, that they could not do more for Natural Science because the subject was not sufficiently taught in the schools; while, on the other hand, the schools did not teach it because so few inducements were held out at the Universities. Both admitted that a change was needed, but each was waiting for the other. Here, again, the influence of some co-ordinating authority was much needed. Then there was the management of our museums. It was generally felt that the erection of the new Natural History Museum at South Kensington should be taken advantage of to effect a change in the governing authority of the British Museum; that, as recommended by the Science Commission, the national collections should be under the charge of directors, responsible to a special Minister of State. At present the different national collections were in competition, not in harmony." The arguments urged in favour of the appointment of an Education Minister were simply eluded by its opponents, though it is at least consoling to think that Mr. Disraeli's speech was carefully guarded; indeed the opinion of many is that in time he will see his way to supporting the appointment of such a Minister.

IN reply to a question in the House of Commons on Monday Lord Sandon stated that arrangements had been made for bringing the various departments at the South Kensington Museum more directly under the control of the Education Department at Whitehall.

LORD RAYLEIGH, F.R.S., a member of the Council of the Mathematical Society, is about to do a very handsome thing, which will make that Society greatly indebted to him, and which should earn the gratitude of all mathematicians and therefore of all scientific workers. He has expressed his intention of presenting 1,000*l*. to the Mathematical Society to assist it in the publication of its Proceedings and in the purchase of mathematical periodicals. The application of this handsome gift shows great discrimination on the part of the donor.

THE Professorship of Zoology and Comparative Anatomy at King's College, London, is rendered vacant by the resignation of Mr. T. Rymer Jones, F.R.S., who has held it since the year 1836.

WE regret having to record the death on June 6 of Dr. Hermann Vogelsang, Professor in the Polytechnicum of Delft, at the early age of 36. He was well known for his various publications on subjects connected with the microscopical structure of rocks and minerals.

AT the meeting of the French Academy on June 8, the death was announced of M. Roulin, librarian to the Academy, and editor of the first volumes of the *Comptes Rendus*.

THE deputation of the Royal Geographical Society which waited on Government in reference to the family of the late Dr. Livingstone recommended that 10,000*l*. or 11,000*l*. should be granted; but it seems the Government have thought 3,000*l*. sufficient, with about 1,000*l*. by way of payment of arrears due to the followers and servants of the doctor. This is in addition to the 200*l*. pension, which is to be continued to the family. The Geographical Society seems to be quite satisfied with this arrangement.

IT seems to be generally allowed that this year's Cambridge commencement has been unusually brilliant; the number of honorary degrees conferred on Tuesday was very large. The names of the scientific men to whom the degree of LL.D. was given we have already mentioned. At the same time the thanks of the

University were conveyed to the Chancellor, the Duke of Devonshire, for his handsome gift of the Cavendish Laboratory. At the Oxford Encænia yesterday, the degree of D.C.L. was conferred, among others, upon Victor Carus, Professor of Comparative Anatomy and Zoology in the University of Leipsig.

We congratulate the University of Cambridge that its Board of Natural Science Studies have at last come to see that the Oxford system in the Natural Sciences Tripos is the only workable one, and the only one which can lead to really valuable results and the discouragement of cramming and superficiality. The Board having had under consideration the reports of the examiners for the Natural Sciences Tripos for several successive years, which express more or less dissatisfaction with the present system on account of the inducements it offers to the candidates to spread their reading over a wide area rather than to study deeply a limited section of natural sciences, think that the objects of the examination—viz. to offer sufficient stimulus to exertion, and at the same time to give encouragement to sound study—will be best secured by dividing the first class into two divisions, and by arranging the names in each of these divisions and in each of the other two classes in alphabetical order. They think it desirable that the first class should consist of those who, having shown adequate general knowledge in the first three days of the examination, have shown superior proficiency in some one, at least, of the branches of natural science included in the examination, and that in the case of every student placed in the first class, the subject or subjects for knowledge whereof he is placed in the first class be signified in the published list. They are also of opinion that it is desirable that those who pass the first three days' examination with credit should be entitled to admission to the B.A. degree. To carry out these recommendations the Board propose certain alterations in the rules of the Tripos defining more strictly the parts to be included in the first three days' examination, and add regulations to carry out their new scheme.

As the statute for settling the future stipend of the Professor of Geology at Oxford has now passed Convocation the Vice-Chancellor will proceed to an election in the course of the present month. Any gentlemen who have not already sent in their names are requested to do so on or before Saturday, June 20.

There are several points in connection with the Annual Commemoration of the University of Sydney, held on March 28 last, which are worthy of notice, and which must be pleasing to the friends of scientific education. The number of students attending lectures at the University during the past Session was 48, being the largest number at one time since the establishment of the University. The number of "superior graduates" now in the University is 87; on this reaching 100 it will be entitled to send a representative to the Legislative Assembly. In recognition of the zeal and efficiency with which Mr. Liversidge has performed his duties as Reader in Geology and Mineralogy, the Senate have promoted him to the higher grade and position of Professor in those sciences, and Demonstrator in Practical Chemistry, and have also voted 500*l.* for the improvement of his laboratories.

Further the Senate of Sydney University have made what many of our readers will regard as a wise law; viz. that candidates, who at the second yearly examination should have displayed a marked proficiency in any one of the three schools of classics, mathematics, or natural science, should be allowed, on the recommendation of the examiners, to devote themselves in their third year exclusively to the subjects of that school, and to be examined for B.A. in them only.

At the same commemoration, a very gratifying act of munificence was announced. Mr. William Macleay, M.L.A., F.L.S., has expressed his intention of bequeathing to the University his valuable library and collection of natural history, upon trust for the promotion of that science, and the instruction of the students and the inhabitants of the colony in the same. He also expresses his intention of leaving to the University the sum of 6,000*l.*, the interest upon which is to be applied to the payment of the salary of a properly-qualified curator, to be specially and exclusively employed in the care and preservation of the specimens belonging to the collection, or any additions that may be made to it. The library already consists of about 2,000 volumes, and Mr. Macleay states that he is continually adding to it all the most valuable of the periodicals and proceedings of Societies of Natural History, published in England, France, Germany, Belgium, and Russia. It includes a large number of books on Natural History, which belonged to the late Mr. William Sharpe Macleay, F.L.S., and which have been presented by his brother, Mr. George Macleay, C.M.G., F.L.S., to accompany the collection. The collection of specimens, we believe, may be considered one of the most extensive and valuable in the world. It was first formed by the late Alexander Macleay, F.R.S., F.L.S., and was considered about fifty years ago the first collection in Europe. Many additions were made to it by his son, the late Mr. W. S. Macleay, who, as well as his father, was considered one of the most eminent entomologists of his day. During the last fifteen years the collection has been greatly enriched by the present owner, Mr. William Macleay, by the accumulation of large numbers of Australian insects, besides a considerable collection from other parts of the world. The library and collection are to be maintained and known by the name of the "Macleayan Natural History Collection," and to be open to the inspection of the students of the University and the general public, at all such proper and convenient times as may be appointed for that purpose. From the admirable spirit which seems to animate the University of Sydney, we should think this munificent gift is likely to be fruitful of the best results.

On June 10 W. H. Miller, F.R.S., Professor of Mineralogy in the University of Cambridge, was elected a Fellow of St. John's College, Cambridge. Prof. Miller took his degree at the college and was formerly for several years a Fellow. He has now been elected for the second time under the statute empowering the college to elect as Fellow "any person eminent for Science or learning." At the same time the Very Rev. C. Meridale, Dean of Ely, Prof. J. C. Adams, and T. Todhunter were elected Honorary Fellows. C. T. Clough, and J. N. Langley have been elected Scholars for proficiency in Natural Science, and A. M. Marshall (Scholar 1873) has received an exhibition in augmentation of his scholarship. First class in the college examination in Natural Science (alphabetical order):—Clough, Langley, Marshall, and Stewart.

We are glad to see from the Fourth Annual Report of the Devon and Exeter Albert Memorial Museum, Schools of Science and Art, and Free Library, that all departments of the institution are in a flourishing and satisfactory condition. It is gratifying to see that the Science schools are gaining ground, and we hope the Committee will do all in its power to develop these and induce those for whose benefit they are intended to take advantage of them. The museum has been greatly improved during the past year by the addition of cases, the arrangement of specimens, and the acquisition of a number of skeletons of typical vertebrates.

We are pleased to see from the Sixteenth Report of the East Kent Natural History Society that it is in a satisfactory condition as regards members, funds, and work; the number of members at the end of 1873 was 97; several valuable and appropriate books have been added to the library and a new microscope purchased. Several important papers have been read bearing on local and general natural history.

THE Committee of the Leeds Mechanics' Institute and Schools of Art and Science have resolved to accede to a generally expressed wish that they should organise a Yorkshire Exhibition of Arts and Manufactures, to be opened in Leeds on May 1, 1875. The object of the Exhibition will be to promote the Fine Arts and Art and Science as applied to Manufactures, and the surplus funds will be applied to the liquidation of the debt now remaining on the Leeds Mechanics' Institute.

A VERY successful meeting, under the presidency of the Mayor of Bristol, was held at the Victoria Rooms, Clifton, for the purpose of inaugurating the formation of a College of Science and Literature for the south and west of England and South Wales, to which we referred in NATURE, vol. x. p. 93. The meeting was perfectly harmonious, and we have no doubt that the scheme so auspiciously begun will be successfully accomplished. It is evidently intended that science will hold an equally important place with literature in the new college.

WINGE AND HEIBERG, of Christiania ("Die puerperalen und pyaemischen processe," H. Heiberg, Leipzig, 1873), point out the remarkable presence of a fungus, which is at least very like a vibrio, in the basis of the sore in cases of pyæmic ulcerative endocarditis (*Mycosis endocardii* Winge), and Heiberg shows in similar cases the crowding of such beings in the superficial lymphatics of some of the viscera. This appears to be an important contribution to the views of Lister as to the septic character of the pyæmic diseases.

A PIECE of native gold weighing 200 kilogrammes, and worth 24,000*l.*, has been found in French Guyana, and sent to Paris to be placed in the Colonial Exhibition at the Champs Elysées.

THE French Academy of Sciences has held a long secret committee meeting on the propriety of granting to M. Chapelas-Coulvier-Gravier a sum of money for his meteoric observatory on the upper part of the Luxembourg Palace. A very strong opposition was offered, and it is doubtful whether the grant will be allowed.

UPWARDS of a year ago there was founded at Berlin in connection with the German Geographical Society, a "German Society for the Exploration of Equatorial Africa," or, shortly, the "African Society," having for its president the well-known Dr. Bastian, and vice-president Dr. Neumayer. The Society has received handsome subscriptions to enable it to carry out its object, including a large sum from the Government. An expedition under Dr. Paul Güssfeldt was soon organised, and in the end of May left Liverpool for the west coast of Africa, in the steamer *Nigretia*, which unfortunately was wrecked off Sierra Leone on June 14, Dr. Güssfeldt losing nearly all the equipments of the expedition. He got another ship to take him to Cabinda in Congo, the seat of the German African Trading Company, where he found Dr. Bastian, who had also gone out to organise the work of the expedition. From Cabinda as a starting-point, several journeys have already been made into the interior, and in the *Correspondenzblatt* of the Society, several numbers of which have been issued, an account of the work done is given in a number of letters from Dr. Bastian, Dr. Güssfeldt, and others.

WE are glad to see that the governors of the Burnley Grammar School in the reconstruction of the buildings have given considerable facilities for the practical teaching of Science. They have provided, among other rooms, two well-contrived laboratories, one of which is to be devoted to chemical manipulation, and the other to experimental physics. The school is expected to open on August 1, and the governors have elected as headmaster Mr. Joseph Hough, B.A. (Cambridge), now Science Master at the Rossall School. It is likewise the intention of the governors to found a central science school, which shall be open in the evening for the instruction of persons occupied in the day-time in commercial pursuits. This school is intended to carry out the recommendation of the Commission on Scientific Instruction in one of their recent reports.

MR. GEORGE SMITH has returned from his second Assyrian expedition. He brings home a very large collection of new cuneiform tablets and fragments, as well as a great many interesting objects of Assyrian art, including the entire lintel in sculptured stone of one of the ancient palace gateways.

THE forthcoming number of Petermann's *Geographische Mittheilungen* will contain an important contribution by Prof. Hanns Hofer, the geologist of Count Wilczek's expedition of 1872, on the geography of Spitzbergen. The paper contains the results of careful observation on the harbours, the configuration of the island, especially in the neighbourhood of Horn Sound, and on the glaciers, which were minutely explored.

A NOVELTY in legislation consists in the recent introduction into the U.S. Congress of a bill proposing to grant the State of Minnesota 200,000 acres of land within its limits, the proceeds of which shall be kept as a perpetual fund, the interest to be applied to the support, maintenance, and equipment of an astronomical observatory and school of mines at St. Anthony's Falls in connection with the Minnesota State University. A special stipulation in this proposed act is that the schools shall be free of charge to all students.

WE have received the first two numbers of the *Quarterly Journal of Conchology*, conducted by Messrs. W. Nelson and J. W. Taylor (Hardwicke). We should think it likely to prove of considerable value to the class to which it is addressed.

WE have received the Report of the Ashmolean Society for the year 1873. During last year the Society has held Seven General Meetings, at which a number of valuable scientific papers were read by well-known men of science.

MESSRS. MACLACHLAN and Stewart, of Edinburgh, have ready for immediate publication a work entitled the "Birds of Shetland," with observations on their habits, migration, and occasional occurrence, by the late Dr. Saxby. It will be published at one guinea.

THE various learned bodies of Massachusetts, especially the American Academy of Arts and Sciences, and the Boston Society of Natural History, are urging upon the Legislature the importance of undertaking a new and thorough scientific survey of the commonwealth. The results expected from such a survey at the present time are a detailed topographical map on a scale of an inch to the mile, maps coloured to show the distribution of rock-formations and economic minerals, with charts on a larger scale of particular localities having special interest or importance; also full descriptions of everything connected with the theoretical and economical mineralogy and geology of the State, and especially full descriptions and truthful illustrations of the animals and plants, including their natural history, transformations, and relations to man and his requirements.

THE additions to the Zoological Society's Gardens during the past week include a Vulturine Guinea Fowl (*Numida vulturina*) from East Africa, presented by Dr. J. Kirk; a Stump-tailed Lizard (*Trachydosaurus rugosus*) from Australia, presented by Mr. N. Clements; a Spotted Cavy (*Cœlogenys paca*) from South America, presented by Mr. J. W. Alexander; a Crested Agouti (*Dasyprocta cristata*) from Colon, presented by Mrs Wood; a Persian Gazelle (*Gazella subgutturosa*) and a Fennec Fox (*Canis fennec*) from Persia, presented by Mr. E. S. Dawes; two Cormorants (*Phalacrocorax carbo*), British, presented by Capt. Salvin; five Mandarin Ducks (*Aix galericulata*) hatched in the Gardens.

SCIENTIFIC SERIALS

Justus Liebig's Annalen der Chemie und Pharmacie. Band 171, Heft 2 und 3.—These parts contain the following papers :—On aldehyde derivatives of napthylamine, by Dr. G. Papasogli. Napthylamine sulphite gives with benzaldehyde napthylamine-benzoyl bisulphite, $C_{10}H_9N.SH_2O_3.C_7H_6O$. This substance is decomposed on heating into sulphur dioxide, water, and a resinous substance of the formula $C_{17}H_{13}N$.—Action of amides on phenol, by Dr. J. Guareschi. The author has tried the action of benzamide and acetamide, also the action of benzamide on cresol, on methyl salicylate, and on ethyl salicylate.—The same author contributes a paper on the various cymenes. Seventeen of these bodies are described and tabulated with bibliographical references. Franz Meilly contributes a long paper on aconitic acid, to which substance the author assigns the constitutional formula $\begin{array}{l} CH \\ \| \\ C{-}CO \\ | \\ CH_2CO_2H \end{array}\!\!>O$.—The following are communications from the laboratory of applied chemistry of Hilger's University :—On Bavarian eclogite by Dr. Gerichten.—On a method of analysing crystalline minerals, by the same.—On a titaniferous iron of abnormal composition, by the same.—On abnormal constituents of urine after taking asparagus, by A. Hilger.—The solubility of tellurium and selenium in sulphuric acid, by the same.—On the quantitative determination of iodine in urine, by the same.—"Synthesis of Phenylbutylene" is the itle of a lengthy paper by B. Aronheim. The author has also accomplished the synthesis of napthalene.—Under the heading, "Researches from the Chemical Laboratory of Kasan, communicated by Alexander Saytzeff," we have the following papers :—On an isomeric pyrotartaric acid, by A. Tupoleff. The acid is ethyl-malonic acid.—On the ether of monobrombutyric acid, by the same.—On some sulphur derivatives of the primary butylic alcohols, by N. Grabowsky and Alexander Saytzeff.—On the reduction of succinyl chloride, by A. Saytzeff. The chief product of the reduction is succinic aldehyde $\begin{array}{l} CH_2COH \\ | \\ CH_2COH \end{array}$ which, by the action of caustic bases, yields a new oxybutyric acid $\begin{array}{l} CH_2CH_2OH \\ | \\ CH_2COOH \end{array}$.—Contributions towards the determination of the structural formulæ of the allyl compounds of acrylic acid, by E. Linnemann.—Contributions to the history of the orcins.—IV. On the iodo-derivatives of the orcins, by John Stenhouse. This paper has already appeared in the Proceedings of the Royal Society.—Researches on the allyl group.—XIII. On α-dibrompropionic acid, by O. Philippi and B. Tollens.—XIV. On α-monobromacrylic acid and conversion of α-dibrompropionic acid into the β acid, by the same authors.—XV. On β-monobromacrylic acid from β-dibromproprionic acid, by R. Wagner and B. Tollens.—XVI. Bye-products of the preparation of β-monobromacrylic acid, by the same.—F. Mohr contributes a lengthy paper on the theory of dissociation or thermolysis. Among other views the author opposes in severe terms that of Horstmann, who has introduced the idea of entropy into the theory of dissociation.—The concluding paper is by J. J. van Renesse, On octylic and caprylic acids.

Bulletin de l'Académie Royale des Sciences, &c., de Belgique, sér. 2, t. xxxvii., No 4.—Mr. A. Gilkinet gives the first of a promised series of papers on the morphology of the Pyrenomycetes. This instalment of twenty-three pages with two plates is occupied with *Sordaria fimicola* (Cesati and De Notaris), which he identifies with *Sphaeria equina* (Fuckel). His observations confirm those made by M. Woronin on *Sordaria fimiseda*, showing that these fungi are sexual. The development and structure of the male and female organs are minutely given.—Dr. F. Putzeys contributes a paper On the centres of vaso-motor nerves. Where are the nerve-centres which affect the tonicity of blood-vessels? is the question he endeavours to solve. His experiments made upon a frog are carefully detailed. He shows that its spinal marrow posseses a reflex vaso-motor power throughout its entire length, thus confirming the work of Schlesinger, Goltz, Freusberg, and Vulpian. Until lately the tonicity of blood-vessels was believed to be under the control of the medulla oblongata alone.—There is a short note by M. Edward Morren, On the application of the mechanical theory of heat to the growth of plants. M. Barthélemy, Professor of Physics at Toulouse, had recently said that he noticed last July a bamboo in the Jardin des Plantes at Montpellier, which grew a centimetre an hour. Such growth, he remarked, must be coincident with the fixture of carbon M. Morren by no means sees that this follows. He says, "Carbon fixed in the green organs of plants under the influence of the sun's rays, by the decomposition of carbonic acid, is not immediately applied to the formation of the tissues by which new organs are formed. The materials of growth are furnished by organic material already elaborated, and their application to the requirements of growth is accompanied by an expenditure of force requisite for their circulation and transformations." Often when we can see plants growing they are not fixing any carbon. Tubers, bulbs, buds, and seeds when sprouting not only do not fix carbon, but lose some. This is in consequence of their respiration, and it is the heat furnished by this combustion which occasions the motions by which they sprout.—There are four chemical papers by M. Louis Henry : On the dry distillation of lactic acid ; On propargyl ; On chloro-bromo-propionic acid ; On glycerine derivatives.—There is also a note On systematic international meteorological observations.

Zeitschrift der Osterreichischen Gesellschaft für Meteorologie.—No. 8 of vol. ix. contains papers by Messrs. Wild, Hany, and Jelinek on methods of reduction to sea-level of barometric readings.—Dr. Ebermayer concludes his notice of Lorenz and Rothe's new "Handbook of Climatology." The second volume is by Dr. Lorenz alone. The "Provinces" into which he proposes to divide Europe are Subarctic, Pontic, Baltic, North and South Oceanic, and Mediterranean. The causes of modifications of climate are discussed and grouped according to their relative importance, and though the greater part is devoted to Europe, a short sketch of characteristics of climate of Asia, Africa, America, and Australia is given —The space devoted to short articles is occupied with a notice of Bruhn's meteorological observations at Leipzic.

Astronomische Nachrichten, Nos. 1,991, 1,992.—These numbers contain a long paper by E. Schönfeld, giving the periods of maximum and minimum of a number of variable stars, with a short history of each. The elements of planet (136) are given as follows :—

$$\begin{aligned} &\text{Epoch April 1874, 0·0 Berlin time} \\ M &= 225^\circ\ 29'\ 2'' \\ \pi &= 331^\circ\ 0'\ 0'' \\ \Omega &= 185^\circ\ 53'\ 4'' \\ i &= 11^\circ\ 30'\ 4'' \\ \phi &= 8^\circ\ 23'\ 2'' \\ \mu &= 1007''\cdot 86 \\ \text{Log. } a &= 0\cdot 36442. \end{aligned}$$

Memorie della Societa degli Spectroscopisti Italiani, March.—This number contains a letter of Prof. B. Wolf, On the maxima and minima of solar spots. He refers to the value 11·111 years for the period, as given by him in 1852, and now finds from further data the period of minima to be 11·114 years, and that of maxima 11·060 years. He claims to have proved the connection between the above periods, and the magnetic and auroral disturbances. A diagram accompanies this number of the chromosphere, for Sept. 1872, and J. Tacchini contributes a paper On some spectroscopic considerations, in which he gives the method he employs for viewing the prominences with a tangential slit, accompanied by drawings.—To this number is an astronomical appendix, containing a paper by Prof. Schiaparelli, On the eleven-year period of the variation of terrestrial magnetism, considered in relation to the frequency of solar spots, to which is added a table showing at once the connection of the two phenomena, from the year 1836.

Der Naturforscher, April. This number consists of *résumés* of papers read before Societies, &c., most of which we have already noticed. Students of the Prehistoric period will find a long article from the *Mittheilungen der Antiquarischen Gesellschaft in Zürich*, on art workmanship of the reindeer period in Switzerland.

Bulletin de la Société d'Acclimatation de Paris, May.—A very practical paper on acclimatisation opens the May number, in which M. J. M. Cornély gives an account of his experiments in inducing kangaroos, wombats, llamas, marmots, Angora goats, and several new varieties of birds and plants to find a congenial home in the soil and climate of France. The former animals would seem to be fully acclimatised, and promise to be a valuable acquisition.—Brazil now seems to enter into the com-

petition with new varieties of silkworms, which are described as possessing many qualities which will render them a most useful addition to the various silkworms now under cultivation.—The Society has been successful in securing two specimens of a fish called the Gourami, from Singapore; attempts have been made to procure some of these fish for introduction into this country, but they have as yet been unsuccessful. The introduction of the *Diospyros*, a Chinese fruit-tree, is recommended, and attempts are being made to acclimatise it.—M. Millet is endeavouring to secure some means of foretelling the approach of cold weather in the spring months, and asks for any observations on the point which others may have made.—An interesting paper by M. J. Lapru, on the Italian bee, points out the superior qualities of that insect, and suggests its more general cultivation.

Jahrbuch der kais. kön. geologischen Reichsanstalt. Band xxiii. Nos. 3 and 4.—The first paper in No. 3 is by Dr. O. Feistmantel On the relation of the Bohemian carboniferous formation to the permian. The palæontological and physical evidence enables the author to arrange these formations as follows:—I. Permian formations. *a* Upper group (with two stages) consisting of red sandstone with bituminous shales, containing animal remains, and red shales with various plant-remains; marl, limestone, and calcareous shales with abundant animal remains. *b* Lower group, or permanent coal-bearing group, containing coal-seams, generally accompanied with bituminous shales. The beds yield permian animal remains, and a rich flora almost entirely non-carboniferous. Red sandstones with *auracarites* are also included in the group. II. Carboniferous formation: grey sandstones and carboniferous shales; coal-seams without accompanying bituminous shales, and without a fauna which can be brought into relation or connection with the permian. The flora shows no admixture of permian types.—In the second article I. Niedzwiedzki gives some account of the basalt rocks met with in the carboniferous basin near Moravian Ostraw; and the other papers in the number are On the occurrence of Tertiary formations in the upper region of the Maritza valley, that is, between the Balkan and the Rhodope mountains in Rumili; and Contributions to the geology of the Fruska Gora in Syrmia.—There are only two geological papers in No. 4, the first of which is a very long contribution, by F. Posepny, On the lead and cadmia veins of Raibl in Carinthia, which is well illustrated with coloured lithographs, showing sections of various vein-stores, ores, minerals, &c., and a map of the workings, &c.—The second paper is by Dr. Mojsisovics, On some triassic fossils from the South Alps; two plates accompany the paper.—Among the "Mineralogical Communications," so carefully edited by Dr. Tschermak, there is one paper of somewhat general interest, An outline of a mechanical theory of the laws of crystallisation, by Dr. J. Hirschwald.

Verhandlungen des naturhist. Vereins d. pr. Rheinlande u. Westphalens, 29ter u. 30ter Jahrgang.—The former of these volumes contains, among other papers, one On Vesuvius, by Von Rath and Von Lasaulx; On the structure of Trilobites, by Von Koenen; On the effect of extreme cold on plants, by Mohr; On *Monas prodigosa*, by Prof. Binz of Bonn; On the pupil of the fox, by Troschel; On benzyl-sulpho-cyanates, by Kekulé; and others on technical points of medicine. In the latter we may note Dr. Braun's description of the Upper Jura, with a geological section; Dr. Umber's measurements of the skulls of numerous mammalia, in which he attempts to find a criterion of their intelligence in the proportion of the anterior to the posterior part of the basis cranii (according to his results the Carnivora are inferior to the Quadrumana; and Horses to Rodents and Marsupials); two papers on the geological and palæontological features of the cave at Balm: one by Rindfleisch On tubercular inflammation; and one by Kekulé On allyl compounds.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 11.—Note on the alleged existence of Remains of a Lemming in Cave-deposits of England, by Prof. Owen, F.R.S.

Note on the Absorption-Spectra of Potassium and Sodium at low temperatures, by H. E. Roscoe, F.R.S., and Arthur Schuster.

In order to obtain the absorption-spectrum afforded by the well-known green coloured potassium vapour, pieces of the clean dry metal were sealed up in glass tubes filled with hydrogen, and one of these was then placed in front of the slit of a large Steinhill's spectroscope, furnished with two prisms having refracting angles of 45° and 60°. The magnifying power of the telescope was 40, and was sufficient clearly to separate the D lines with one prism. A continuous spectrum from a lime-light was used, and that portion of a tube containing the bright metallic globule of potassium was gently heated until the green vapour made its appearance. A complicated absorption spectrum was then seen, a set of bands (α) in the red coming out first, whilst after a few moments two other groups appeared on either side of the D lines, the group β (less refrangible) being not so dark as the group γ. These bands are all shaded off towards the red, and in general appearance resemble those of the iodine spectrum. In order to assure ourselves that the bands are not caused by the presence of a trace of an oxide, tubes were prepared in which the metal was melted in hydrogen several times on successive days until no further change in the bright character of the globule could be perceived. On vapourising the metal, which had been melted down to a clean portion of the tube, the bands were seen as before, and came out even more clearly, the globule, after heating, exhibiting a bright metallic surface. An analysis of the potassium used showed that it did not contain more than 0·8 per cent. of sodium, although, of course, the double line D was always plainly seen.

In order to ascertain whether an alteration in the absorption-spectrum of the metal takes place at a red heat, fragments of potassium were placed in a red-hot iron tube, through which a rapid current of pure hydrogen gas was passed, the ends of the tube being closed by glass plates. The magnificent green colour of the vapour was clearly seen at this temperature on looking through the tube at a lime-light placed at the other end. Owing, doubtless, to the greater thickness or increased pressure of the vapour, the bands seen by the previous method could not be resolved by the small spectroscope employed, the whole of the red being absorbed, whilst a broad absorption-band in the greenish yellow was seen occupying the place of the group γ.

The positions of the bands obtained by the first method were measured by means of a telescope and distant scale, and the wave-lengths obtained by an interpolation curve, for which well-known air-lines were taken as references. The following numbers give the wave-lengths of the most distinct, that is, the most refrangible edge of each band. As the measurements had to be quickly made owing to the rapid darkening of the glass by the action of the metallic vapour, these numbers do not lay claim to very great accuracy, but fairly represent the relative positions of the band, and show that they do not always occur at regular intervals, although they are pretty regularly spread over the field, and all are shaded alike.

Bands of potassium shaded off towards red. Wave-length in tenth metre:—

6844		6459		6311		5949		5763	
6762		6430		6300	α	5930	β	5745	
6710		6400		6275		5901		5732	
6666		6379		6059		5860		5712	
6615	α	6357	α	6033		5842		5700	γ
6572		6350		6012	β	5821	γ	5690	
6534		6331		5988		5802		5674	
6494		6322		5964		5781		5667	

The bright potassium lines in the red and violet were not seen reversed, the intensity of the lime-light being too small at both extremes to render an observation possible.

In order to ascertain whether the vapour of sodium, which, when seen in thin layers, appears nearly colourless, exhibits similar absorption-bands, tubes containing the pure metal, which had been prepared and preserved out of contact with any hydrocarbon, were prepared, the metal being obtained free from oxide and the absorption-spectrum being observed in the manner already described. As soon as the metal began to boil a series of bands in the blue (Na γ) made their appearance, and shortly afterwards bands in the red and yellow (Na α), stretching as far as the D lines, came out. At this period of the experiment the D lines widened, thus blotting out a series of fine bands occurring in the orange (Na β), some of which could in consequence not be mapped. All the bands of the sodium-spectrum shade off like the potassium bands towards the red.

When the vapour of sodium is examined in a red-hot iron tube the colour of the lime-light as seen through it is a dark blue. As the sodium is swept away by the current of hydrogen passing through the colour becomes lighter, and the transmitted rays can be analysed by the spectroscope. At first the whole red and green and part of the blue is cut out entirely. The D lines are

considerably widened, and an absorption-band is seen in the green, apparently coinciding with the double sodium line, which comes next in strength to the D lines. All the colours, therefore, seem to be shut out except part of the orange, part of the green, and the ultra blue. As the sodium vapour becomes less dense more light passes through, and the same absorption-bands are seen as are observed in the other method. The vapour then has a slight bluish-green tint, but is nearly colourless.

The following numbers give the wave-lengths of the more refrangible edge of the sodium absorption-bands in tenth-metres obtained in the manner above described :—

6668		6361		6105		5999	β	4964	
6616		6272		6092		5150		4927	
6552		6235		6071		5129		4889	
6499	α	6192	α	6051	β	5082	γ	4863	γ
6450		6162		6035		5038		4832	
6405		6149		6016		5002		4810	

The drawings accompanying the paper show the general appearance of the two absorption-spectra.

Linnean Society.—Anniversary Meeting, May 25.—G. Busk, vice-president, in the chair.—The chairman announced the officers who had been elected for the year (see NATURE, vol. x. p. 72).—It was moved by Mr. Busk, seconded by Mr. Carruthers, and carried unanimously :—"That the secretaries be requested to convey to Mr. Bentham the cordial thanks of the Society for his invaluable services throughout the thirteen years during which he has occupied the president's chair, to express to him the regret with which the Fellows contemplate the loss of his services, and to assure him that the zealous interest which he has taken in the welfare of the Society and the great efforts which he has made with so much liberality and success, to increase its prosperity and usefulness will always be held in grateful remembrance."—It was moved by Mr. Busk and unanimously resolved :—"That the thanks of the Society be also given to Mr. Stainton on his retirement from the office of secretary, with an expression of the Society's deep regret on losing his valuable services in that capacity."

June 4.—Mr. G. J. Allmann, president, in the chair.—The president exhibited a number of living specimens of fire-fly (*Luciola italica*) recently taken by himself in the neighbourhood of Turin, calling attention to the remarkable synchronous emissions of flashes of light by numerous individuals, and pointing out that the phosphorescence is a phenomenon not of darkness merely, but of twilight or night.—Prof. Thiselton Dyer described the structure of the flowers of *Pringlea* and *Lyallia*, which had recently been sent to this country for the first time by Mr. Moseley, from Kerguelen's Land, and which had been analysed by Prof. Oliver, and subsequently by himself. Dr. Hooker pointed out that several peculiarities in the structure of *Pringlea*, the absence of petals and of the usual glands between the bases of the stamens, the exserted anthers, and the papillæ of the stigma extended into a tuft of hair, appeared to point to this plant (a native of a country where there are no winged insects), being a wing-fertilised member of a class of plants that are ordinarily fertilised by insects.—The following papers were then read :—1. Contributions to the botany of the *Challenger* expedition. Presented by Dr. J. D. Hooker, C.B.—XII*a*. *Challenger* Lichens (Cape de Verdes), by Dr. J. Stirton.—XVII*a*. Letter from Mr. H. N. Moseley to Dr. Hooker, dated Cape Otway, Australia, March 16, On the botany of Kerguelen's Land, Marion, and Heard Islands.—XVIII. List of hitherto unrecorded species from Kerguelen's Land, Marion, and Heard Islands, with a note on *Lyallia kerguelensis* Hook f., by Prof. Oliver.—Synopsis of the mosses of the Island of St. Paul, by W. Mitten (Appendix to Dr. Hooker's paper On St. Paul's Island plants).—On the Restiaceæ of Thunberg's herbarium, by M. T. Masters, F.R.S. At the time that the author published his monograph On the South-African Restiaceæ, in the Journal of the Society, vol. viii. p. 211, and vol. x. p. 209, he had had no opportunity of examining the type specimens described by Thunberg. The few figures published by that naturalist are excellent ; but his descriptions are often so imperfect that not even the sex of the plant is mentioned. In common therefore with all who had previously studied these plants, the author had to guess at the species intended by Thunberg. Lately, however, by the kindness of the authorities at Upsal, Thunberg's African collections have been transmitted to Kew for examination, and the author availed himself of the opportunity to study the Restiaceæ. The paper now read contains a list of these specimens with their names, synonyms, and such rectifications in the nomenclature as the examination rendered necessary.—On *Napoleona*, *Omphalocarpum* and *Asteranthos*, by J. Miers. The plants forming the small group of the *Napoleoneæ* are confined to two very heterogeneous genera, one from Africa, the other from Brazil. *Napoleona* was discovered in 1787 at Owaree, by Palisot-Beauvois ; *Asteranthos* was established in 1820 by Desfontaines, when he associated it with *Napoleona* as a group belonging to *Symplocineæ*. These plants have been ever since a complete puzzle to botanists, who have assigned to them remotely dissimilar positions, the last being that given by the authors of the "Genera Plantarum," who make them a sub-tribe of Lecythideæ, one of their tribes of Myrtaceæ. A careful examination of these plants has convinced the author that most botanists have been wide of the mark in regard to their true affinity. Mr. Miers brought forward a large mass of information concerning *Napoleona*, from which he drew the conclusion that there is nothing in its structure to show the slightest relation to Myrtaceæ ; that it is equally irreconcilable with the Barringtonieæ and with Lecythideæ ; and in consequence of these negative results we must search elsewhere for its true affinity. This led the author to examine *Omphalocarpum*, a genus from the same region as *Napoleona*, and whose flowers and fruit of similar form grow upon the trunk of the trees. This genus has been generally regarded as belonging to Sapotaceæ ; but the authors of the "Genera Plantarum" place it in Ternstrœmiaceæ. *Napoleona* cannot, it is true, belong to Sapotaceæ ; but as it offers so many points of resemblance, and as it cannot find a place in any known natural order it must remain the monotype of a distinct family, to be placed in juxtaposition with Sapotaceæ. In regard to *Asteranthos* the author shows by analytical figures that it bears scarcely any resemblance in any of its features to *Napoleona*. A strong resemblance exists in the form of its calyx to that represented by Wight in an Indian species of *Rhododendron*. And there seems nothing therefore to separate *Asteranthos* from other genera of Rhododendreæ, except its more rotate corolla.

Mathematical Society, Thursday, June 11.—Dr. Hirst, F.R.S., president, in the chair.—The president made a statement to the effect that he had much pleasure in announcing to the members present that he had received a letter from Lord Rayleigh in which that gentleman expressed his intention of handing over to the Society the sum of 1,000*l*. to be invested and applied to assist in the publication of the Proceedings, and the purchase of mathematical periodicals. As the subject will be brought before the members more fully in November next, no further action was taken, but the announcement of the munificent offer gave general satisfaction to the meeting.—Prof. Cayley, F.R.S., V.P., having taken the chair, Mr. S. Roberts gave an account of his paper On the parallels of developables and of curves of double curvature.—Lord Rayleigh next read a note On the numerical calculation of the roots of fluctuating functions.—In the absence of the authors, the secretary read parts of papers by Mr. Griffiths and Mr. Routh, F.R.S. In his note On a remarkable relation between the difference of two Fagnanian arcs of an ellipse of eccentricity e, and that of two corresponding arcs of a hyperbola of eccentricity $\frac{1}{e}$ Mr. Griffiths establishes the following relation : $\frac{\text{arc } PP_o - \text{arc } QQ_o}{\text{arc } P^1P_o^1 - \text{arc } Q^1Q_o^1} = e^3 x x_o \xi\xi_o$ where the unaccented letters refer to the ellipse and the accented letters to the hyperbola, and x, ξ, x_o, ξ_o are the abscissæ of P, Q, P_o, Q_o. The object of Mr. Routh's first paper, viz. Stability of a dynamical system with two independent motions, will be gathered from the following extract :—"The equations of motion of a dynamical system performing small oscillations with two independent motions are of the form

$$A\frac{d^2x}{dt^2} + B\frac{dx}{dt} + Cx + F\frac{d^2y}{dt^2} + G\frac{dy}{dt} + Hy = 0$$

$$A^1\frac{d^2x}{dt^2} + B^1\frac{dx}{dt} + C^1x + F^1\frac{d^2y}{dt^2} + G^1\frac{dy}{dt} + Hy^1 = 0$$

To solve these we eliminate either x or y, and obtain a biquadratic of the form

$$aD^4 + bD^3 + cD^2 + dD + e = 0$$

The whole nature of the motion depends on the forms of the roots of this equation. Rules are given in books on the theory of equations to determine whether the roots are real or imaginary, but this is not exactly what we want to know. It is often

important to ascertain whether the equilibrium about which the oscillation takes place is stable or unstable. The necessary and sufficient conditions for stability are that the real roots and the real parts of the imaginary roots should all be negative. It is proposed to investigate a method of easy application to decide this point."—Mr. Routh's second paper was On rocking stones, and a third was On small oscillations to any degree of approximation.

Anthropological Institute, June 9.—Prof. Busk, F.R.S., president, in the chair.—Sir John Lubbock, Bart., read a paper On the discovery of stone implements in Egypt. The author began with a sketch of the writings and opinions of M. Arcelin and Dr. Hamy, who maintained that the flint implements found along the valley of the Nile, including a hatchet of the St. Acheul type at Deir-el-Bahari, indicated the existence formerly of a true stone age there as in Western Europe. MM. Mortillet and Broca concurred in that view.—On the other hand Dr. Pruner-Bey, and especially Dr. Lepsius, had expressed the opinion that most of the objects described, such as the flint flakes, were naturally produced. M. Chabas also took the same view as Dr. Lepsius, and denied the existence of any evidence of a stone age either in Egypt or elsewhere. On the occasion of a late visit to Egypt with the object of getting conclusive personal evidence on the question, the author found worked flints at various spots along the Nile Valley, especially in the valley of the tombs of the kings of Thebes, and at Abydos, and after carefully weighing the facts and arguments brought forward by MM. Lepsius and Chabas, he was disposed to agree with MM. Arcelin and Hamy in considering that these flint implements really belonged to the stone age, and were ante-Pharaonic. Sir John exhibited a full series of the Egyptian flint implements found by himself during his visit, and the paper concluded with a minute description of each specimen.—Prof. Owen, F.R.S., then read a paper On the ethnology of Egypt. Since the observations recorded in 1861, by Dr. Pruner-Bey, on the race-characters of the ancient Egyptians, mainly based on the characters of skulls, evidences, in the author's opinion, of a more instructive kind have been discovered, chiefly by M. Mariette-Bey. They consist of portrait-sculptures, chiefly statues, found in tombs accompanied by hieroglyphic inscriptions revealing the name, condition, and date of decease. A study of those works led to the conclusion that three distinct types were indicated. (1) The Primal Egyptian, bearing no trace of negro or Arab, but more nearly matched by a high European facies of the present day. (2) The type of the conquering race of Shepherd Kings, or Syro-Arabian, exemplified in the Assyrian sculptures. (3) The Nubian Egyptian, typified in the bas-relief figure of Cleopatra in the Temple of Denderah. In conclusion, the professor drew a graphic picture of the high state of civilisation attained by the Primal Egyptian race, whose exquisite works, done six thousand years ago, are now rendered accessible to man. The paper was amply illustrated by a series of photographs, maps, and diagrams.

Royal Horticultural Society, June 4.—Scientific Committee.—A. Grote, F.L.S., in the chair.—The Rev. M. J. Berkeley exhibited trusses of Pelargonium "St. George," in which all the flowers, and not the central one only, were destitute of spur, thus presenting an illustration of what is termed regular Peloria, and approximating to the genus Geranium.—Messrs. Veitch sent a coffee-bush from Ceylon affected with a fungus, which overruns some 1,000 acres of plantation. This was probably the *Hemileia vastatrix*.—Mr. A. Murray alluded to the moth, *Pronuba yuccasella*, which has the habit of gathering the pollen of *Yucca*, and in so doing often fertilises the stigma.—Dr. Masters showed the roots of a Deodar, which had suddenly died after having been planted about fourteen years. On examination the plant was found infested by mycelium, and on further inquiry it was ascertained that the tree had been planted on the site of an old tan-pit, which had doubtless furnished the nidus for the spawn.—Prof. Thiselton Dyer read the following extract from a letter addressed to Admiral Spratt by his son:—"Dalhousie, Feb. 22, 1874.—On the night of the 10th of this month we had a change of white to blood-looking snow. The native mind was much excited, and said this falling of blood and snow was a sign of some coming great war. . . The blood and snow was snow mixed with dust. Now as the whole of the hills at the foot for some distance had been for many days well saturated, this dust must have come from a long distance, and must have ascended a considerable height. The snow-cloud must have been full of dust, or the atmosphere between us and it, probably the latter. The amount of discoloured snow was $\frac{3}{4}$" and the contents of one superficial foot $12\frac{1}{2}$ grains. Under the microscope it looked like small transparent laminations of mica or silica."—Prof. Thiselton Dyer communicated a note on the temperature of hill and dale.

General Meeting.—W. A. Lindsay in the chair.—The Rev. M. J. Berkeley commented on a new hybrid *Sarracenia*, raised between *S. flava* and *S. purpurea*, also on a plant of *Amorphophallus Berkeleyi*, found at Rangoon by his son Capt. Berkeley, and the stems of which were said to be sold in the Indian markets like asparagus.

Paris

Academy of Sciences, June 8.—M. Bertrand in the chair.—The president announced the death of M. Roulin, librarian to the Academy, and principal editor of the first volumes of the *Comptes Rendus*.—The following papers were read:—Determination of the number of similar triangles which satisfy four conditions, by M. Chasles.—On the distribution of the heat developed by collision, by M. Tresca. The author was led to this research by observing the production of oblique luminous streaks on the lateral faces of the platinum-iridium bar (described at the last meeting by General Morin) during the process of forging.—Several communications on vine-culture were read, all relating to *Phylloxera*. The first of these was by M. Dumas, entitled "Memoir on the means of repelling the invasion of *Phylloxera*." The author considers ammonium sulphhydrate the safest substance for the destruction of the pest without injuring the vine.—On the progress of the vine disease during winter. On the practical means of opposing the disease, by M. H. Marès. The author advocates likewise the use of ammonium sulphhydrate.—On the employment of carbon disulphide to repel *Phylloxera*, by M. le Baron de Chefdebein.—On the employment of sand in the treatment of vines attacked by *Phylloxera*, extract from a letter from M. J. Lichtenstein to M. Dumas. It appears that the insect cannot make way through sand owing to the loose nature of this substance. Since sand contains no fertilising principle, it is proposed to mix it with ashes and guano. The extract concludes with the following advice:—"Surround your stocks largely with sand, *Phylloxera* will not come, or, if there, it will perish and your vines will recover."—Prof. Cayley communicated a note entitled, "On a Formula of Unlimited Integration."—On the age and position of the Saint-Béat marble, a geological note, by M. Leymerie.—On the minute motions of a material system in stable equilibrium, by M. F. Lucas.—Modification of the commutator of Clarke's machine, by M. A. Barthélemy.—On friction in the collision of bodies, by Mr. G. Darboux.—On the lines of curvature of ruled surfaces, by M. E. Weyr.—Note on the spectrum of Coggia's comet (1874 III.), by M. G. Rayet. The spectrum is continuous from the orange to the blue (spectrum of the nucleus) and is traversed by three bright bands (spectrum of the coma) in the yellow, green and blue.—On the motion of the air in pipes, by M. Ch. Bontemps.—On a physiological peculiarity of Axolotl, by M. C. Dareste. The peculiarity in question is the presence of a mucous substance more or less red and containing blood corpuscles in the cloaca of both sexes during the period of reproduction.—On the metamorphoses of the *Acari* of the families *Sarcoptidæ* and *Gamasidæ*, by M. Mégnin.

CONTENTS

THURSDAY, JUNE 25, 1874

THE NEW PHYSICAL LABORATORY OF THE UNIVERSITY OF CAMBRIDGE

ON the 16th inst., at a congregation held in the Senate House, Cambridge, the Cavendish Laboratory was formally presented to the University by the Chancellor. The genius for research possessed by Prof. Clerk Maxwell and the fact that it is open to all students of the University of Cambridge for researches will, if we mistake not, make this before long a building very noteworthy in English science. We therefore put before our readers, as prominently as we can, a description of it.

The Cavendish Laboratory has been erected entirely at the expense of his Grace William Cavendish, Duke of Devonshire, K.G., Chancellor of the University, who has also signified his intention of supplying it with the apparatus necessary for a complete physical laboratory. The building consists principally of three floors, of which the accompanying figures show the plan on a scale of 32 ft. to the inch; Fig. 1 representing the ground-floor, and Figs. 2 and 3 the first and second floors respectively. The west front consists entirely of Ancaster stone; with the exception of the lecture-room and the staircase, which will presently be described, the only ornate portion of the building is the great gateway, X Fig. 1, situated near the south end of this front. The doors, which are very massive, are beautifully carved in oak, and bear, in old English letters, the inscription "Magna opera Domini exquisita in omnes voluntates ejus," which is the Vulgate version of Psalm cxi. 2. Over the gateway are the arms of the Duke of Devonshire on the left, and the University arms on the right, the motto of the Cavendish family, "Cavendo tutus," occupying the centre; and the whole is surmounted with a beautifully carved statue of the Duke in his robes as Chancellor of the University, and bearing in his hand the Cavendish laboratory. The lower portion of the building on the right of the entrance is occupied by the resident attendant. The external walls are 2 ft. thick, the foundation being at a depth of 15 ft. below the surface: with the exception of the west front, the tower, and the portion occupied by the lecture-room, they are built of brick, with Ancaster stone dressings. The tower (marked A in the plans), which is about 17 ft. by 14 ft. 6 in. internal measurement, and 59 ft. in height, contains a very handsome stone staircase with carved oak balustrades.

In describing the internal arrangements seriatim, we shall commence with the room at the east end of the ground-floor marked B in Fig. 1. This room is set apart for magnetic and other observations requiring great steadiness. At *a* is a brick pier about 18 in. high, with a stone top about 4 ft. square. This pier is quite distinct from the tiled pavement of the room, the brickwork being commenced at a depth of about 18 in. below the pavement, and this resting on a foundation of concrete about 18 in. thick. On this pedestal is placed the great electro-dynamometer of the British Association, the two large coils of which are each about half a metre in diameter, and each contains 225 turns of No. 20 copper wire. The diameter of each circle of wire has been accurately measured, as has also the distance betweeen the two bobbins, which is about equal to the radius of either. The resistance of each coil has also been determined, and thus all the electrical constants of this instrument are known with great accuracy. It is by comparison with these coils that the electrical constants of all the other electro-magnetic apparatus in the laboratory will be determined. For example, the magnitude and position of each circle of wire in each coil being known, the coefficient of induction of the first coil on the second can be at once found. Suppose, then, we wish to find the coefficient of induction of a third circuit upon a fourth whose resistance is known. Let the same primary current be sent through the first and third circuits, and let resistances be introduced in the second or fourth until the currents in the two latter are equal. Then the electromotive forces in the second and fourth circuits are proportional to the whole resistance in the circuits, and thus the coefficient of induction of the two pairs of circuits are compared.

At *b* and *c* are stone slabs each 4 ft. square, supported on foundations similar to those last described. On the slab at *b* is placed a unifilar magnetometer of the pattern adopted at Kew. In the upper part of the north wall of this room is a small window for the purpose of determining the direction of the meridian by astronomical observations. This direction being once determined, vertical mirrors will be placed opposite each other on the walls, each mirror being supported by three screws and accurately adjusted by means of nuts so as to serve the purpose of collimation marks. Three mirrors will be placed respectively on the north, east, and south walls of the room, but the fourth mirror will be fixed on the west wall of the room marked F in Fig. 1, in such a position as to be visible through the doorways from the mirror on the north wall of room B. The room marked C in Fig. 1 is called the clock room. In it is a stone pier, *d*, on foundations separate from the rest of the building and intended to carry the principal clock. This clock will be in electric communication with the other clocks in the building, and will from time to time be compared with the clock at the Astronomical Observatory. In this room is also erected a massive stone frame, *e*, intended to carry an experimental pendulum. This, like the clock pedestal, is erected on a foundation similar to that which supports the electro-dynamometer.

Each of the rooms B and C is about 30 ft. by 20 ft. The windows in all the rooms throughout the building have wooden shutters fitted to them, by which they can be completely darkened. On the inside of each window is a large stone shelf, and on the outside a similar shelf in the same plane with it, so that an instrument may be erected with some of its feet inside and some outside the window, a small channel being left between the two to allow the escape of rainwater. The room marked E in Fig. 1 has two large windows on the north side, and will be used exclusively for balances. The best balance at present in the laboratory was constructed by Oertling, and when loaded with a kilogramme in each pan will turn to the weight of a milligramme. This balance, while capable of carrying a very considerable weight, is sufficiently delicate for most physical purposes.

The room marked F in Fig. 1 is called the heat room; in it will be conducted experiments in calo-

rimetry, and the like. This room at present contains an apparatus devised by Prof. Clerk Maxwell for determining the viscosity of air.* This is done by causing three glass plates to vibrate between four parallel fixed plates in an air-tight receiver, by means of the torsion of a steel wire. A mirror being connected with the plates, the amplitude of vibration is determined by viewing through a telescope the image of a fixed graduated scale formed by the mirror. The room G on the ground-floor is used for unpacking apparatus, &c., which is brought directly into this room from the street. The apparatus is then raised to the floor above by means of a lift at *k*. H Fig. 1 is used for a workshop; it is furnished with a carpenter's bench and tools, two vices, &c. A 5-inch self-acting screw-cutting lathe will shortly be added, and

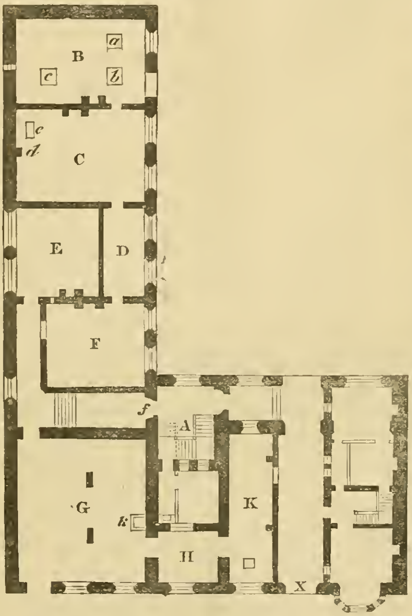


Fig. 1.—Ground Floor.

thus the means will be provided for adjusting and repairing on the premises most of the apparatus required in physical research. The room K is called the battery room; it is situated immediately under the lecture-room, into which wires will be carried from the battery through small hatches in the floor. The battery which will be employed is Sir William Thomson's tray battery, in which the zinc plates will be supported on porcelain cubes of 1-inch edge. The internal resistance of one of these cells is about ·16 ohm. A gas holder containing oxygen gas will also be kept in this room, from which pipes will be carried up into the lecture-room, so that the oxy-coal-gas limelight will be always at hand. The south wall of this room, which is 18 in. thick, passes up into the lecture-room independently of the floor, and carries the lecture table. The floor of the lecture-room is supported on two brick piers, which are built about an inch away from this wall. On the stone pavement of the ground-floor a long line will be carefully measured, and with this the other measures of length used in the laboratory will from time to time be compared. At *f* is an old stone gateway of the sixteenth century, which formerly served as the entrance to the Science Schools.

Passing now to the east end of the first floor we find ourselves in the general laboratory (L Fig. 2). This room is 60 ft. long and 30 ft. wide, and is designed to contain twelve large tables, though there are but ten in it at present. Each of the tables in this, as in all the rooms on the first and second floors, is supported independently of the floor on beams resting on brackets fixed in the walls of the

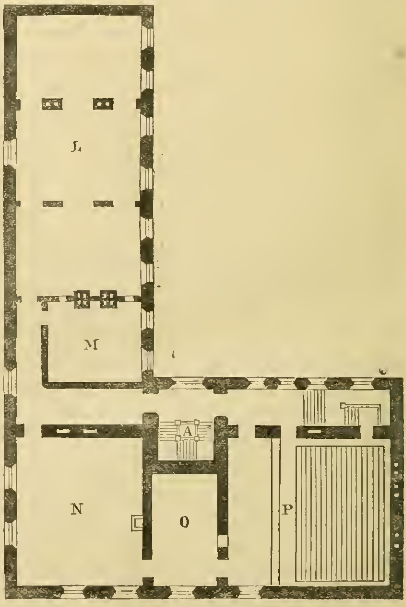


Fig. 2.—First Floor.

rooms below, holes being left in the floor and blocks placed upon the beams so as to be flush with the flooring; it is on these blocks that the legs of the table rest. A stand-pipe, conveying gas, passes up through the centre of each table, and carries connections for four Bunsen or other burners, but can be removed at pleasure. A closet, provided with a good draught into the chimney, will be erected at the east end of this laboratory, in which any experiment producing objectionable fumes, &c., can be conducted. This laboratory is intended for the general use of students. Each room, with one or two exceptions, is provided with an open hearth for a basket fire and a ventilator leading into the chimney near the ceiling. Water is also laid on to all the rooms, which are likewise furnished with leaden sinks; and a plentiful supply of indiarubber tubing lined with canvas will be always on

* See the Bakerian Lecture, Phil. Trans. 1866.

hand in case of fire. The room marked M in Fig. 2 is the Professor's private room. It communicates with the general laboratory by two hatches, which can be opened or closed at pleasure. In the south-west corner of this room is placed Sir William Thomson's quadrant electrometer, made by White of Glasgow. N Fig. 2 is called the apparatus-room. This room will be furnished with glass cases and cabinets, in which will be kept the apparatus which is not in immediate use, and amongst others several classical instruments belonging to the British Association, as for example the original standard unit of electrical resistance and the governor, coil, &c., used in determining this unit. The room O Fig. 2 is called the "preparation-room;" it communicates through a hatch with the lecture-room P. It is intended that the preliminary arrangements

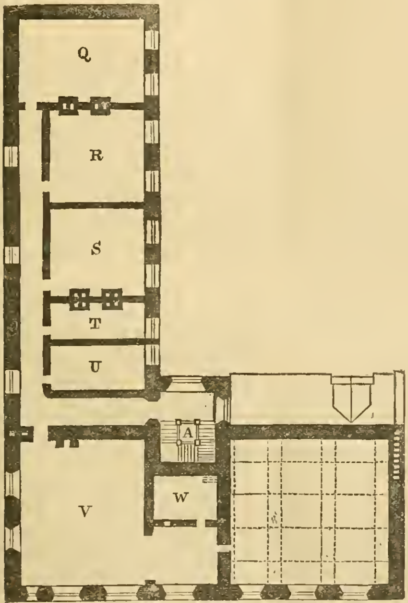


FIG. 3.—Third Floor.

necessary for making experiments during the lectures should be carried out in this room. The lecture-room P is about 38 ft. by 35 ft. and 28 ft. high, and will afford accommodation for about 180 students. The lecture table, which extends throughout the width of the room, is of oak, and is supported on the top of an 18-inch wall as previously described. The seats for the class rise at an angle of about 30°, and there are three doors to provide sufficient means of egress for the audience. The room is panelled to a height of about 9 ft., above which the walls are brick relieved by handsome pillars, which spring from triple conical brackets, and support the ceiling. The room is lighted by three windows at a height of about 17 ft. from the floor, and one window below. Each window is furnished with wooden shutters, which fold together, thus completely darkening the room. The shutters of the three upper windows are opened and closed together by means of endless screws attached to a horizontal shaft which runs under each. The ceiling of the room consists of wooden panels, those near the walls being perforated and forming the bottoms of two horizontal shafts, which lead into a chimney, thus providing an efficient means of ventilation. Three of the panels over the lecture table, as well as the styles between them, can be removed. Above these are two strong tie-beams of the roof, from which Foucault's pendulum or other heavy bodies may be suspended over the lecture table. The panels and styles adjoining the north wall of the lecture-room can also be removed to allow of diagrams being suspended against the wall. On the other three sides of the room the ceiling does not abut directly upon the wall but is coved in the form of a quadrant of a circle, giving the room a very beautiful appearance. This lecture-room is in every respect a model room of its kind. All the rooms on the ground-floor and first floor, with the exception of the lecture-room, are about 15 ft. in height.

On the third floor the room Q Fig. 3 is intended for experiments on acoustics. The room R will be employed for making drawings and calculations; S will be devoted to researches on radiant heat; and T and U are for optical experiments. V is the electrical room. The air in this room will be kept dry by Mr. Latimer Clark's contrivance, which consists of a heated copper roller over which an endless band of flannel passes. The roller is heated by gas-lights within it, and, being kept in constant rotation, every part of the flannel becomes heated in turn by passing over it. The vapour which rises from the heated flannel is carried off by the current of air which supplies the burners inside the roller, and escapes by the flue. The flannel when thus dried and cooled passes into the open air of the room, where it again absorbs moisture from the air, which thus becomes dried, so that the electrical instruments in the room are preserved in a highly insulating condition. From this room a small doorway enters the lecture-room at a height of about 17 ft. from the floor of the latter. An insulated wire connected with the prime conductor of the electric machine will pass through this doorway and thus supply electricity on the lecture table when the air in the lecture-room is too damp to allow of the satisfactory working of the machine. W is a small dark room for photographic and other similar purposes. A small window for a heliostat is placed in the west wall of the electrical room, opposite the door, from which a beam of light may be sent along the whole length of the building so as to allow of diffraction and other experiments, with rays of light 120 ft. in length. All the rooms are heated by hot-water pipes connected with a boiler in the basement. Near the east end of the building copper pipes are employed on each floor for the sake of the magnets in room B.

A lofty flight of steps in the tower leads from the second floor into the roof above the lecture-room, and a few more steps lead into the highest room in the building, which occupies the upper portion of the tower, its floor being more than 50 ft. above the ground. In this room will be placed a Bunsen's water pump, the water from which will thus have a vertical fall of considerably more than 50 ft. This pump will be used to exhaust a large receiver, from which pipes will communicate with the different rooms,

so that if it be desired to exhaust the air from any vessel it will only be necessary to connect it with one of these pipes and *turn on a vacuum*. If a more perfect vacuum be desired than can be obtained by this means, the vessel may be subsequently exhausted by the Sprengel or other air-pump. A metal tube filled with mercury, with glass gauges on every floor for observing the height of the mercury within, will extend throughout the whole height of the tower and will serve as a manometer. The lower end of the tube will pass through the wall and terminate in F Fig. 1. On the top of the tower will be fixed a wooden mast carrying a pointed metal rod, for the purpose of collecting atmospheric electricity. The rod will communicate with the interior of the laboratory by an insulated wire.

The floors of the building are liberally supplied with hatches about 8 in. square, and in most cases those in the first floor are placed vertically under those in the second floor, so that wires may be suspended through the whole height of the building.

The laboratory was designed by Mr. W. M. Fawcett, M.A., of Jesus College, and the way in which he has turned to account the space available for his purpose, as well as the simple beauty of his designs have been the subjects of great admiration. Loveday of Kibworth was the contractor.

After the congregation on the 16th the Duke of Devonshire, Sir Bartle Frere, Sir Garnet Wolseley, Prof. Stoletow of Moscow, Prof. Balfour Stewart, Prof. Roscoe, and other distinguished visitors inspected the laboratory and expressed great satisfaction with the building and the arrangements.

Amongst the apparatus at present in the laboratory besides the electro-dynamometer of the British Association, may be mentioned the original B.A. units of resistance, together with the rotatory coil, speed governor, and bridge used in their construction; Sir William Thomson's quadrant electrometer, resistance coils up to 100,000 ohms (a megohm as well as some coils of very small resistance are expected shortly), three mirror galvanometers of different constructions, a 3 ft. 6 in. glass plate electric machine, and a 30 in. ebonite electric machine, Holtz's electric machine, and a hydraulic press, of a peculiar construction, made by Ladd and Co.

THE "CHALLENGER" IN THE SOUTH ATLANTIC

At the last meeting of the Royal Society a letter from Prof. Wyville Thomson on board H.M.S. *Challenger*, to Admiral Richards, was read, which contained results of such high importance to biological science that were it the only result of the expedition England might have been proud to have had a hand in it. It is most interesting too as carrying on the story of the daily life on board ship which has been touched upon by Prof. W. Thomson in former communications to NATURE. The letter, which is dated Melbourne, March 17, starts by telling us that south of the line observations in matters bearing upon Prof. Thomson's department were made most successfully at nineteen principal stations, suitably distributed over the track, and including Marion Island, the neighbourhood of the Crozets, Kerguelen Island, and the Heard group.

After leaving the Cape, several dredgings were taken a little to the southward, at depths from 100 to 150 fathoms. Animal life was very abundant; and the result was remarkable in this respect, that the general character of the fauna was very similar to that of the North Atlantic, many of the species even being identical with those on the coasts of Great Britain and Norway.

Marion Island was visited for a few hours, and a considerable collection of plants, including nine flowering species, was made by Mr. Moseley. A shallow-water dredging near Marion Island gave a large number of species, again representing many of the northern types, but with a mixture of southern forms, such as many of the characteristic southern Bryozoa and the curious genus *Serolis* among Crustaceans. Off Prince Edward's Island the dredge brought up many large and striking specimens of one or two species of Alcyonarian zoophytes, allied to *Mopsea* and *Isis*.

The trawl was put down in 1,375 fathoms on Dec. 29, and in 1,600 fathoms on the 30th, between Prince Edward's Island and the Crozets. The number of species taken in these two hauls was very large, and many of them belonged to especially interesting genera, while many were new to science. There occurred, with others, the well-known genera *Euplectella*, *Hyalonema*, *Umbellularia*, *Flabellum*, two entirely new genera of stalked Crinoids belonging to the Apiocrinidæ, *Pourtalesia*, several Spatangoids new to science, allied to the extinct genus *Ananchytes*, *Salenia*, several remarkable Crustaceans, and a few fish.

The *Challenger* reached Kerguelen Island on Jan. 7, and remained there until Feb. 1. During that time Dr. von Willemoes-Sühm was chiefly occupied in working out the land-fauna, Mr. Moseley collected the plants, Mr. Buchanan made observations on the geology of those parts of the island which were visited, and Mr. Murray and Prof. Thomson carried on the shallow-water dredging in the steam-pinnace. Many observations were made, and large collections were stored.

Two days before the expedition left Kerguelen Island they trawled off the entrance of Christmas harbour, and the trawl-net came up on one occasion nearly filled with large cup-sponges belonging to the genus *Rossella* of Carter, and probably the species dredged by Sir James Clark Ross near the ice-barrier, *Rossella antarctica*.

The *Challenger* reached Corinthian Bay in Yong Island on the evening of the 6th, and all arrangements had been made for examining it, as far as possible, on the following day; but a sudden change of weather obliged Capt. Nares to put to sea. Fortunately Mr. Moseley and Mr. Buchanan accompanied Capt. Nares on shore for an hour or two on the evening of their arrival, and took the opportunity of collecting the plants and minerals within their reach.

The most southerly station was made on Feb. 14, lat. 65° 42′ S., long. 79° 49′ E. The trawl brought up, from a depth of 1,675 fathoms, a considerable number of animals, including Sponges, Alcyonarians, Echinids, Bryozoa, and Crustacea, all much of the usual deep-sea character, although some of the species had not been previously observed.

Prof. Thomson gives a list of the various classes of

animals from Sponges to Teleostei, that were met with in nine successful dredgings, at depths beyond 1,000 fathoms, between the Cape and Australia. Many of them, Prof. Thomson states, are new to science, and some are of great interest from their relation to groups supposed to be extinct. This is particularly the case with the Echinodermata, which are here, as in the deep water in the north, a very prominent group.

During the present cruise special attention has been paid to the nature of the bottom, and to any facts which might throw light upon the source of its materials. This department has been chiefly in the hands of Mr. Murray; and Prof. Thomson gives the following extracts from Mr. Murray's notes:—

"In the soundings about the Angulhas bank, in 100 to 150 fathoms, the bottom was of a greenish colour, and contained many crystalline particles (some dark-coloured and some clear) of Foraminifera, species of *Orbulina*, *Globigerina*, and *Pulvinulina;* a pretty species of *Uvigerina*, *Planorbulina*, *Miliolina*, *Bulimina*, and *Nummulina*. There were very few Diatoms.

"In the deep soundings and dredgings before reaching the Crozets, in 1,900, 1,570, and 1,375 fathoms, the bottom was composed entirely of *Orbulina*, *Globigerina*, and *Pulvinulina*, the same species which we get on the surface, but all of a white colour and dead. Of Foraminifera, which we have not got on the surface, I noticed one *Rotalia* and one *Polystomella*, both dead. Some Coccoliths and Rhabdoliths were also found in the samples from these soundings. On the whole, these bottoms were, I think, the purest carbonate of lime we have ever obtained. When the soundings were placed in a bottle, and shaken up with water, the whole looked like a quantity of sago. The *Pulvinulinæ* were smaller than in the dredgings in the Atlantic. We had no soundings between the Crozets and Kerguelen.

"The specimens of the bottom about Kerguelen were all from depths from 120 to 20 fathoms, and consisted usually of dark mud, with an offensive sulphurous smell. Those obtained farthest from land were made up almost entirely of matted sponge-spicules. In these soundings one species of *Rotalina* and one other Foraminifera occurred.

"At 150 fathoms, between Kerguelen and Heard Island, the bottom was composed of basaltic pebbles. The bottom at Heard Island was much the same as at Kerguelen. The sample obtained from a depth of 1,260 fathoms, south of Heard Island, was quite different from anything we had previously obtained. It was one mass of Diatoms, of many species, and mixed with these a few small Globigerinæ and Radiolarians, and a very few crystalline particles.

"The soundings and dredgings while we were among the ice in 1,675, 1,800, 1,300, and 1,975, gave another totally distinct deposit of yellowish clay, with pebbles and small stones, and a considerable admixture of Diatoms, Radiolarians, and Globigerinæ. The clay and pebbles were evidently a sediment from the melting icebergs, and the Diatoms, Radiolarians, and Foraminifera were from the surface-waters.

"The bottom, from 1,950 fathoms, on our way to Australia from the Antarctic, was again exactly similar to that obtained in the 1,260 fathoms sounding south of Heard Island. The bottom at 1,800 fathoms, a little farther to the north (lat. 50° 1′ S., long. 123° 4′ E.), was again pure 'Globigerina-ooze,' composed of *Orbulinæ*, *Globigerinæ*, and *Pulvinulinæ*.

"The bottom at 2,150 fathoms (lat. 47° 25′ S., long. 130° 32′ E.) was similar to the last, with a reddish tinge, and that at 2,600 fathoms (lat. 42° 42′ S., long. 134° 10′ E.) was reddish clay, the same which we got at like depths in the Atlantic, and contained manganese nodules and much decomposed Foraminifera."

Mr. Murray, Prof. Thomson goes on to say, "has been induced by the observations which have been made in the Atlantic, to combine the use of the towing-net at various depths from the surface to 150 fathoms, with the examination of the samples from the soundings. And this double work has led him to a conclusion (in which I am now forced entirely to concur, although it is certainly contrary to my former opinion) that the bulk of the material of the bottom in deep water is in all cases derived from the surface.

"Mr. Murray has demonstrated the presence of Globigerinæ, Pulvinulinæ, and Urbulinæ throughout all the upper layers of the sea over the whole of the area where the bottom consists of 'Globigerina-ooze' or of the red clay produced by the decomposition of the shells of Foraminifera; and their appearance when living on the surface is so totally different from that of the shells at the bottom, that it is impossible to doubt that the latter, even although they frequently contain organic matter, are all dead. I mean this to refer only to the genera mentioned above, which particularly form the ooze. Many other Foraminifera undoubtedly live in comparatively small numbers, along with animals of higher groups, on the bottom."

It is very curious to note that in the extreme south the conditions were so severe as greatly to interfere with all work. "We had," Prof. Thomson says, "no arrangement for heating the work-rooms, and at a temperature which averaged for some days 25° F. the instruments became so cold that it was unpleasant to handle them, and the vapour of the breath condensed and froze at once upon glass and brass work. Dredging at the considerable depths which we found near the Antarctic circle became a severe and somewhat critical operation, the gear being stiffened and otherwise affected by the cold, and we could not repeat it often.

"The evening of Feb. 23 was remarkably fine and calm, and it was arranged to dredge on the following morning. The weather changed somewhat during the night, and the wind rose. Captain Nares was, however, most anxious to carry out our object, and the dredge was put over at 5 A.M. We were surrounded by icebergs, the wind continued to rise, and a thick snow-storm came on from the south-east. After a time of some anxiety the dredge was got in all right; but, to our great disappointment, it was empty—probably the drift of the ship and the motion had prevented its reaching the bottom. In the meantime the wind had risen to a whole gale, force = 10 in the squalls, the thermometer fell to 21°·5 F., the snow drove in a dry blinding cloud of exquisite star-like crystals, which burnt the skin as if they had been red hot, and we were not sorry to be able to retire from the dredging-bridge.

"The specific gravity of the water has been taken

daily by Mr. Buchanan; and during the trip Mr. Buchanan has determined the amount of carbonic acid in 25 different samples—15 from the surface, 7 from the bottom, and 2 from intermediate depths. The smallest amount of carbonic acid was found in surface-water on Jan. 27, near Kerguelen; it amounted to 0·0373 gramme per litre. The largest amount, 0·0829 gramme per litre, was found in bottom-water on Feb. 14, when close to the Antarctic ice. About the same latitude the amount of carbonic acid in surface-water rose to the unusual amount of 0·0656 gramme per litre; in all other latitudes it ranged between 0·044 and 0·054 gramme per litre. From the greater number of these samples the oxygen and nitrogen were extracted, and sealed up in tubes.

"While we were among the ice all possible observations were made on the structure and composition of icebergs. We only regretted greatly that we had no opportunity of watching their birth, or of observing the continuous ice-barrier from which most of them have the appearance of having been detached. The berg- and floe-ice was examined with the microscope, and found to contain the usual Diatoms. Careful drawings of the different forms of icebergs, of the positions which they assume in melting, and of their intimate structure, were made by Mr. Wild, and instantaneous photographs of several were taken from the ship.

"I need only further add that, so far as I am able to judge, the expedition is fulfilling the object for which it was sent out. The naval and the civilian staff seem actuated by one wish to do the utmost in their power, and certainly a large amount of material is being accumulated.

"The experiences of the last three months have, of course, been somewhat trying to those of us who were not accustomed to a sea-life; but the health of the whole party has been excellent. There has been so much to do that there has been little time for weariness; and the arrangements continue to work in a pleasant and satisfactory way."

COLONIAL GEOLOGICAL SURVEYS

I.—CANADA

Report of Geological Survey of Canada for 1872-73.

RATHER less than thirty years ago the Canadian Legislature passed a vote for the institution of a Geological Survey of the province, with the object of ascertaining definitely the mineral resources of the country. In pursuance of this decision, the Governor-General, after some inquiry about a properly qualified individual to take charge of the Survey, finally appointed Mr. W. E. Logan, who, born in Canada, had made his name known in England by some careful surveys of the South Welsh Coalfield, and by original observations on the origin of coal. For thirty long years of unremitting labour, with obstacles of every kind, physical, pecuniary, political, the brave and sagacious director stuck to his post. Many a time with a legislature impatient for practical results in the discovery of minerals, and a ministry indifferent to science and bent on popularity by retrenchment of the budget, the chances of the Canadian Survey seemed desperate. But the pilot who guided its destinies showed himself as shrewd a judge of men, and as able to win them over, as he was a skilful pioneer in geology. And the result is that he has made the Canadian Geological Survey one of the first in the world, excellent in its equipment, considering the slender means placed at his disposal, and altogether admirable for the vast amount of solid work which it has accomplished—work which has not merely been of service to Canada, but has acquired a world-wide interest. In doing this he has made his own name a household word among geologists of every country. Canada may well be proud of her Sir William Logan.

About four years ago, having toiled so long and hard, he felt compelled to relinquish his post and seek the rest which his old age so needed and deserved. He was succeeded by Mr. Alfred R. Selwyn, who had been trained in the early days of the Geological Survey under Sir Henry De la Beche, had done much excellent and difficult geological work in Wales, and had thereafter held for a number of years the post of Director of the Geological Survey of Victoria. The Victorian authorities in 1869 suppressed their survey. When Mr. Selwyn lost that appointment, he was induced to accept the guidance of the establishment in Canada. There could hardly have been found a fitter successor to Sir William Logan. Long experience in all the details of geological surveying, both in civilised and in still unexplored regions, must have made it an easy matter for Mr. Selwyn to adapt himself to Canadian modes of exploration. He was renowned in his old Welsh days for his prowess as a mountaineer, and to judge from the present report the advance of years has not perceptibly impaired his bodily activity and powers of endurance. During the comparatively brief season when geological reconnaissances are possible in British North America he is found at one time away in the far east of the dominion inspecting mines in Nova Scotia, at another time with his colleagues and Indians laboriously toiling through river, lake, and portage, in the still only partially explored regions towards Fort Garry, or camping out for many weeks on the shores of Lake Superior. During 1872 the operations of the Canadian Survey under his charge extended across the whole breadth of North America at its broadest part, that is from the Queen Charlotte Islands to the headlands of Nova Scotia—a distance, in a straight line, of considerably more than 3,000 miles.

The success of such a service as that of the Canadian Geological Survey must depend, however, in large part on the calibre of the men who act under the director. And Mr. Selwyn is fortunate in his staff, which is nearly the same as that under Sir William Logan. Of his explorers in the field Mr. R. Bell and Mr. James Richardson have done much of that sound work on which the reputation of the Canadian Survey rests. To Mr. Billings, who determines his fossils, and to Dr. Dawson, who, though not attached to the Survey, generously lends his assistance in the palæontological department, the Survey is likewise largely indebted. As an analyst of minerals and ores and an able writer on chemical geology Sir William Logan had a tower of strength in Dr. Sterry Hunt, who has lately accepted an appointment in the United States. Dr. Hunt's successor, Dr. Harrington, carries with him into his new duties the good wishes of all geologists who take

interest in the pursuit of mineralogy and petrography and in the perplexing problems of metamorphism. One of the oldest and best of Sir William's staff, Mr. Murray, has now an independent sphere of work in Newfoundland. He has issued a number of reports, to which and to his other services we shall return on a future occasion.

Geological field-work in Canada differs very markedly from field-work in most other countries. Most of the districts over which the Survey is now extending are in great measure, or wholly, unexplored, some of them, indeed, having never been visited by a white man before the adventurous geologist attacked their rocks with his hammer. There being no roads, and the country thickly timbered, the rivers form the natural routes for exploration. Each member of the staff receives in the early summer his instructions as to the area to be surveyed during the five or six months at most when surveying is possible. Providing himself with birch-bark canoes, two or more white men as *voyageurs*, and a variable band of Indians as guides and portage carriers, likewise with provisions for the entire party for the whole season during which the tour is to last, he starts on his voyage of discovery. Of course in such regions he has either no map at all or some mere rough sketch, so that he needs to construct the topography as well as the geology of his charts. Ascending the river which has been chosen, the party halts each night at some favourable creek and sleeps under cloaks or skins upon the shore. Sir William Logan used to sleep in a sack on the beach of Lake Superior, with his head stuck out of the mouth of it, and after tucking himself in would sometimes need to creep out again to knock off the edge of some protuberant rock, and thus literally to smooth his bed with his hammer. Expertness as a shot forms a valuable qualification in one of these explorers, and enables himself and his comrades now and then to enjoy the luxury of fresh meat. Great trouble often arises with the Indian attendants. Sometimes they cannot be had at all, and when obtained are apt to depart at a moment's notice, leaving the white men to manage their journey as they best can.

The Report of the Canadian Survey for 1872-73 bears the stamp of the same thorough unostentatious work which has characterised the whole of the long series of Reports from 1843 downwards. In such a yearly summary of progress we cannot expect the completeness of a finished memoir. The observers merely chronicle what they have seen in the tracts visited by them. But on this account their Reports are probably all the surer an index to their powers of rapid observation and of grasping main features of geological structure. In this aspect Mr. Richardson's Report, On the coalfields of Vancouver and Queen Charlotte Islands, deserves high commendation. By the time he could get himself transported across the continent to San Francisco, and thence by steamer to the part of Vancouver Island where his explorations were to be made, it was the beginning of July, and the heavy rains began before the end of September. In spite of wind and wet, however, he stuck to his work, and after storing away his boat, tent, and camp-equipage for next year's service, set out once more on his long journey, and reached Montreal in the middle of December. During these few and interrupted months he added considerably to what was previously known regarding the secondary coalfields of that part of America, made a number of careful measurements of the thicknesses of the strata, and brought home many fossils, both plant and animal, new to science.

He found that the coal-bearing rocks lie upon a vast depth of older crystalline masses among which he detected fossiliferous limestones. This metamorphosed series he estimates at somewhere about 17,000 ft. in thickness. When the fossils were submitted to Mr. Billings, that able palæontologist found them too obscurely preserved to warrant a definite opinion as to their age. From his reference of some of the corals to such genera as *Zaphrentis*, and the occurrence of *Productus*, *Spirifer*, and *Fenestella*, the rocks would at least seem to be certainly Upper Palæozoic, though he does not go further than to suggest that they may be "either Permian or Carboniferous, more probably the latter." On this great metamorphic group the coal-bearing rocks rest unconformably. To these rocks Mr. Richardson assigns a thickness of 5,000 ft. They consist of various shales, sandstones, shell-bearing limestones, and conglomerates with intercalated seams of coal, very much resembling apparently some parts of our Carboniferous sections in Britain. Their geological position appears to be about the parallel of our Cretaceous and perhaps the upper part of our Jurassic series. Among the plants Dr. Dawson finds some forms of cypress and yew, cycads and ferns, with species of oak, birch, and poplar, and remarks that these fossils furnish additional evidence of a fact already noticed, "that in the Cretaceous period the generic types of American trees were as well marked as at present." Among the shells, Mr. Billings finds 16 species of Ammonites, 2 of Belemnites, a Nautilus, 4 Gasteropods, and 9 genera of Lamellibranchs, the general facies of the whole being decidedly Cretaceous and Upper Jurassic. He admits the view of the States geologists to be substantially correct, that the coal of Vancouver Island belongs to one of the Cretacous groups which is developed in northern California and Oregon. At the same time the fossil evidence suggests that while the Vancouver beds may be Upper Cretaceous, those of the Queen Charlotte Islands are partly Lower Cretaceous and partly Upper Jurassic. From the fact that the fossils in the Cretaceous formations on the west side of the Rocky Mountains are specifically different from those on the east side, Mr. Billings suggests the former existence of a land-barrier down the American continent on which the abundant Cretaceous flora flourished.

The route followed by Mr. Bell, of which an account is given in this Report (On the country between Lake Superior and Lake Winnipeg), presented comparatively little of general interest, though it gave scope for the same methodical and careful work for which his previous reports are distinguished. One fact deserves notice among his remarks, namely, that he has confirmed his previous observations of a great conformable series of metamorphosed Huronian rocks resting upon the Laurentian gneiss. Mr. Selwyn suggests that the conformability may be only local and deceptive. This is certainly a matter deserving attentive examination. Mr. McOuat contributes a well-written Report on the country between Lakes Temiscamang and Abbitibbe, where he was busy tracing the relations of some of the metamorphic rocks there to those on Lakes Huron and Superior. Mr. Ven-

nor's Report deals with a more civilised part of the country, which had already, to some extent, been examined by the Survey. He is evidently an accession of great strength to the staff.

While explorations were in progress on the shores of the Pacific among the Vancouver coalfields, other members of the Survey were busy on the Atlantic borders among the coalfields of New Brunswick and Nova Scotia. Prof. Bailey and Mr. Matthews have written a valuable account of the New Brunswick region, which it is to be hoped will be extended and published with sections and fuller details. Several other Reports are included in the volume, having more of a practical than a scientific interest. In fine, the Geological Survey of Canada may be congratulated upon the evidences of continued activity which this volume furnishes. The form of such Annual Reports necessarily precludes a systematic treatment of the subject, and makes it somewhat difficult for readers unfamiliar with the localities to grasp the main features of geological importance amid the manifold local details. It is earnestly to be wished, therefore, that before many years pass away another general volume may be issued like that which Sir William Logan published eleven years ago.

ARCH. GEIKIE

(*To be continued.*)

OUR BOOK SHELF

Field Ornithology. By Dr. Elliot Coues. (Naturalists' Agency, Salem.)

OUR ornithological readers are all familiar with Dr. Coues' excellent "Key to North American Birds," which we noticed on its appearance. In that work it was intended that instruction in the best means of collecting and preserving birds should have been incorporated, which was prevented by the unexpected dimensions which the volume assumed. The same author now gives us these important instructions in a separate small manual, with which he combines a check list of the species described in the "Key," arranged in accordance with his own views, as a supplement to the larger work. The subjects treated of will be found of great service to all collectors, especially to those, both amateur and professional, who are commencing to attempt the accumulation and the preservation of bird-skins. The hints on the selection of a gun, shot, &c., will be of especial service to all sportsmen of small game, whilst the carefully-written account of the best way in which the skinning of birds, both large and small, should be undertaken, will well repay the perusal, even of the experienced. The various less well-known means of preserving specimens, as in spirit, and by means of carbolic acid, which latter is not inaptly termed by the author "mummification," are described in detail. Of the carbolic-acid method it is remarked: "I mention the process chiefly to condemn it as an atrocious one; I cannot imagine what circumstances would recommend it, while only an extreme emergency could justify it. It is further objectionable because it appears to lend a dingy hue to some plumages, and to dull most of them perceptibly." Notwithstanding these disadvantages there is one point which recommends this process, it being that the bodies of the birds preserved by it are in a condition quite fit for the dissection of the muscles and other organs, after they have been soaked for some time. Nothing is more difficult than for the students of internal structure to get most of the bodies of which they despondently regard so many skins; and they naturally look with delight at any method which gives them a chance of obtaining the species they desire. The check list will be found of much use to those who collect the birds of North America. It is printed on one side of the page only, and separate copies are to be printed, which can be cut up for cabinet purposes. For those who are commencing ornithology practically we know no book which will prove so serviceable as Dr. Coues' little work.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Proposed Issue of Daily Weather Charts of Europe and the North Atlantic

I HAVE the honour to inform you that Capt. Hoffmeyer, Director of the Royal Meteorological Institute of Copenhagen, has sent me a circular announcing his intention to publish daily charts of the weather for the district from 60° E. to 60° W. long. and from 30° to 75° N. lat. The charts for the three months—Dec. 1873-Feb. 1874—will be published as an experiment.

The cost will be four francs per month, exclusive of postal charges.

Capt. Hoffmeyer states that he can only deal with central offices, and has requested me to undertake these islands as regards the distribution of the charts. I have therefore to announce that I have been instructed by the committee to subscribe for twenty-five copies of these charts, and I shall be happy to supply copies for the three months to any gentleman, at the cost of 11*s*. to cover carriage from Copenhagen, and postage from London to his address.

ROBERT H. SCOTT, *Director*

Meteorological Office, June 22

The Degeneracy of Man

DR. OSCAR PESCHEL, in his recently published "Völkerkunde" (p. 137), calls attention to a remark by the late Dr. von Martius, of much interest to anthropologists. It is well known that this distinguished naturalist avowed in the strongest terms his belief that the savage tribes of Brazil were the fallen descendants of more cultured nations. In 1838 he said:—"Every day I spent among the Indians of Brazil increased my conviction that they had once been in quite another state, but that in the lapse of dark ages there had broken in upon them manifold catastrophes, which had brought them down to their actual condition, that of a peculiar decline and degeneration. The Americans are not a wild race, they are a race run wild and degraded." To students of civilisation (myself for example) Dr. Martius' views have been most embarrassing. It was not strange that the theory of savages being the degraded offspring of primeval civilised men should have been advocated by Archbishop Whately, who did not even take the trouble to examine his own evidence. Nor is it surprising that the Bishop of Ely, in the "Speaker's Commentary," should still appeal to Whately as an unrefuted authority, for one hardly expects an orthodox commentator to test the arguments on his own side. But the case with Dr. Martius was quite different. Here was an eminent ethnologist, intimately acquainted with savage thought and life, declaring that it seemed to him not to indicate natural wildness, but to show traces of decay from an ancient higher culture. What made the matter more puzzling, was that Dr. Martius, in his researches, had come upon facts which he acknowledged to be evidence of progress taking place from savage toward civilised institutions. Thus, among the forest tribes of Brazil he found the rudest form of the "village community," with its tribe-land common to all, but the huts and patches of tilled ground treated as acquired private property, not indeed of individuals, but of families. It was manifest that these tribes were passing through stages of that very development of the law of real property which is so clearly shown in the history of European law. This is a strong argument in favour of the development-theory of civilisation, but how could an ethnologist who understood the force of such arguments, remain an upholder of the degeneration-theory?

Dr. Peschel considers that he did not so remain, but had changed his opinion when, nearly thirty years later, he wrote as

follows as to the tribes of the vast region of the Amazons. "There are as yet no grounds for considering that the present barbaric condition in these districts is secondary, that any other higher social condition had ever here preceded it, that this swarming-ground of ephemeral unsubstantial hordes had ever been the theatre of a cultured nation."* It is to be noticed, however, that this passage does not seem necessarily to involve a recantation by Dr. Martius of his former opinion. He leaves it quite open that the tribes of the Amazons, though they did not degenerate in this region from civilised ancestors, might have done so elsewhere, and then migrated as savages into the forest regions where as savages they remain. The context may on the whole favour this view of his meaning. Now this matter quite deserves further looking into. It would be well worth while if Dr. Peschel, from personal or published sources available to him, would settle once for all the question whether the great Bavarian ethnologist continued through life the degenerationist that we in England suppose him to have been. Some twenty years ago, Dr. Prichard ("Natural History of Man," 1843, p. 497), citing Martius as to this very matter of the supposed fall of the South American tribes from an original higher state, remarked that "had he taken a more extensive survey of the nations of the whole continent, his opinion might have been somewhat modified." As Dr. Martius did take the more extensive survey thus recommended, it would be particularly curious to ascertain whether it did have the effect thus foretold on his mind.

EDWARD B. TYLOR

* Martius, "Beiträge zur Ethnographie Amerikas," vol. i. p. 375. The other passages here referred to will be found in the same volume, pp. 5, 83.

Flight of Birds

ALLOW me to return thanks to such of your correspondents as have been kind enough to notice the query (vol. viii. p. 86) on this subject which I made through your columns.

As the matter seems to have excited some little interest perhaps you will permit me to state in what respect the solutions proposed appear satisfactory.

That an "upward start" of wind of sufficient velocity would support a bird of given weight and surface of resistance is no doubt the case. As in still air a bird, by holding its wings in a plane slightly inclined to the horizontal, will glide with a velocity which ultimately becomes uniform, in a straight line obliquely downwards, so the same bird in the same position, but in a current slanting upwards in a like direction and with a like velocity, must remain at rest. Nevertheless there are difficulties in the way of thus explaining the phenomenon.

(1) It supposes the existence of air-currents of greater rapidity and at a greater angle of elevation than are likely often to be met with. Taking the number of square feet in the whole resisting surface of the bird to be equal to the number of pounds in its weight, then a *vertical* current of 15 miles per hour would be required to support a bird with its tail and wings fully unfurled but motionless, and a current of 30 miles per hour would be required if the current ascended at an angle of 30° with the horizon. Now wind directed upwards by encountering the side of a mountain is not likely to be inclined at a greater angle than this, which is the average slope of a very steep mountain side, and moreover the phenomenon of hovering without wing motion may be observed where such rapid currents have no existence.

(2) The phenomenon is sometimes observed where it is almost impossible to suppose the existence of any upward air-currents whatever. The first time it attracted my attention was in the neighbourhood of London, towards Finchley Common, where it will, I think, be admitted that there is nothing in the natural configuration of the ground to determine an upward current of sufficient velocity to produce the required effect. The wind at the time was certainly not boisterous, but as the bird was at a considerable elevation there is still room to imagine that the upper currents in which it was situated might be different from those below. I was informed at the time that the bird in this case was a kite; this may have been an error, as I understand that kites are now rarely seen near London. However this may be I should gladly hear from such of your correspondents as have the opportunity of watching the motions of the kite as to whether the position of motionless hovering, which I believe this bird continually assumes, can be explained always by the existence of upward currents. I do not of course deny but what birds, while hovering, avail themselves of upward currents where they can. If the position is the result of considerable though imperceptible muscular action they would naturally seek to economise their strength as far as possible by availing themselves of whatever support they could get from upward wind currents.

As your correspondent, J. Herschel, implies, it is difficult to dissociate the hovering and the soaring of birds. That birds soar, that is, that they continue suspended in the air for long periods of time together, in rapid motion, with no further apparent movement of the wings than is necessary to guide them, and this under circumstances where it is obviously impossible for them to avail themselves of upward air slants, cannot be denied. Whoever has made the voyage to the Cape must have observed this in the case of the albatross. This bird appears to rise from the sea with great difficulty and with the expenditure of much wing power; but, being once fairly launched in the air, its flight becomes a most inexplicable phenomenon. In the open ocean, during a steady wind, it soars for hours about a ship going at the rate of six or eight knots an hour, without apparent difficulty, and with no further wing motion than seems necessary to guide it, now skimming the water in the wake of the ship, now sweeping round to the side or in front, rising and falling by what has been well described as an apparent act of volition, and with no perceptible loss of velocity. Now I think it must be admitted that the motionless hovering and the soaring of birds are phenomena closely allied to each other, that no explanation of the one is satisfactory which does not explain the other also, and that, as the theory of upward slants cannot possibly explain the soaring of birds, it cannot be accepted as a satisfactory explanation of their hovering.

Besides the "upward air slant" theory, a correspondent of one of your contemporaries refers me to the Duke of Argyll's "Reign of Law" under the supposition that the matter is fully explained in the third chapter of that work. I only refer to this to point out the curious example it furnishes of fallacious reasoning. The author obviously thinks that, by a proper arrangement of its wings and tail and the position of its body, a bird can without muscular exertion remain suspended in a horizontal air-current, *provided the latter be of sufficient velocity* (see p. 170). This of course requires no refutation; but the whole of the chapter in which it occurs may be read with interest as illustrating the curious mistakes a clever and earnest amateur will fall into in writing on even the most elementary scientific subjects in which he has had no exact training.

F. GUTHRIE

Graaff Reinet College, Cape Colony

An Optical Delusion

THE following is an optical delusion which is none the less interesting for being very easily explained.

Let a person standing before a looking-glass look attentively at the reflection of the pupil of one of his eyes, and then at that of the other—let him look at different *parts* of the eye, and from one eye to the other, first at one and then at the other. Knowing that in thus changing the direction of his gaze his eyes *must* move about in their sockets he will expect to see that they do so in the glass. As a fact *they will appear perfectly still.*

If he looks at the eyes of another person trying the experiment, the peculiar fixedness of his own will be still more striking, when he looks at them again.

I will not spoil the riddle by giving the answer at the end.

J. H.

Longevity of the Carp

CAN any of your readers give any well-ascertained proof of the length of life attained by the carp? When residing as a youth at St. Germain, I was told by an aged Legitimist that his father had watched the same carp throughout the whole of his life, and the son asserted that he had known the identical fish for twenty and thirty years after his father's death, thus giving to them an age of from sixty to seventy years. That remarkable statement is more than substantiated by Lady Clementina Davies, who, in "Recollections of Society" (p. 49), alludes to the longevity of the carp in the moat of the Château de St. Germain, one bearing in his gills a ticket proving him to be over 200 years of age; and others at Versailles, bearing silver rings through their gills with the name of the courtier who had inserted it, and testifying to an almost incredible longevity. What amount of truth may we attribute to these statements?

Croydon, Surrey, June 13

ROBT. RODOLPH SUFFIELD

LE GENTIL'S OBSERVATION OF THE TRANSIT OF VENUS

AS all the world is now thinking of the transit of Venus, an episode of old time in connection therewith should be very interesting.

In a series of articles by M. W. de Fonvielle in *La Nature*, from which the accompanying illustration is taken, some interesting facts are given concerning Le Gentil's observations of the transit of Venus in the open sea about the middle of last century. These we reproduce here with some supplementary information from Le Gentil's own interesting work referred to below. His voyages extended altogether from 1760 to 1771. They consequently commenced before the transit of 1761, and were continued after that of 1769.

The expeditions of Le Gentil, the account of which, published by the royal press, fills two magnificent volumes, have left an ineffaceable mark upon the history of astronomy. His work is a proof that a man of energy and perseverance who sets himself to the solution of a great and beautiful problem can find, in spite of all obstacles, the means of immortalising himself. Posterity certainly owes some indemnification to the indefatigable astronomer, since his determination to solve scientific questions was undoubtedly prejudicial to his interests, and even to his love-affairs.

A pupil of De l'Isle, Le Gentil was intended for the church by his family, whose home was at Coutances, where he was born Sept. 12, 1725; but his attachment to Mlle. Potier, belonging to one of the richest families of Cotentin, made him give up all idea of so very celestial a profession. A happy marriage, contracted in 1771, after eleven years of absence, enabled him to triumph over his enemies, who had taken advantage of his being far away to fill up his place in the Academy of Science, and against his

Transit of Venus observed on the open sea by Le Gentil in 1761.

relations, who had attempted to take possession of his property; he had to go to law to make them give up what they had taken. His death, which had been announced so often, was very nearly becoming a reality, for he was seized by a dangerous malady, which would have carried him off but for the affectionate care of his wife.

The Duc de la Vrillière, Minister of State, entrusted with the distribution of *lettres de cachet*, was then Director of the Academy. Le Gentil, having received from his bureau the orders of the King, embarked in 1760 for the Isle of France, on board the *Berryer*, a vessel of the Indian Company, which carried fifty guns, and sailed in company of the *Comte-d'Artois* of sixty-four. On July 10 he arrived at the Isle of France. Le Gentil resolved to proceed to Rodriguez, where he did not know that Canon Pingré, who had left Paris after him, had arrived, to execute a mission which he had received from the Academy. The two astronomers would have unexpectedly met on that island, then almost a desert, if Le Gentil had not found at the Isle of France the *Sylphide*, a frigate sent to the help of Pondicherry, Le Gentil's original destination. He, full of ardour, did not hesitate to embark on board of this vessel. But the winds were adverse to the expedition, and the *Sylphide* wandered from March 25, 1761, to May 24, the sport of calms and of the irregular winds of the north-east monsoon. On May 24, when off the coast of Malabar, Le Gentil learned that Pondicherry had been taken by the English. It was then necessary to return to the Isle of France, where the *Sylphide* arrived only on June 23, after having touched at Point de Galle on May 30.

It was between these two stations that Le Gentil observed the transit of Venus, of which the following is his description, stripped of all extraneous details:—

"To observe the entry of Venus I employed an excellent objective of 15 ft. (French) focus, fixed to a tube composed of four pine planks which I had made sufficiently solid without being too heavy. To work it I got a

small mast with a halliard fitted on the port quarter-deck. I saw that it was useless to attempt to notice the first moment of the entry of Venus, for I did not want to fatigue myself and run the risk of not being able to observe the total immersion. Indeed, I had sufficient trouble to fix the sun, on account of the movement of the ship.

"When Venus had half entered, or nearly so, on the disk of the sun, which I recognised by my reflecting quadrant, I attached myself, so to speak, to the telescope of 15 ft. to try to catch the moment of total entry. As my watch was none of the best, and as I could not take the height of the sun precisely at the moment when Venus appeared to me to be totally immersed, it occurred to me to make use of the sand-glass, by means of which the way of the vessel was measured, and I had by my side a man well up to turning the glass at the instant in such a way that it was impossible to have an error of more than a quarter of a second each time.

"The weather having become overcast, and the rain having shown itself, I did not think it would be possible to notice the exit of Venus. Consequently I did not cause the mast to be changed, as I ought to have done, for we had tacked since half-past 11.

"At 2 o'clock it cleared a little, and shortly after the weather cleared so that I could see Venus very distinctly with my green objective, and without the help of any other coloured glass, and I was not incommoded. I saw, from this observation, that it was not impossible for a person used to the movement of a vessel, and accustomed to the use of large instruments, to observe, especially when the sea is calm, the immersions of the satellites of Jupiter with a telescope of 12 or 15 ft., which would have a large field, and to determine the time of those immersions in the above manner; for I believe myself safe in asserting that I did not make from them from 15 to 20 seconds in time of error on an immersion of the first satellite of Jupiter."

The observations made under these extraordinary circumstances, give for the total immersion of Venus, 8h. 27m. 56½s.; the commencement of the exit, 2h. 22m. 53s.; the total exit, 2h. 38m. 52½s., which gives for the duration, 6h. 10m. 55¾s., and for the time taken by the diameter to cross the limb of the sun, 15m. 59s. As M. de Seligny had observed at the Isle of France the exit of Venus, Le Gentil formed, for the meridian of his observation, 88° 20′ 15″. The log-book gave 87° 14′ 0″.

As there was to be another transit of Venus on June 3, 1769, Le Gentil resolved to spend eight years in the southern hemisphere in wait for it. He had the devotion to carry this resolution into effect, spending his time in making a series of curious and interesting observations in the Mascarene Islands, Madagascar, Marianne Islands, the Philippines, and the coasts of India. He had fixed on Manilla as his place of observation, and reached it about August 1866, but he was ordered to return to Pondicherry. By what must seem a cruel fatality, this patient devotee of science, when the day of the Transit arrived, found his view of the sun completely shut out by clouds during the whole phenomenon, although for many days previous the sky had been cloudless. On the other hand, two friends whom he had left at Manilla were fortunate enough to witness the transit without obstruction. Le Gentil died on October 22, 1792.

ON THE TEMPORARY FADING OF SOME LEAVES WHEN EXPOSED TO THE SUN

FOR some time past I have taken much interest in this subject, since it at first seemed to indicate that chlorophyll in living plants could be decomposed by light in the same manner as when dissolved out from them by alcohol or other solvents. It also seemed to agree with the fact which I had established by comparative quantitative analysis, that leaves grown much exposed to the sun contain a relatively less amount of chlorophyll than those somewhat more shaded, in some cases even only one-third the quantity. My attention was first called to a diurnal change in the colour of a kind of moss commonly grown in hothouses, by Mr. Ewing, of the Sheffield Botanical Gardens, and subsequently to a similar change in a tropical species of maiden-hair fern, by Dr. Branson of Baslow. In both cases the colour of the fronds, after the darkness of night, was deep green, but after exposure to the bright sun of day it was a far paler and whiter green, which was again restored by the subsequent absence of light. I was particularly anxious to ascertain whether this change was due to a diminution in the amount of chlorophyll, but was unable to detect any well-marked difference by careful comparative quantitative analyses. I therefore came to the conclusion that, at all events in the case of the moss, the change in colour was due to some sort of mechanical alteration in the structure of the fronds, but did not examine the question more fully. The true explanation appears to be that adopted by Prillieux, who describes his observations in *Comptes Rendus*, t. lxxviii. p. 506. According to him and to the previous experiments of Famintzin and Borodin, exposure to bright light causes both granular and amorphous chlorophyll to collect together at the sides of the cells, instead of being more evenly distributed. The result of this is that a much larger relative proportion of white light is reflected, and the leaves or fronds appear of a paler and whiter green. These conclusions are thus in perfect agreement with my own quantitative analyses, and we may, I think, look upon this combined evidence of two independent methods as furnishing a satisfactory explanation of the greater part, if not of the whole, of the temporary change in colour.

H. C. SORBY

THE COMET

AFTER a very unusual amount of difficulty in the determination of the orbit I have succeeded in deducing a set of parabolic elements which appear to possess considerable precision. They are as follows:—

Perihelion passage, July, 8·83652 Greenwich M.T.

	° ′ ″	
Longitude of Perihelion ...	271 3 51·5	Mean equinox
,, Ascending node ...	118 43 25·5	July 0
Inclination to ecliptic ...	66 21 16·0	
Log. Perihelion distance ...	9·8298719	

Motion direct.

Our last observation, a very good one, gives this position:—

June 22, at 10h. 4m. 21s. M. T. at Twickenham.

R.A. ... 7h. 21m. 58·05s.

D. ... + 68° 9′ 34″·5

which compared with the above orbit (parallax and aberration allowed for) shows only the following insignificant differences—in R.A. − 2″; in D. + 14″.

This close agreement with parabolic motion is not favourable to identity of the comet with that of 1737, notwithstanding similarity of elements, but we must look to observers in the southern hemisphere to enable us to decide this point. The comet may certainly be there observed till October or November in the Antarctic circumpolar heavens.

The subjoined ephemeris will suffice to indicate the course of the comet, while it continues visible in our latitudes:—

AT GREENWICH—*Midnight.*

	R.A.	N.P.D.	Distance.	Intensity of light.
	h. m.	° ′		
June 25	7 27·3	22 33	0·816	2·4
27	7 30·6	23 11	0·769	2·8
29	7 33·7	24 3	0·721	3·3
July 1	7 36·5	25 10	0·673	3·9
3	7 39·1	26 34	0·624	4·6
5	7 41·3	28 24	0·575	5·5
7	7 43·2	30 46	0·528	6·6
9	7 44·8	33 48	0·482	7·9
11	7 46·2	37 39	0·437	9·6
13	7 47·5	42 30	0·396	11·5
15	7 48·6	48 33	0·359	13·7

I have assumed the intensity of light on June 13 = 1.

The orbit of the comet makes a very close approach to that of the planet Venus. My last elements indicate for least distance of orbits . . 0·011.

For calculation of places after July 15 the following expressions for the comet's heliocentric co-ordinates referred to the equator, will be useful, in conjunction with X, Y, Z, of the *Nautical Almanac.*

$$x = r\,[9{\cdot}77492]\sin(v + 26^\circ\ 8'{\cdot}5)$$
$$y = r\,[9{\cdot}98665]\sin(v + 276^\circ\ 17'{\cdot}1)$$
$$z = r\,[9{\cdot}92408]\sin(v + 176^\circ\ 54'{\cdot}5)$$

J. R. HIND

Mr. Bishop's Observatory, Twickenham, June 23

The following additional information is taken from a letter by Mr. Hind in yesterday's *Times*:—

"The comet will be nearest to the earth on the night of July 22, its distance being then less than 0·3.

"Last night at 11.30, the moon being yet above the horizon, the comet appeared to be in the least degree fainter than the star Upsilon, Ursæ Majoris, which Argelander estimates rather higher than the fourth magnitude. In the strongly illuminated sky of these midsummer nights it was very sensibly brighter than the neighbouring stars 42 and 43 Camelopardi. By measures of the nucleus taken with the filar-micrometer, it appeared to be rather more than 4,000 miles in diameter, and the tail, assuming it to be projected from the nucleus in the line of the radius-vector, would be 4,000,000 miles in length.

"During the first fortnight in July the comet will undoubtedly be a pretty conspicuous object in the constellation Lynx, where there are few bright stars.

"At the end of September its brightness, by theory, should be the same as on the night of discovery (April 17), and it will then be well observed in the southern hemisphere, in the neighbourhood of the star Alpha Chamæleontis."

MR. HIND, in a letter with which he has favoured me, lays great stress upon the star-like appearance of the nucleus of the comet now visible, as seen in a telecope; and M. Rayet has already, in a communication to the Paris Academy, shown that its spectrum is continuous, that of the coma giving the three ordinary cometary bands. On Monday evening last the comet was bright enough, in spite of the moonlight, to enable me to observe this continuous spectrum with my 6¼ inch Cooke and a pocket spectroscope. It struck me that the spectrum was short, *i.e.* that it was deficient in blue rays; and as one saw in the telescope a fan-like structure above the nucleus (as seen in an inverting telescope), so also in the spectroscope, the continuous spectrum sparkled as if many short bright lines or bands were superposed upon it. I shall be glad to learn that other observers with more powerful instruments have had their attention directed to these two points.

J. NORMAN LOCKYER

NOTES

ON the 3rd inst. the corner stone of the American Museum of Natural History in New York was laid by the President of the United States. The ground belonging to the Museum measures about eighteen acres, and the building when completed according to plan will be larger than the British Museum. The object of the Museum is twofold:—First to interest and instruct the masses; and secondly, and specially, to render all possible assistance to specialists. The library presented to the Museum by Miss Wolfe, with a large collection of shells, also donated by Miss Wolfe to the Museum in memory of her father, who was its first President, was purchased by her at a cost of 35,000 dols. The other collections at present in the temporary Museum are valued at 250,000 dols. A rare and newly complete series of American birds, and many fine birds of Paradise and pheasants, now in the collection formerly belonging to Mr. D. G. Elliott, will be added. The Trustees have purchased the collection of Prince Maximilian, of Neuwied, on the Rhine, and a large number of specimens belonging to the late Edward Verreaux, of Paris. Large donations of shells, corals, and minerals, have been received, as also a collection of 20,000 insects. The collections will be bought and cared for by moneys contributed by the Trustees individually and the public, but the building now in progress will be erected at the expense of the city, which has already appropriated 500,000 dols. for this purpose.

Prof. Joseph Henry of the Smithsonian Institution gave an address on the above occasion, in which he spoke as follows on the necessity of endowing scientific research:—"The development of the institution would not be completed were it furnished with all the appliances I have mentioned. There is another duty which this city owes to itself and to the civilisation of the world. I allude to an endowment for the support of a college of discoverers and a number of men capable not only of expounding established and known truths, but of interrogating nature and discovering new facts, new phenomena, and new principles. The blindness of the public to the value of the abstract sciences and the matter of endowments of colleges for their support is remarkable. It is not everyone, however well educated he may be, that is capable of becoming a first-class scientist. Like poets, discoverers are born, not made, and when one of this class has been found he should be cherished, liberally provided with the means of subsistence, fully supplied with all the implements of information, and his life consecrated to the high and holy office of penetrating the mysteries of nature. What has been achieved in the knowledge of the forces in operation in nature, and the uses to which it is applied in controlling and directing these forces to useful purposes, constitutes the highest claim to the glory of our race.'

THE Duke of Devonshire, speaking at the banquet at Trinity College, Cambridge, on the 17th inst., said it had fallen to his lot during the last three or four years, while acting on a Royal Commission for inquiring into Scientific Education and the Advancement of Science, to become acquainted with the development and extension of scientific teaching in the several Universities of the kingdom, and of learning the views of those best qualified to express an opinion as to the requirements remaining to be supplied. The result of the inquiry had been satisfactory, inasmuch as it showed that a great deal had been done in the direction indicated, and that University authorities had manifested a strong desire that the Universities should be provided with all appliances necessary not only for centres of scientific education, but as centres also of general intellectual activity and of original research. This latter point was strongly insisted on in the evidence before the commissioners, and received their concurrence. A University which recognised the advancement and extension of knowledge as one of the main purposes of its existence was surely to be regarded as of a higher and nobler type than one which was satisfied with the position of a mere educational body. There was nothing antagonistic in these two objects; on the contrary, great advantage might be derived from their combination.

THE Emperor of Austria has been pleased to confer upon Mr. Robert H. Scott, F.R.S., the Director of the Meteorological Office, the Order of the Iron Crown, Third Class.

DR. TOLOZAN, physician to the Shah of Persia, has been elected a corresponding member of the French Academy in the section of Medicine and Surgery, and M. Studer of Berne in that of Geology. The latter is a veteran of 79 years.

THE organisation of the French National Observatory will

very soon be complete, *Les Mondes* says. The French Government have voted 30,000 francs to the meteorological department, and M. Le Verrier is about to resume the work of international meteorology, with the fixed intention of abandoning local meteorology to the departmental observatory of Mont-Souris. M. Le Verrier is at present in this country, having come over to get his Cambridge degree conferred. He is to visit Newcastle, to inspect Mr. Newall's large telescope, and Edinburgh and Glasgow in connection with meteorology. The printing has been begun of a very large catalogue of stars observed at the Paris Observatory. MM. Fizeau and Cornu are measuring anew the speed of light under conditions which encourage us to look for a definite result.

THERE will be ample opportunities for practical work in Natural Science during the long vacation (July and August) at Cambridge. The laboratories of Experimental Physics, of Chemistry and Physiology, will be open, and the professors, or the demonstrators, or both, will be in attendance to give assistance to students. Prof. Newton has given notice of a practical class for Comparative Anatomy; and Prof. Humphry has given notice of a practical class for Human Anatomy (more particularly Osteology), and also for Histology.

THE Rev. S. J. Perry, the head of the expedition sent out by the Admiralty to observe the transit of Venus, together with Lieut. Coke, R.N., Paymaster Brown, R.N., and the Rev. W. Sidgreaves, were among the passengers by the steamer *Windsor Castle*, which left Dartmouth on Tuesday for the Cape of Good Hope.

THE *conversazione* of the Society of Arts held in the South Kensington Museum last Friday was a great success. It is said there were about 3,500 guests present.

AT the annual meeting of the Palestine Exploration Fund, Lieut. Conder, R.E. (officer in charge of the survey of Palestine), described the work of the expedition. Before leaving Palestine he had completed half the map, and it was expected that within four years, instead of eight, the whole of Palestine would have been surveyed. There were now 300 square miles added to the map, being five times the result at first expected to be accomplished.

THE discovery of a new planet by Mr. Perrotin, of Toulouse, is announced.

AT the half-yearly meeting of the Highland and Agricultural Society of Scotland, a long discussion took place in reference to the filling up of the vacancy in the chemical department, as also on the proposal for granting bursaries with a view to the encouragement of agricultural education throughout the country. It was ultimately agreed to remit the matter back to the directors, with instructions to inquire as to the amount of funds that could be placed at their disposal for the educational and chemical departments. A motion for memorialising Government on the propriety of establishing agriculture as a branch of the system of physical science taught under the superintendence of the Department of Science and Art, and proposing that the Society offer a premium for the best text-book for such a course, was adopted.

IN reliance on the receipt of further subscriptions to prosecute the Sub-Wealden Exploration, it has been decided to continue the boring to a farther depth of 200 ft. The hon. secretary has offered to become personally responsible to the Diamond Rock Boring Company for the cost of the extra 200 ft. His offer has been accepted, and he has been requested to issue another appeal for subscriptions. In doing so he urges upon "all who like to be considered generous, enlightened, wise, and good, to vie with each other in contributing to complete this the first boring for scientific purposes in England."

AT the Anniversary Meeting of the Royal Geographical Society on Monday it was stated that there had been an increase of 342 new membering and 9 honorary corresponding members; the Society now numbers 2,900 Fellows. In accordance with the announcement already made, the Founder's Gold Medal was presented to Dr. Georg Schweinfurth, in whose absence it was received for him by the German Ambassador Count Münster; and the Victoria (or Patron's) Gold Medal, which had been awarded to Col. P. Egerton Warburton, for his journey across the previously unknown part of Western Australia, was received by his nephew, Mr. Bateman. Mr. Francis Galton, F.R.S., then introduced the successful competitors for the annual geographical medals. A gold medal for physical geography was awarded to Louis Weston (City of London School), and a bronze medal for the same subject to Francis Charles Montague (University College School). For political geography, a gold medal was gained by W. H. Turton (Clifton College, Bristol), and a bronze medal by Lionel Jacob (City of London School). The president, Sir Bartle Frere, then delivered his address on the progress of geography, and announced as his successor in the presidential chair, Major-Gen. Sir Henry C. Rawlinson, K.C.B. Medals were also given to Chumah and Susi, two of Livingstone's black servants, who brought his MSS. to England. The Rev. H. Waller stated they were of invaluable aid to Mr. T. Livingstone in editing the MSS., both from their accurate knowledge of the country and their intelligent comprehension of the maps. At the anniversary dinner in the evening, among those who were present and who spoke were M. Leverrier and Chief-Justice Daley, President of the American Geographical Society.

THE fourth part of Tryon's "American Marine Conchology" has made its appearance, with eight coloured plates, and embracing the family of the *Chitonidæ*, of which six species are indicated, the orders *Opisthobranchiata* and *Pteropoda*, the commencement of the class *Acephala*, beginning with the *Pholadidæ*. The work was commenced early in 1873, and if it be confined to the five or six parts originally proposed, will soon be brought to a completion.

AT the annual distribution of the prizes in connection with the Newcastle College of Physical Science, on the 17th inst, the address of the Dean was, on the whole, very hopeful. The number of students has not greatly increased, but the quality of the work done has advanced considerably. We regret to see that the evening classes have not been so great a success as was hoped; but we hope the professors will not be easily induced to discontinue them, but will take every means to let their advantages be known to the young men of the district. During the past year the facilities of the college for imparting knowledge has been very much increased. The laboratory has been extended; a large and valuable collection of minerals has been added to Dr. Page's museum; and several expensive instruments have also been added to Mr. Herschel's collection. It is hoped that very soon a Chair of Biology will be established in the University. Arrangements have been made by which the degree of B.Sc. will be conferred on any deserving student by the University of Durham; and we are glad to see that the requirements for this degree have been made very considerable. Arrangements have also been made by which the college will be fully represented in the Senate of Durham.

A GEOLOGISTS' FIELD CLUB was instituted at Halifax at the close of the University lectures (Cambridge extension scheme) last April. The excursions which had been made from time to time with Mr. Sollas, B.A., made the students wishful to keep them up; hence the formation of a club which numbers about

ninety members. The proceedings are reported in the local papers, and judging from the programme sent us the club means to go in for hard and earnest, and we hope fruitful, field-work.

It gives us much pleasure to see from a recent number of the *Dunstable Borough Gazette* that that paper devotes a fair amount of space to science, under the title of "Our Science Column." The number before us, June 17, contains a good popular article on the value of scientific knowledge, some meteorological data, and an original communication on the botany of Dunstable, being the continuation of a list of plants of the district, with their common and scientific names. We hope the editor will continue his science column, and make it a means of enlightening his readers, and that the number of provincial papers which have a "Science Column" may go on rapidly increasing.

The *Gardeners' Chronicle* learns that a committee has been formed, and funds are being collected, for the much needed restoration of Selborne Church as a memorial to Gilbert White. It is also proposed to erect a Cross to his memory on the "Plestor." It is hoped that a sufficient sum will be raised, beyond what will be required for these objects, to found an exhibition to one of the colleges at Oxford, with which he was connected, to be called the "Gilbert White" Exhibition. It is calculated that at least 5,000*l*. will be required. The committee includes the names of the Right Hon. Lord Selborne, the President and Fellows of Magdalen College, Oxon; Prof. Bell, F.R.S., &c.; the Rev. F. Parsons, Vicar of Selborne, and others.

At a special meeting of the Anthropological Institute, to be held at Bethnal Green Museum, on July 1, Col. Lane Fox will give an Address on the principles of classification in his anthropological collection.

Dr. Lea has added another volume to his large work on the Unionidæ, illustrated by twenty-two lithographic plates.

A proposal has been made in the *American Chemist* that a centenary meeting should be held on August 1 to commemorate the discovery of oxygen by Priestley on August 1, 1774. The *American Journal of Science and Arts* points out that this would afford an opportunity to discuss interesting chemical topics and to review the progress made during the century.

On Wednesday the 17th the President of the Geological Society held an inaugural reception of the Fellows in their new apartments at Burlington House, to which many ladies were also invited. Although the meeting-room has been in use for a few weeks, and the removal of the library from Somerset House has been completed, the removal of the museum has but just commenced, and as the collections are so extensive it will occupy many weeks.

The Statistical Society will hold its Fortieth Anniversary Meeting on Tuesday, June 30, at 3.30 P.M.

A project has been set on foot to provide Bridlington Quay with a marine aquarium. It is estimated the work will cost about 5,000*l*., towards which several gentlemen in the locality have promised to subscribe. The affair will probably take the shape of a limited liability company.

The additions to the Zoological Society's Gardens during the last week include two Huanacos (*Lama huanaco*) and a Patagonian Cavy (*Dolichotis patachonica*) from Patagonia, presented by Mr. W. G. Parry; a Common Racoon (*Procyon lotor*) from North America, presented by Mr. T. Taylor; a Bonnet Monkey (*Macacus radiatus*) from India, presented by Mr. Wood; two Blue-cheeked Barbets (*Megalæma asiatica*) and two White Cranes (*Grus leucogeranos*) from India; a Honey Buzzard (*Pernis apivorus*), European, purchased; a Malay Tapir (*Tapirus indica*) from Malacca, deposited.

CONFERENCE FOR MARITIME METEOROLOGY

The Sub-committee for Maritime Meteorology appointed by the Permanent Committee of the Vienna Congress have determined to hold a private conference on the subject in London, to commence on Aug. 31. The meetings will be held, by permission of the meteorological committee, at the Meteorological Office, 116, Victoria Street, London, S.W. The invitations are to be issued this week, and the following is the Programme of Questions to be discussed. I may say that I have already received replies to the circular respecting the Brussels Conference from all the countries to which it was addressed.

Robert H. Scott,
Secretary to the Sub-Committee

A general wish has of late been expressed that the measures for the prosecution of Maritime Meteorology proposed at the International Conference at Brussels in 1853 should be reconsidered, now that the experience of more than twenty years of the operation of these measures has enabled meteorologists to form opinions as to their utility.

At the Meteorological Conference at Leipsig in 1872, and again at the International Congress at Vienna in 1873, preliminary discussions took place on the subject of the more successful prosecution of Ocean Meteorology. Certain resolutions were adopted at Leipsig and confirmed at Vienna, and accordingly it seems proper to embody them in the present programme. They run as follows:—

"1. Thorough uniformity in methods and instruments should be aimed at in the same measure as for observations on shore. This will be most satisfactorily obtained by the chiefs of the central institutes—the establishment of which in all countries in which they do not already exist, and in which the maritime interests demand them, must be declared as absolutely necessary—entering into relations with each other and agreeing on the separate details, the construction of the instruments, the hours of observation, the journal, &c.

"2. Unity of measures and scales is desirable, and to this end the introduction of millimetres for the barometer and the centigrade scale for the thermometer should be aimed at. While, however, the comparison of standard instruments of the individual central stations must be insisted on, the uniformity of scales is at present only declared as desirable.

"3. The Committee would urge the importance of the co-operation of the navies, inasmuch as by their assistance, and by the opportunities afforded thereby of completeness in certain observations, the determination of factors and constants is rendered possible, which can be used with advantage for the reduction of certain results derived from the general system of observations.

"4. With reference to the utilisation of the results, the Committee would urge similarly the importance of uniformity in the methods employed. In close relation therewith was the carrying out of the division of labour of the central stations of the individual states. This principle must be recognised as of the greatest importance for the further development of Marine Meteorology. The repetition of work over definite regions, with reference to the area to be investigated, must be declared as indefensible in the interests of this development."

It was further resolved—"That the convening of a Maritime Meteorological Conference is desirable."

While accepting the above resolutions as a general expression of the principles which should form the basis of an agreement as to future operations in the field of Ocean Meteorology, the Sub-Committee to whom the negotiations preparatory to the assembling of a Conference have been entrusted, consider that it is advisable to enter more minutely into the details, and have accordingly agreed on the following series of questions:—

In the case of a nation which sent any representative to the Brussels Conference in 1853, a circular should be addressed to the chief of the Office for Maritime Meteorology, if such exist, or to the chief of the meteorological organisation of the country, requesting him to state:—

1. To what extent the resolutions adopted at Brussels have been carried out in this country?

2. What have been the grounds for departure from them, if such departure has taken place?

and to send his reply to the Secretary to the Sub-Committee, Mr. Robert H. Scott, 116, Victoria Street, London, S.W.,

before June 1 next, in order to allow ample time to draw up a report on the replies for consideration at the Conference.

It seems advisable that, as above stated, the action taken at Vienna should be carefully reconsidered under several heads which will now be recapitulated.

I. *Observations.*—In respect of this subject it will be most convenient to take the "Abstract Log" of the Brussels Conference, and to discuss the several subjects of observation therein in the order of sequence of the columns.

Cols.	1 and 6.	Date and position of the observations.—Is it your opinion that a fresh column should be added, headed "Course and Distance by the Log in every Watch of four hours"?
,,	7 and 8.	Currents.
,,	9	Magnetic variation.—Is it desirable to give an additional column for the "Direction of Ship's Head"?
,,	10 and 11.	Wind, direction and force.—Is it possible to employ an anemometer at sea so as to give trustworthy results? Can the use of the Beaufort Scale be made universal?
,,	12 and 13.	Barometer.—To what degree of minuteness is it necessary to observe this instrument?
,,	14 and 15.	Thermometer—Dry bulb and wet bulb.—Should these observations be required from all ships?
,,	16.	Forms and direction of clouds.—Is this column sufficient, or should any notice be taken of more than one stratum of clouds?
,,	17.	Proportion of sky clear.—Is it not advisable to substitute for this heading "Proportion of sky clouded"?
,,	18.	Hours of rain, fog, snow, &c.—Is it desirable to retain this heading, or to substitute for it and No. 23 a column headed—"Weather by Beaufort Notation"?
,,	19.	State of the sea.—Should this be given according to a numerical scale?
,,	20.	Temperature of sea surface.
,,	21.	Specific gravity of sea surface.
,,	22.	Temperature at depths.—Is it desirable to retain these two last columns, or can the observations when taken be inserted in the column for "Remarks"?
,,	23.	Weather. See No. 18.
,,	24.	Remarks.

II. *Instruments.*—What patterns of instruments should be employed for any observations which may require them? Is there a reasonable possibility of introducing the metric and centigrade systems for general use at sea?

III. *Instructions.*—Is it possible to devise a general form of instructions to ensure uniformity in regard of methods of observation and registration?

IV. *Observers.*—What control should be exercised over the observers as to their instruments and registers? Is it desirable that all instruments employed should be the property of the central establishment, and *lent* to the observers?

V. *Co-operation of the Royal Navy.*—To what extent can ships of war assist in forwarding the ends of meteorological inquiry?

VI. *Discussion.*—Can general suggestions be thrown out as to the most profitable mode of discussion of the observations?

VII. *Subjects of Inquiry.*—To what extent can a division of labour as regards subjects of inquiry be carried out in a spirit of fairness to the collecting and discussing establishments respectively?

VIII. *Sailing Directions.*—In how far are purely practical investigations, such as the preparation of sailing directions, admissible for a scientific institution?

Any gentleman into whose hands this programme may come, and who is himself not likely to attend the Conference, is requested to forward any remarks he may wish to make on any of the subjects mentioned herein to Mr. Scott, at the above address, before July 1, 1874.

SCIENTIFIC SERIALS

THE *Journal of the Chemical Society* for May contains the following papers communicated to the Society:—On the action of bromine on alizarin, by W. H. Perkin. Alizarin heated in a sealed tube with a solution of bromine in carbon disulphide yields monobromalizarin, $C_{14}H_7BrO_4$. This latter substance heated with acetic anhydride gives diacetobromalizarin, $C_{14}H_5Br(C_2H_3O)_2O_4$, and with nitric acid a mixture of phthalic and oxalic acids, while free bromine is given off. Specimens of cotton prints showing the difference in the shade of colour produced by alizarin and bromalizarin when used as dyeing materials accompany the paper.—Note on the action of trichloracetyl chloride upon urea, by Raphael Meldola and Donato Tommasi. The authors have obtained trichloracetyl urea $CO \left\{ \begin{matrix} NH(C_2Cl_3O) \\ NH_2 \end{matrix} \right.$.—Researches on the action of the copper-zinc couple on organic bodies. Part V. On the bromides of the olefines; and Part VI. On ethyl bromide, by Dr. J. H. Gladstone and A. Tribe. The couple acts upon dry ethylene bromide, producing ethylene by double decomposition; in presence of alcohol the decomposition is explosive. The action of the couple is the same either in presence of alcohol or water, and the fact that these substances facilitate the action is explained by the authors by the solvent action of these liquids on the film of zinc bromide formed on the surface of the couple. Propylene and amylene bromides are decomposed in a similar manner, yielding the corresponding olefines. With regard to the action of the couple on ethyl bromide the authors are of opinion that ethylobromide of zinc $\left. \begin{matrix} C_2H_5 \\ Br \end{matrix} \right\} Zn$ is always formed, and this on further heating produces zinc ethyl and zinc bromide or two semi-molecules of ethyl may decompose with the formation of ethane and ethylene. In presence of water or alcohol ethane is always produced according to the reactions:—

$$\left. \begin{matrix} C_2H_5 \\ Br \end{matrix} \right\} Zn + H_2O = \left. \begin{matrix} HO \\ Br \end{matrix} \right\} Zn + C_2H_6$$

$$\left. \begin{matrix} C_2H_5 \\ Br \end{matrix} \right\} Zn + \left. \begin{matrix} C_2H_5 \\ H \end{matrix} \right\} O = \left. \begin{matrix} C_2H_5O \\ Br \end{matrix} \right\} Zn + C_2H_6$$

—The agglomeration of finely-divided metals by hydrogen, by Alfred Tribe. Copper, palladium, and platinum in a finely-divided state agglomerate when hydrogenised. By way of hypothesis the author suggests that the minute particles of the metals are surrounded by layers of liquid hydrogen which coalesce.—The last paper is by Andrew Fuller Hargreaves On the spontaneous combustibility of charcoal. The maximum amount of oxygen is absorbed from the atmosphere within three days after carbonisation, so that from that time charcoal may be used for gunpowder without danger, but up to that period spontaneous combustion is liable to occur. About three-fourths of the journal is devoted to foreign abstracts.

Transactions of the Manchester Geological Society, vol. xiii. Part IV.—The papers in this part are the following:—On coal-cutting machinery, by Mr. W. H. J. Traice; Additional notes on the millstone grit of the parish of Halifax, by Mr. James Spencer; On Permian and Trias, by Mr. E. W. Binney, F.R.S.,; On Pleistocene mammalia found near Castleton, Derbyshire, by Mr. J. Plant, F.G.S.

Proceedings of the Geologists' Association, vol. iii. No. 5.—Besides an account of some of the excursions made by the Association during 1873 the number contains the following papers, abstracts of which have been given in our reports of the Society's proceedings:—On some fossils from the Margate chalk, by J. W. Wetherell, with illustrations; On the valley of the Vézère, Périgord, its limestones, caves, and Prehistoric remains, by Prof. T. Rupert Jones, F.R.S.; On ammonite zones in the Isle of Thanet, by F. A. Bedwell. The last-mentioned occupies a large part of the number, and is illustrated.

Bulletin of the Essex (*Salem, U.S.*) *Institute*, vol. iv., 1872.—The principal papers in the *Bulletin* of this very efficient Institute for 1872 are a communication from Mr. S. A. Nelson On the Meteorology of Mount Washington, the main purpose of which is to show the advantages for meteorological purposes mountain-stations offer over those less elevated; and a "Catalogue of the Mammals of Florida, with notes on their Habits, Distribution," &c., by C. J. Maynard.—The *Bulletin* for 1873 contains more papers of scientific interest than that of the previous year.—The first paper is a short one, by Dr. A. S. Packard, On the glacial phenomena of north-east America compared with those of Europe.—There is a short but interesting statement by Mr. J. H. Emerton of the results of his observations on worms of the genus *Nais.*—Mr. S. M. Allen contributes a paper On ancient and modern theories of light, heat, and colour.—Mr. H. Herrick contributes a Partial Catalogue, of con-

siderable length, of the birds of Grand Menan, N.B.—Mr. F. W. Putnam has a paper on the various forms of cutting instruments made of stone.—"Notes on the bird-fauna of the Salt Lake Valley and the adjacent portions of the Wahsatch Mountains," is the title of a long paper by Mr. R. Ridgway, who also contributes a paper on the birds of Colorado, and, along with Mr. S. F. Baird, one on some new forms of American birds.—There are also interesting accounts of the numerous and profitable excursions made during the summer months by the Institute.—There is a very minute account of the celebration of the 25th anniversary of the Institute on March 5, 1873. Many well-known scientific men were present, and among others Prof. O. C. Marsh, who paid the high compliment to the Institute that through its influence the botany and zoology of Essex county were better understood than those of any other county in the United States. It was at the hands of the Essex Institute, he said, that he himself acquired his taste for scientific investigation.

Poggendorff's Annalen der Physik und Chemie, No. 3, 1874.—This number commences with a translation of Dr. Draper's recent paper on photography of the diffraction spectrum (which has already appeared in our columns).—The conductivity of flame for galvanic currents is known to be greatly exalted by presence of metallic vapours, and M. Herwig was led to inquire whether a gaseous layer, entirely formed of such vapours, would not show good conductivity even at low temperatures. He experimented with mercury, dense vapours of which can be had several hundred degrees under white heat. The vapour conductivity he finds to resemble that of the voltaic arc, rather than that of a simple metallic conductor. There is a peculiar transition-resistance, which is great in comparison with the hindrances which the current finds within the vapour-layer itself; so that the total resistance is in great measure independent of the extent of the vapour-layer. The transition-resistance is less with increased electromotive force of battery or strength of current. Further, the vaporisation in the positive mercury surface was increased by the current; another point of analogy to the voltaic arc (in which, if the electrodes be mercury and platinum, the mercury is vaporised only when it forms the positive pole); and, using a platinum point and a mercury surface, the resistance of the vapour (like that of the arc) was greater when the mercury surface was positive.—M. Friedrich Müller concludes his investigation on galvanic polarisation and the distribution of the current in electrolytes. He states that, with copper plates in dilute sulphuric acid, and also in a solution of sulphate of copper mixed with sulphuric acid, the polarisation follows a simple law: it is a linear increasing function of the density of current. Another observation of the author is that cupric oxide is reduced to copper by galvanic hydrogen (confirming previous observations that galvanic hydrogen is considerably more active than ordinary hydrogen).—The galvanic conductivity of sulphuric acid and muriatic acid, and its dependence on temperature, is the subject of a communication from M. Grotrian.—In pursuing his researches on the compressibility of elastic fluids M. Regnault did not experiment with pressures lower than one atmosphere. The difficulty of the inquiry has perhaps deterred physicists since. We here find it undertaken, however, by M. Siljeström, who contributes a paper on the subject; in the first part here given the details of apparatus are fully described, and the numerical results of some sixteen series of experiments tabulated.—M. Schneider communicates a ninth paper on new salts of sulphur, and M. Kessler describes "the simple euthyoptic spectroscope."—Among matter from other journals we note a valuable paper by M. Boltzmann, On experimental determination of the dielectricity constants of insulators.

Astronomische Nachrichten, No. 1,995.—This number contains a large number of observations of position, taken at Leipsig, of some of the minor planets—Comet II. (Tempel), Comet III. (Borelly), Comet IV. (Henry), and Comet VII. (Coggia); also the mean planes of sixty-nine variable stars for the year 1873.—Prof. d'Arrest sends his observations on the position of Coggia's comet, taken during May last.—An astronomical prize is offered by the Academy at Copenhagen for research on the data of the ancients comprised between the time of Ptolemy and the eighteenth century.—The discovery of a new planet is anounced from Toulouse by Mr. Perrotin, May 19, 10 P.M. R.A. 16h. 28m. 30s., D. 22° 48'.—No. 1,996 contains a discussion of the errors of levels due to the change of direction of attraction caused by the spheroidal figure of the earth and other local causes, and Prof. Spoerer gives the results of his sun-spot and protuberance observations for April and May last.

Abhandlungen der Schlesischen Gesellschaft für Vaterländische Cultur, 1872–73.—Dr. Grätzer here furnishes a number of social statistics regarding Breslau gathered from the census made in December of that year. From a comparison with Berlin, the population of which (825,389) was then nearly four times that of Breslau, it appears that Breslau is less crowded; there being in it a dwelling-house to every 38·9 of the inhabitants, whereas in Berlin the proportion is 1 to every 56·9. On the whole it appears that, notwithstanding the better proportion of dwellings in Breslau, the health of the two cities is nearly alike, Breslau having counterbalancing disadvantages in bad buildings, sites, drinking and underground water, and soil.—M. Limpricht contributes a report on the watershed between Weide and Bartsche, with a list of the plants found in that region.

Verh. der k.k. zool. bot. Gesellschaft in Wien, *23ter* Band, 1873.—This volume, of more than 600 closely-printed pages, is chiefly occupied by papers on entomology and botany. Among the most important are:—*Insecta*.—Contributions to the Orthoptera of the Tyrol: Krauss; Diptera collected in Galicia; Hymenoptera: Kriechbaumer; Microlepidoptera of Leghorn, by J. Mann; Contributions to the nocturnal Lepidoptera of North America, by Prof. Zeller (second part) with figures: more than a hundred new species are described; Contributions to the Phryganidæ, by Dr. Hagen of Cambridge, U.S.; Hungarian Diptera: Kowarz; Eight new German species of Diptera: Beling; New butterflies from Asia Minor; On certain species of Tipula and its allied genera: Beling.—*Crustacea*.—On *Lepidurus lubbockii* and the Phyllopoda.—*Vertebrata*.—A graphic account of the breeding and habits of the Pelican on the Danube. Beside *P. onocrotalus* and *P. crispus*, *P. minor* was also found. On *Comephorus baicalensis*, a fish allied to the genus *Cottus*, with two figures: Dybowski.—*Mollusca*.—Contributions to the genus *Aeolidia* and its allies, by Dr. Bergh of Copenhagen.—*Botany*.—Contributions to the flora of Lower Austria, by Von Reuss, jun.; Lichens of the Tyrol, by F. Arnold; Fauna of the Brdygebirg in Bohemia; Fungi of south-east Hungary, by Prof. Harslinsky; The flora of the state districts in the south-east of Lower Austria: Woloszczak; Contributions to the flora of Lower Austria, by Hackel. The volume contains a photographic portrait of the late Secretary of the Society, Ritter von Frauenfeld, with his latest contributions to Entomology and a biographical notice, by Von Wattenwyl.

Reale Istituto Lombardo. Rendiconti: t. vii., Fasc. i. e ii.—These parts contain the following papers:—Prof. Serpieri communicates his observations of the meteor shower of August 10, 1873, made at Urbino.—Observations concerning the constitutions and combinations of bodies, a paper on molecular physics, by Dr. Guido Grassi.—On a fact of importance in silkworm culture, by Prof. G. Balsamo Crivelli.—Prof. Cesare Lombroso tabulates the height and weight, cranial measurements and capacities, facial angle, &c., of 832 Italian prisoners, dividing them into homicides, thieves, highwaymen, incendiaries, tricksters, deserters, &c. These prisoners were Sicilian, Sardinian, Calabrian, Neapolitan, Piedmontese, Genoese, and Lombardian. The results are discussed in great detail.—Prof. Antonio Bucellati contributes a paper on political economy, entitled "On the theory of capital."

SOCIETIES AND ACADEMIES

London

Royal Society, June 11.—Spectroscopic Notes.—On the Evidence of Variation in Molecular Structure, by J. N. Lockyer, F.R.S.

1. In an accompanying note I have shown that when different degrees of dissociating power are employed the spectral effects are different.

2. In the present note I purpose to give a preliminary account of some researches which have led me to the conclusion that, starting with a mass of elemental matter, such mass of matter is continually broken up as the temperature (including in this term the action of electricity) is raised.

3. The evidence upon which I rely is urnished by the spectroscope in the region of the visible spectrum.

4. To begin by the extreme cases, all solids give us continuous spectra; all vapours produced by high tension spark give us line spectra.

5. Now the continuous spectrum may be, and as a matter of fact is, observed in the case of chemical compounds, whereas all compounds known as such are resolved by the high tension spark into their constituent elements. We have a right, therefore, to assume that an element in the solid state is a more complex mass than the element in a state of vapour, as its spectrum is the same as that of a mass which is known to be more complex.

6. The spectroscope supplies us with intermediate stages between these extremes.

(α) The spectra vary as we pass from the induced current with jar, to the spark without the jar, to the voltaic arc, or to the highest temperature produced by combustion. The change is always in the same direction; and here again the spectrum we obtain from elements in a state of vapour, a spectrum characterised by spaces and bands, is similar to that we obtain from vapours of which the compound nature is unquestioned.

(β) At high temperatures the vapours of some elements (which give us neither line nor channelled-space spectra at those temperatures, although we undoubtedly get line spectra when electricity is employed, as stated in No. 4), give us a continuous spectrum at the more refrangible end, the less refrangible end being unaffected.

(γ) At ordinary temperatures, in some cases, as in selenium, the more refrangible end is absorbed; in others the continuous spectrum in the blue is accompanied by a continuous spectrum in the red. On the application of heat the spectrum in the red disappears, that in the blue remains; and further, as Faraday has shown in his researches on gold-leaf, the masses which absorb in the blue may be isolated from those which absorb in the red. It is well known that many substances known to be compounds in solutions, give us absorption in the blue or blue and red, and also that the addition of a substance known to be compound (such as water) to substances known to be compound which absorb the blue, superadds an absorption in the red.

7. In those cases which do not conform to what has been stated the limited range of the visible spectrum must be borne in mind. Thus I have little doubt that the simple gases at the ordinary conditions of temperature and pressure have an absorption in the ultra-violet; that highly compound vapours are often colourless because their absorption is beyond the red, with or without an absorption in the ultra-violet. Glass is a good case in point; others will certainly suggest themselves as opposed to the opacity of the metals.

8. If we assume in accordance with what has been stated that the various spectra to which I have referred are really due to different molecular aggregations, we shall have the following series, going from the more simple to the more complex.

First stage of complexity of molecule.	Line spectrum.
Second stage	Channelled-space spectrum.
Third stage	Continuous absorption at the blue end, not reaching to the less refrangible end. (This absorption may break up into channelled spaces.)
Fourth stage	Continuous absorption at the red end, not reaching to the more refrangible end. (This absorption may break up into channelled spaces.)
Fifth stage	Unique continuous absorption.

9. I shall content myself in the present note by giving one or two instances of the passage of spectra from one stage to another, beginning at the fifth stage.

From 5 to 4

1. The absorption of the vapours of K in the red-hot tube, described in another note, is at first continuous. As the action of the heat is continued, this continuous spectrum breaks in the middle, one part of it retreats to the blue, the other to the red.

From 4 to 3

1. Faraday's researches on gold leaf best illustrate this, but I hold that my explanation of them by masses of two degrees of complexity only, is sufficient without his conclusion ("Researches in Chemistry," p. 417), that they exist "of intermediate sizes or proportions."

From 3 to 2

1. Sulphur vapour first gives a continuous spectrum, at the blue end, on heating this breaks up into a channelled-space spectrum.

2. The new spectra of K and Na (more particularly referred to in the following note) make their appearance after the continuous absorption in the blue, and red vanishes.

From 2 to 1

1. In many metalloids the spectra without the jar are channelled; on throwing the jar into the circuit the line spectrum is produced, while the cooler exterior vapour gives a channelled absorption-spectrum.

2. The new spectra of K and Na change into the line-spectrum (with thick lines which thin subsequently) as the heat is continued.

Spectroscopic Notes.—On the Molecular Structure of Vapours in connection with their Densities, by J. N. Lockyer, F.R.S.

1. I have recently attempted to bring the spectroscope to bear upon the question whether vapours of elements below the highest temperatures are truly homogeneous, and whether the vapours of different chemical elements at any one temperature are all in the same molecular condition. In the present note I beg to lay before the Royal Society the preliminary results of my researches.

2. We start with the following facts:—

I. All elements driven into vapour by the induced current give line-spectra.

II. Most elements driven into vapour by the voltaic arc give us the same.

III. Many metalloids when greatly heated, some at ordinary temperatures, give us channelled-space spectra.

IV. Elements in the solid state give us continuous spectra.

3. If we grant that these spectra represent to us the vibrations of different molecular aggregations, and this question is discussed in another the previous (note) spectroscopic observations should give us facts of some importance to the inquiry.

4. To take the lowest ground. If, in the absence of all knowledge on the subject, it could be shown that all vapours at all stages of temperature had spectra absolutely similar in character, then it would be more likely that all vapours were truly homogeneous and similar among themselves as regards molecular condition than if the spectra varied in character, not only from element to element, but from one temperature to another in the vapour of the same element.

5. At the temperature of the sun's reversing layer the spectra of all the elements known to exist in that layer are apparently similar in character, that is they are all line spectra; hence it is most probable that the vapours there are truly homogeneous and that they all exist in the same molecular condition, than if the spectrum were a mixed one.

6. The fact that the order of vapour densities in the sun's atmosphere which we can in a measure determine by spectroscopic observations does not agree with the order of the modern atomic weights of the elements, but more closely agrees with the older atomic weights, led me to take up the present research. Thus I may mention that my early observations of the welling up of Mg vapour all round the sun *above the Na vapour*, have lately been frequently substantiated by the Italian observers. So that it is beyond all question, I think, that *at the sun* the vapour density of Mg is less than that of Na.

7. The vapour densities of the following elements have been experimentally determined:—

H	1	S	32 (at 1,000°)
K	39	I	127
As	150	Hg	100
Br	80	N	14
Cd	56	O	16
Cl	35·5	P	62

8. To pursue this inquiry the following arrangements have been adopted:—

The first experiments were made last December upon Zn in a glass tube closed at each end with glass plates; and I have to express my obligations to Dr. Russell for allowing them to be conducted in his laboratory, and for much assistance and counsel concerning them.

A stream of dry H was allowed to pass. The tube was heated in a Hofmann's gas furnace, pieces of the metal to be studied having previously been introduced. It was found that the glass tube melted; it was therefore replaced by an iron one. The inconvenience of this plan, however, owing to the necessity for introducing the metal into the end of the hot tube when the first charge had volatilised, and moreover the insufficiency of the heat obtainable from the gas furnace, soon obliged me to replace both tube and furnace by others, which have now been in use for many weeks, and which still continue to work most satisfactorily

The iron tube is 4 ft. in length, and is provided with a central enlargement, suggested to me by Mr. Dewar, forming a T-piece by the screwing in of a side tube, the end of which is left projecting from the door in the roof of the furnace. Caps are screwed on at each end of the main tube; these caps are closed by a glass plate at one end, and have each a small side tube for the purpose of passing hydrogen or other gases through the hot tube. The furnace is supplied with coke or charcoal, an electric lamp connected with thirty Grove's cells is placed at one end of the tube and a one-prism spectroscope at the other. The temperatures reached by this furnace may be conveniently divided into four stages:—

I. When the continuous spectrum of the tube extends to the sodium line D, this line not being visible.

II. When the continuous spectrum extends a little beyond D, this line being visible as a bright line.

III. When the spectrum extends into the green, D being very bright.

IV. When the spectrum extends beyond the green and D becomes invisible as a line, and the sides of the furnace are at a red heat.

I may add (1) that I have only within the last few days been able to employ the third and fourth stages of heat, as the furnace was previously without a chimney, and the necessary draught could not be obtained; and (2) that I was informed a little time ago by Prof. Roscoe that with a white-hot tube he had observed new spectra in the case of Na and K. These spectra which I now constantly see, when these temperatures are reached, I shall call the "new spectra."

9. The results of the experiments, so far as the visible spectrum is concerned, between the stages indicated, may be stated as follows:—

H No absorption.
N ,, ,,
K I have observed either separately or together.
 (α) The line absorption line near D.
 (β) Continuous absorption throughout the whole spectrum.
 (γ) Continuous absorption in red and blue at the same time, the light being transmitted in the centre of the spectrum (as by gold-leaf).
 (δ) Continuous absorption clinging on one side or other of the line. (This phenomenon which, so far as I know, is quite new, will be described in another note.)
 (ε) The new spectrum.
Na I have observed either separately or together.
 (α) D absorbed.
 (β) Continuous absorption throughout the whole spectrum.
 (γ) Continuous absorption clinging on one side or the other of D.
 (δ) The new spectrum.
Zn Continuous absorption in the blue. (An unknown line sometimes appears in the green, but certainly no line of Zn.)
Cd Continuous absorption in the blue.
Sb New spectrum with channelled spaces and absorption in the blue.
P The same. (This, however, in consequence of the extreme delicacy of the spectrum requires confirmation.)
S Channelled-space spectrum (previously observed by Salet).
As Probable channelled-space spectrum. (Observations to be repeated.)
Bi No absorption.
I Channelled spectrum in the green and intense bank of general absorption in the violet, where at the ordinary temperature the vapour transmits light.
Hg No absorption.

10. These results may be tabulated as follows:—

	V.d.	Modern atomic weight.	
H	1	1	No visible absorption.
K	39	39	Line absorption.
As	150	75	Probable channelled-space absorption.
Cd	56	112	Continuous absorption in the blue.
I	127	127	Channelled-space absorption + band of absorption in violet.
Hg	100	200	No absorption.
N	14	14	,, ,,
O	16	16	Not observed.
P	62	31	Channelled-space spectrum probable.
Na	(?)	23	Line absorption.
Zn	(?)	65	Continuous absorption in the violet.
Sb	(?)	122	Channelled-space spectrum and absorption in the blue.
S	32	32	Channelled-space spectrum.
Bi	(?)	208	No absorption.

11. It will be seen from the foregoing statement that if similar spectra be taken as indicating similar molecular conditions, then the vapours, the densities of which have been determined, have not been in the same molecular condition among themselves. Thus the vapours of K, S, and Cd at the fourth stage of heat gave us line, channelled space, and continuous absorption in the blue, respectively. This is also evidence that each vapour is non-homogeneous for a considerable interval of time, the interval being increased as the temperature is reduced.

On the alleged Expansion in Volume of various substances in passing by Refrigeration from the state of Liquid Fusion to that of Solidification, by Robert Mallet, F.R.S.

Since the time of Reaumur it has been stated with very various degrees of evidence, that certain metals expand in volume at or near their points of consolidation from fusion. Bismuth, cast-iron, antimony, silver, copper, and gold are amongst the number, and to these have recently been added certain iron-furnace slags. Considerable physical interest attaches to this subject from the analogy of the alleged facts to the well-known one that water expands between 30° F. and 32°, at which it becomes ice; and a more extended interest has been given to it quite recently by Messrs. Nasmyth and Carpenter having made the supposed facts, more especially those relative to cast-iron and to slags, the foundation of their peculiar theory of lunar volcanic action as developed in their work "The Moon as a Planet, as a World, and a Satellite" (4to, London, 1874). There is considerable ground for believing that bismuth does expand in volume at or near consolidation; but with respect to all the other substances supposed to do likewise, it is the object of this paper to show that the evidence is insufficient, and that with respect to cast-iron and to the bassic silicates constituting iron slags, the allegation of their expansion in volume, and therefore their greater density when molten than when solid, is wholly erroneous. The determination of the specific gravity in the liquid state of a body having so high a fusing temperature as cast-iron is attended with many difficulties. By an indirect method, however, and operating upon a sufficiently large scale, the author has been enabled to make the determination with considerable accuracy. A conical vessel of wrought iron of about 2 ft. in depth and 1·5 ft. diameter of base, and with an open neck of 6 in. in diameter, being formed, was weighed accurately empty, and also when filled with water level to the brim; the weight of its contents in water, reduced to the specific gravity of distilled water at 60° F. was thus obtained. The vessel, being dried, was now filled to the brim with molten grey cast-iron, additions of molten metal being made to maintain the vessel full until it had attained its maximum temperature (yellow heat in daylight) and maximum capacity. The vessel and its contents of cast-iron when cold were weighed again, and thus the weight of the cast-iron obtained. The capacity of the vessel when at a maximum was calculated by applying to its dimensions at 60° the coefficient of linear dilatation, as given by Laplace and others, to its range of increased temperature; and the weight of distilled water held by the vessel thus expanded was calculated from the weight of its contents when the vessel and water were at 60° F. after applying some small corrections.

We have now the elements necessary for determining the specific gravity of the cast-iron which filled the vessel when in the molten state, having the absolute weights of equal volumes of distilled water at 60° and of molten iron. The mean specific gravity of the cast-iron which filled the vessel was then determined by the usual methods. The final result is that, whereas the specific gravity of the cast-iron when cold was 7·170 it was only 6·650 when in the molten condition; cast-iron, therefore, is less dense in the molten than in the solid state. Nor does it expand in volume at the instant of consolidation, as was conclusively proved by another experiment. Two similar 10-inch spherical shells 1·5 in. in thickness, were heated to nearly the same high temperature in an oven, one being permitted to cool

empty as a measure of any permanent dilatation which both might sustain by mere heating and cooling again, a fact well known to occur. The other shell, when at a bright red heat, was filled with molten cast-iron and permitted to cool, its dimensions being taken by accurate instruments at intervals of thirty minutes, until it had returned to the temperature of the atmosphere (53° F.), when, after applying various corrections, rendered necessary by the somewhat complicated conditions of a spherical mass of cast-iron losing heat from its exterior, it was found that the dimensions of the shell whose interior surface was in perfect contact with that of the solid ball which filled it were, within the limit of experimental error, those of the empty shell when that also was cold (53° F.), the proof being conclusive that no expansion in volume of the contents of the shell had taken place, which was further corroborated by the fact that the central portion was found much less dense than the exterior, whereas if the cast-iron expanded in consolidating the central portions must be more dense than the exterior.

It is a fact, notwithstanding what precedes and well known to iron-founders, that certain pieces of cold cast-iron do float on molten cast-iron of the same quality, though they cannot do so through their buoyancy, as various sorts of cast-iron vary in specific gravity at 60° F., from nearly 7·700 down to 6·300, and vary also in dilatability; that thus some cast-irons may float or sink in molten cast-iron of different qualities from themselves through buoyancy or negative buoyancy alone; but where the cold cast-iron floats upon molten cast-iron of less specific gravity than itself, the author shows that some other force, the nature of which yet remains to be investigated, keeps it floating; this the author has provisionally called the repellent force, and has shown that its amount is, *cæteris paribus*, dependent upon the relation that subsists between the volume and "effective" surface of the floating piece. By "effective" surface is meant all such part of the immersed solid as is in a horizontal plane, or can be reduced to one. The repellent force has also relations to the difference in temperature between the solid and the molten metal on which it floats.

The author then extends his experiments to lead, a metal known to contract greatly in solidifying, and with respect to which there is no suggestion that it expands at the moment of consolidation. He finds that pieces of lead having a specific gravity of 11·361 and being at 70° F. float or sink upon molten lead of the same quality, whose calculated specific gravity was 11·07, according to the relation that subsisted between the volume and the "effective" surface of the solid piece, thin pieces with large surface always floating, and *vice versa*. An explanation is offered of the true cause of the ascending and descending currents observed in very large "ladles" of liquid cast-iron, as stated by Messrs. Nasmyth and Carpenter. The facts are shown to be in accordance with those above mentioned, and when rightly interpreted to be at variance with the views of these authors.

Lastly, the author proceeds to examine the statements made by these authors, as to the floating of lumps of solidified iron-furnace slag upon the same when in a molten state; he examines the conditions of the alleged facts, and refers to his own experiments upon the total contraction of such slags, made at Barrow Ironworks, and a full account of which he has given in his paper On the true nature and origin of volcanic heat and energy, printed in Phil. Trans. 1873, as conclusively proving that such slags are not denser in the molten than in the solid state, and that the floating referred to is due to other causes. The author returns thanks to several persons for facilities liberally afforded him in making these experiments.

Chemical Society, June 18.—Prof. Frankland, F.R.S., vice-president, in the chair.—The following papers were read:—On the action of chlorine, bromine, &c., on isodinapthyl, by W. Smith.—Dr. Armstrong then read four communications from the laboratory of the London Institution, No. XIII. On coal-tar cresol and some derivatives of paracresol, by H. E. Armstrong, and C. L. Field; No. XIV. On the action of the chlorides of the acids of the sulphur series on organic compounds, by H. E. Armstrong and W. H. Pike; No. XV. On chloro, bromo, and iodo-nitrophenolparasulphonic acids, by H. E. Armstrong and F. D. Brown; and No. XVI. Note on the decomposition of dichloronitrophenol by heat, by H. E. Armstrong and F. D. Brown.—The sixth paper was by Mr. F. Neison, On the products of the decomposition of castor oil, No. III. On decomposition by excess of alkaline hydrate, in which he has succeeded in elucidating the conflicting statements of different chemists on this subject.—On hydrogen persulphide, by Dr. W. Ramsay.—Suberone, by Dr. C. Schorlemmer and Mr. R. S. Dale.—On the action of nitrosyl chloride on organic bodies. Part I.—On phenol, by Dr. W. A. Tilden,—An apparatus for determining the moisture and carbonic anhydride in the atmosphere; A method for determining ozone in the presence of chlorine and nitric oxide; and On the constitution of urea, by Dr. D. Tommasi.—On the restitution of burnt steel, by Mr. S. L. Davies.—On the action of earth on organic nitrogen, by Mr. E. C. Stanford.—Aniline and its homologues in coal-tar oils, by Mr. W. Smith.

Zoological Society, June 16.—Dr. A. Günther, vice-president, in the chair.—An extract was read from a letter received from Dr. A. B. Meyer, concerning two birds (*Rectes bennetti* and *Campephaga aurulenta*) lately described in the Society's Proceedings by Mr. Sclater.—A letter was read from Mr. William Summerhayes, relating to certain species of Curassows found in Venezuela.—Dr. J. Murie read a paper on the nature of the sacs vomited by the Hornbills, which he stated, in confirmation of Prof. Flower's account of these objects, to consist of the epithelial lining of the stomach.—Mr. W. Saville Kent, F.L.S., communicated a second paper upon the gigantic cephalopods recently encountered off Newfoundland. From further information received, Mr. Saville Kent apprehended that it would be necessary to refer the two individuals preserved in St. John's Museum to the genus *Ommatostrephes*, thus avoiding the institution of a new genus for their reception, as proposed in his former paper.—Mr. A. H. Garrod read a paper on the "showing off" of the Australian Bustard (*Eupodotis australis*) and pointed out the peculiar structures by which this "showing off" was accomplished.—A communication was read from Dr. F. Stolicza, containing a description of the *Ovis polii* of Blyth, of which he had lately obtained specimens in Yarkand.—Mr. R. B. Sharpe read a paper on a new genus and species of Passerine birds from the West Indies, which he proposed to name *Phœnicomanes iora*.—A communication was read from the Rev. O. P. Cambridge, containing descriptions of some new species of Spiders of the genus *Erigone* from North America.—Dr. Günther read a paper describing some new species of reptiles from the Camaroon Mountains, West Africa. Amongst these were two new species of Chameleon, and a new snake of the family of Lycodontidæ, proposed to be called *Bothrolycus ater*. One of these Chameleons was referred to a new subgenus (*Rhampholeon*), being remarkable for its abbreviated tail and the development of a denticle at the inner base of each claw.—Mr. Sclater read a paper containing a description of three new species of the genus *Synallaxis* from M. Jelski's collections in Central Peru, which he proposed to call *S. Pudibunda*, *S. graminicola*, and *S. virgata*.—Messrs. H. P. Blackmore and E. R. Alston communicated a joint paper on the Arvicolidæ which have hitherto been found in a fossil state.—Prof. Newton read an account of a living Dodo shipped for England in the year 1628, extracted from letters in the possession of Dr. J. B. Wilmot, of Tunbridge Wells.—Mr. J. E. Harting read a paper on the common Lapwing of Chili, which he proposed to separate from *Vanellus cayanensus*, under the name *V. occidentalis*.—A second paper read by Mr. Harting contained an account of the eggs of some new or little-known Limicolæ.—A communication was read from Mr. R. Swinhoe containing an account of a new Cervine form discovered in the mountains near Ningpo, China, by Mr. A. Michie, and proposed to be called *Lophotragus michianus*.—Dr. J. Murie read a paper on the structure of the skeleton of *Fregilupus varius*, based on a specimen in the Museum of Cambridge.

Meteorological Society, June 17.—Dr. R. J. Mann, president, in the chair.—On the connection between colliery explosions and weather in the year 1872, by Robert H. Scott, F.R.S., and W. Galloway, Inspector of Mines. The paper is in continuation of those by the same authors read before the Royal Society in 1872, and before the Meteorological Society in 1873, which contained the results for the four preceding years. The number of fatal explosions which occurred during the year was 70, causing the loss of 163 lives. Three of these killed each of them more than ten men, being the same as the average number of serious explosions for the last twenty years. The number of non-fatal explosions was 224. A comparison of the dates of all recorded explosions with the curves of the barometer and thermometer kept at Stonyhurst for the Meteorological Office, as shown on a diagram, lead to the following results:—58 per cent. of the explosions are due to changes of pressure, 17 per cent. to great heat of the weather, while 25 per cent. are not attributed

by the authors to meteorological agencies. These proportions are nearly the same as those which have come out from the discussions of similar facts for previous years. The paper next deals with an objection which has been raised to the reasoning in its predecessors, viz. that it is not fair to take the meteorological records for Stonyhurst as a test of the atmospherical phenomena in a coalfield situated at some distance from the observatory. The authors show, by taking an instance of a barometrical depression, whose centre passed over Stonyhurst, and which was accompanied by an explosion in South Wales, that such an objection as that cited could never have originated with anyone accustomed to deal with daily weather charts. The next question discussed was the alleged greater prevalence of explosions with certain winds; and it was shown by the most reliable data for our climate that the ordinary changes of pressure and temperature in the windrose were hardly sufficient to account for the explosions which are found to accompany the *sudden* changes of weather. The paper proceeds with a discussion of a diagram exhibiting the continuous curve of barometrical pressure from Glasgow Observatory for the last nine months of 1873, and a curve showing the prevalence of fire-damp in the mines of the West of Scotland district for the period. These latter returns have been furnished by Mr. Galloway from the entries in the books ordered to be kept at each mine by the Coal Mine Regulation Act, 1872. The books of thirty-five mines about Glasgow have been used for the comparison. The two curves show a very remarkable accordance in their course, though that of fire-damp exhibits some striking irregularities, owing probably to the fact of the men having been slow to learn the new duties required of them by the Act. It may be expected that these irregularities will disappear in future years. The result places it beyond the possibility of a doubt that the escape of fire-damp is related mainly to the conditions of atmospherical pressure, and that a careful watch over the barometer is, above all, necessary in each colliery, though one such record would suffice for several adjacent mines. The paper gives some instances of explosions which might all have been prevented by proper ventilation and by the use of safety-lamps, and states how pressing the need is that safety-lamps only should be used in all places where fire-damp may accumulate, whenever the atmosphere is in a disturbed condition, as shown by the record of the barometer and thermometer. The authors conclude by stating their conviction that it is not too much to ask those charged with the responsibility of the safety of miners' lives to learn the first principles of the laws of diffusion and intermixture of gases, and to familiarise themselves with the use of the barometer and thermometer, so as to know when it behoves them to take extra precautions in the management of their mines.—Solar radiation, 1869–74, by Rev. F. W. Stow.—The diurnal inequalities of the barometer and thermometer, as illustrated by the synchronous observations made during May 1872 at the summit and base of Mount Washington, New Hampshire, at the respective heights of 2,615 ft. and 6,283 ft. above the sea-level, by W. W. Rundell. The hourly mean differences of pressure and temperature at these stations and at Portland, Maine, the nearest U.S. station to Mount Washington, are discussed and their most probable coefficients are determined, also the times at which their maxima and minima occur.—On the diurnal variation of the barometer at Zi-Ka-Wei, and mean atmospheric pressure and temperature at Shanghai, by Rev. A. M. Colombel.—Weather report for 1873 at Woosung, China, by C. D. Braysher.—Notes regarding a remarkable hailstorm at Pietermaritzburg, Natal, on April 17, 1874, by Rev. J. D. La Touche.

Royal Astronomical Society, June 12.—Prof. Adams, president, in the chair.—A paper by Mr. Stone, the Government astronomer at the Cape of Good Hope, was read, describing his observations of the eclipse of April 16 made near Klipfontein, in South Africa, of which an account has been given in NATURE (vol. x. p. 59).—Mr. Bidder described a micrometer which he had contrived for measuring the position of very faint stars. Ghosts of the wires, which can be rendered dimmer or brighter at the discretion of the observer, are projected into the field of view by means of reflecting prisms; and diaphragms can be used, cutting out the light of the wires from any portion of the field.—M. d'Abbadie was called upon to give some account of the French preparations for the transit of Venus. The French Government will occupy five stations, and will make use of the Daguerreotype in preference to the collodion process. Their photographs will be taken in the principal focus of their instruments, and the image of the sun will thus be only about 36 millimetres in diameter. The trial photographs are so sharp that they hope to be able to make use of a magnifying power of 250 in measuring the photographs for the purposes of reduction.—The President announced to the Society that a petition was about to be presented to the Dean of Westminster, praying him to admit of the erection of some memorial to Jeremiah Horrox in Westminster Abbey.—It was announced that the next meeting of the Society would be held in their new room in Burlington House.

PARIS

Academy of Sciences, June 15.—M. Bertrand in the chair.—The following papers were read:—Solar theories; reply to some recent criticisms, by M. Faye. The author meets objections raised by MM. Ledieu, Duponchel, and P. Secchi, in former numbers of the *Comptes Rendus*.—On the heat evolved by chemical reactions in the different states of bodies, by M. Berthelot. The author considered the heat developed in the gaseous, liquid, and solid states.—Observations on the communication relating to Phylloxera made by M. Lichtenstein during the *séance* of June 8.—A note by M. Blanchard, in which the author highly eulogises the experiments of Lichtenstein.—Researches on the electrolysis of the alkaline carbonates and bicarbonates, by MM. P. A. Favre and F. Roche. This is a thermo-chemical research undertaken with a view of throwing light on the constitution of these bodies.—On the phenomena of static induction produced by means of Rhumkorff's coil; a note by M. E. Bichat. The author finds that static electricity, as from the Holtz machine, when passed through the secondary wire gives rise in the primary wire to the development of a current possessing all the properties of the voltaic current, and like this current appearing to have only one direction.—M. J. M. Gaugain presented a note on magnetism.—On some properties of the systems of curves ($\mu = 1, \nu = 1$), by M. Fouret.—Generalisation of a theorem communicated at the *séance* of June 1, by M. H. Durrande.—On oxyfluoboric acid, by M. A. Basarow. This acid is stated to be produced when boric fluoride is passed into water, and the assigned formula is $BO_2H, 3HF$. The present research tends to prove that no such body exists, the composition formerly determined by analysis being a result of chance.—On the absorption of ammonia from the air by vegetables, by M. T. Schlœsing. The author has been growing two tobacco plants under precisely the same conditions, except that one plant was freely supplied with ammonia, while the other was excluded from this gas. Analyses prove that the plant supplied with ammonia is much richer in nitrogeneous compounds than the other.—Research on the oxygen dissolved in the water of artesian wells, by M. A. Gérardin. The author concludes that oxygen is never found in subterranean waters if these are kept out of contact with the air.—On a case of lead-poisoning, by MM. G. Bergeron, and L. l'Hote.—On creatine, by M. R. Engel. The author has studied the reactions of this substance.—Anæsthesia by intravenous injection of chloral after the method of Prof. Oré; removal of a cancer from the rectum, by MM. Deneffe and Van Wetter.—On the geology of the regions comprised between Tangiers, El-Araich et Meknès (Morocco), by M. Bleicher. The author has recognised the following formations—recent, tertiary, cretaceous, and jurassic.—On the character of the littoral zone in the English Channel, the ocean, and the Mediterranean, by M. P. Fischer.

CONTENTS

THURSDAY, JULY 2, 1874

ON OSTEOLOGICAL MONOGRAPH-WRITING

IN biological Societies, and in others which have any biological interests, there is a question which is daily becoming more and more prominent; one that if not fully investigated shortly will lead to results which are far from advantageous to the science itself, and will throw discredit on its votaries; whilst, if some decided opinion is expressed in such a manner that no doubt can be entertained as to its true meaning, much hard work and unnecessary disappointment may be easily saved.

Some half century or so ago, when zoology was just commencing a new lease of life, as it may be termed, the opportunities afforded to those who were studying the anatomy and physiology of the animal kingdom were comparatively few. Museums were scarce; most of those existing being very incomplete in an educational point of view, and it was almost impossible to procure specimens of any desired species by means of a pecuniary offer. The case is now, however, extremely different. Museums are numerous, and are daily becoming more so. The facilities for locomotion make it easy for anyone anxious to see what cannot be obtained nearer, to visit the British Museum or that of the Royal College of Surgeons; there are dealers who are able to offer typical specimens at a moderate price, and to obtain the rarer forms if necessary. Such being the case it must be evident that a certain change ought to have come over zoological literature, in order that it should progress with the science itself. What was then indispensable is now no longer required, and that which was then unknown takes its place. Nevertheless there are a few comparative anatomists who do not seem to realise the change which has so gradually and so markedly occurred. They think and write with the ideas of fifty years ago, and, what is more, expect us to appreciate their productions as if they were not the least *de trop*.

Formerly, no doubt, it was extremely valuable to have descriptions given in print of the detailed anatomy of particular species. Of their osteology this was especially the case. These descriptions drew attention to previously scarcely recognised characters, and, what was perhaps still more important, did much to fix the nomenclature of the skeleton generally; because, though this had been previously accomplished as far as human anatomy is concerned, there are many reasons, known to all practical students, which make the names adopted in anthropotomy unsatisfactory and incomplete when they have to be applied to the lower vertebrata.

The case is now very different. Skeletons of almost all known animals being contained in museums, and those of common species being abundant, any student prosecuting his investigations in the spirit which insures successful results, will find no difficulty in obtaining opportunities of handling and comparing the bones themselves, and will have but little or no need to refer to plates or descriptions, which are never so satisfactory as the specimens themselves, and are often as difficult to obtain as they are expensive to purchase.

It therefore becomes a question, and a not unimportant one either, as to whether it is to the best interests of our learned Societies to expend their funds in encouraging the further publication of long and exhaustive descriptions of the osteology of common types, and the execution of a large number of elaborate drawings of bones, whose intrinsic worth is considerably less than the cost of their putting on wood or stone. In several instances within the last two or three years, lengthy papers, without doubt the result of much time and attention, have been presented to different Societies, evidently with a full idea on the part of the authors that their monographs will be published, unopposed, in the form in which they send them in; and yet these many pages are found to contain nothing more than the monotonous and unsuggestive descriptions of the bones, one by one, and surface by surface, profusely illustrated, of animals as common as some of the best-known Marsupial mammals or Struthious birds.

A full account of the myology, neurology, or visceral anatomy of almost any animal has a value which no one would wish to depreciate in the least, because these parts are difficult to preserve, and it requires a special training, together with considerable experience in one direction, before such investigations can be undertaken, as they are but too infrequently. But as bones are so easily preserved in a state which cannot shock the most delicate hands or the most sensitive nose, there is no excuse for any student not practically knowing the most important peculiarities of any skeleton, nor for his not prosecuting his investigations to any degree of minuteness when occasion requires.

It has been remarked that these fully illustrated monographs are of especial value in palæontological investigations; that the study of the Pleistocene remains of Australia, for instance, can be conducted on the spot with greater facility when comparisons can be made with existing forms. But, we may ask, where can it be easier, than in Australia itself, to obtain the skeletons of now living Marsupials? and we all know how much better it is to have the bones themselves than drawings of them, however well executed. Further, it has been said that after a certain time it is impossible for any author, however able, to continue to develop generalisations and theories from any number of fresh facts; and such being the case, can those who really like their subject do better than devote themselves to the careful description, uncomplicated with any attempt at inductive reasoning, of what they have the opportunity of observing? We think they can, for we see no reason why the inferior productions of an able man should, on account of his previous reputation, be allowed to be placed on a level with the better work of others, and above those productions of the same quality, the attempts of less known authors.

The fact, however, is that the time is passed for the publication as simple statements of the commonplace facts of osteology; the subject is more than overloaded with them already. What is now wanted is the application to them of some methods by which, like the doctrine of evolution, or the vertebrate theory of the skull, those at present on hand may be turned to better account in determining the true affinities of different animals, or the means by which the present state of things has been arrived at. The comparison of simple fact-accumulation to the introduction of fresh methods of research, or lines of thought, is so insuperably in favour of the latter, that the former

has quite descended below the level of that quality of work which needs the distinguishing encouragement afforded by the publication of the results obtained in the "Transactions" of any learned Society.

PICKERING'S "PHYSICAL MANIPULATION"

Elements of Physical Manipulation. By Edward C. Pickering, Phayer Professor of Physics in the Massachusetts Institute of Technology. Part I. (London: Macmillan & Co., 1874.)

To write a satisfactory text-book for students in physical laboratories is a task beset with difficulties; and although Prof. Pickering has had the advantage of no small experience and judgment in the composition of the work the title of which is given above, we do not think that he has entirely overcome them.

There can be little doubt that oral teaching is that which is best suited to students who are beginning experimental work of any sort, and that as much may often be learnt in five minutes by seeing another perform an experiment as would be acquired in as many hours with the aid of a book alone to explain the construction and use of the apparatus; and Prof. Pickering is therefore right in aiming at supplementing rather than superseding the efforts of an instructor.

The work is divided into sections, each of which relates to one or more experiments, and comprises two parts, the first of which, entitled "Apparatus," gives a description of the instrument required, and is designed to aid the instructor in preparing the laboratory for the class, while the second, headed "Experiment," explains in detail to the student what he is to do.

The subjects treated of in the first volume, the only one at present published, are Mechanics, Sound, and Light, an arrangement that does not agree with the order in which they would probably be studied in the laboratory, as the elementary parts of heat ought certainly to be taken with mechanics; but the plan adopted has the advantage that heat and electricity, the subjects in which tables are most required for reference, will be placed together in the second volume, in which also, we presume, sets of tables will be included among the "matters of general interest to the physicist" that are promised in the preface.

Apart, however, from any detailed criticism, we must notice the important preliminary question, how far a work of this sort is likely to fulfil the object with which it is written, of enabling an instructor to superintend a larger class than he could otherwise attend to at once? The members of the class, according to the method of instruction pursued in the Massachusett's Institute, and described in the preface, are not informed precisely what experiments will be allotted to them until they enter the laboratory, and as such is the plan probably generally adopted where the number of pupils is large, it is absolutely necessary for the instructor to have at hand, either in a text-book or in manuscript, short papers on the theory of the different experiments. We do not, however, feel sure that the descriptions of apparatus and methods of performing experiments will prove so valuable as might at first sight appear probable. The instruments required for physical work are often so costly as to make constant supervision necessary over those who are not accustomed to them, and their construction is so various, at all events in minor particulars, that directions for their use which might be all that could be desired in one laboratory might be misleading in another. Another difficulty arises in describing experimental proofs of the simpler laws of Mechanics and Physics which do not require elaborate apparatus for their exhibition, as a choice has often to be made between several different methods, an account of all of which would make the text-book unwieldy in bulk, while the omission of any is apt to make it less useful in laboratories other than that for which it was originally intended. The selection of experiments of this sort must in great measure depend upon the time the pupil is able to devote to the study of physics, the objects he has in view in pursuing it, and in many cases upon his knowledge of mathematics; and we regret that Prof. Pickering seems occasionally to have chosen those which are likely to give the best numerical results, in preference to others which, depending more upon skill, are not indeed so suitable for the exact verifications of physical laws, but have a greater educational value in improving the powers of observation.

The method selected, for instance, for illustrating the laws of falling bodies is that of suspending a ball to a spring, which, when the connecting thread is severed and the ball allowed to fall, completes a galvanic circuit in which a chronograph is included, and which is again broken by the impact of the ball on a plate placed below to receive it. This method is well adapted to show the relation between the time of falling from rest and the distance traversed; but Attwood's machine, of which no account is given, illustrates the fundamental laws of dynamics much more completely, is capable, if fitted with proper electric arrangements, of giving extremely good results, and is better suited for use by the pupil, as in our opinion all such instruments ought at first to be used, with some means of measuring time, such as the stop-watch, water-clock, or metronome, dependent upon skill, and not upon a purely mechanical arrangement.

Some of the experiments described are avowedly given as a preparation to those who may have to give lectures on physics, and others are, we presume, inserted with the same intention, as it would hardly be necessary for those possessing that "moderate familiarity with the general principles of physics" which "the class is supposed to have previously attained" to spend time over the experimental proofs given of the laws of the composition of forces, or the equality of the angles of incidence and reflection.

The earlier pages of the book are devoted to general remarks on physical measurements, and on methods of working up the results of experiments, and they will prove very useful.

The knowledge of mathematics assumed throughout is small, and in several instances the line has in this respect been drawn too tightly, no account being given of the method of determining the coefficient of torsion by means of the torsion pendulum, or of the determination of gravity by the reversible pendulum, probably on account of the small amount of rigid dynamics required in these problems.

In a book, however, which must necessarily be intended for use by pupils of very different attainments, it would be difficult to avoid criticisms of this kind, and we think the experiments on the whole judiciously selected and clearly explained. We shall look with interest for the appearance of the second volume, and when finished "Physical Manipulation" will no doubt be considered the best and most complete text-book on the subjects of which it treats. A. W. R.

OUR BOOK SHELF

Mineralogy. By F. Rutley, F.G.S. (Murby's Text Books.)

MR. RUTLEY'S little treatise on mineralogy has the merit of expressing in a clear and simple form the facts that are most wanted to be known by the general student of a science for which a small elementary English book is needed. The descriptions are concise, and the selection of the matter under each mineral generally good. Mr. Rutley, furthermore, gives some fifty pages of preliminary matter, which, though not always put in the most intelligible form, yet embodies a considerable amount of useful technical teaching in regard to the physical properties of minerals. Mr. Rutley even enters, and very rightly does so, on the subject of optical characters. But in these pages, as in the page on thermo-electricity, the author does not seem to have carefully revised what he wrote, or he would not have followed other authors in speaking of boracite as a uniaxal crystal, and would hardly have classed the dispersion of light by a diamond with the play of colour exhibited by an opal. Nor is an optic axis correctly described as the only direction by looking along which the doubly refracted images of a spot can be got to coincide, as Mr. Rutley will see if he looks at the spot through two opposite faces of the hexagonal prism of a calcite crystal. He ingeniously endeavours to indicate the nature of the faces of his crystals by a sort of heraldic hatching and marking. The use of small letters always indicating the character of the faces, as in Des Cloizeaux and other French treatises, might have done this usefully; Mr. Rutley's puzzling figures will probably only serve to scare away the English student, who needs every allurement to the study of the neglected science of crystallography—a science neglected merely because the rudiments of geometry and trigonometry are not made a necessary part of every scientific student's education. And it is a significant circumstance in connection with this neglect of scientific crystallography, that the geometrical methods and simple notation introduced forty years ago by our distinguished fellow-countryman, the first living crystallographer, Prof. Miller, are, we believe, untaught in any single lecture-room in London. Is England to be the last country to adopt a system made European by Sénarmont, Sella, Beer, and Grailich, and which is fast overcoming even in Germany itself a natural prejudice in favour of the more unwieldy, though in its time useful and ingenious, notation of the great Leipsig Professor?

Sanitary Arrangements for Dwellings, intended for the use of Officers of Health, Architects, Builders, and Householders. By William Eassie, C.E., &c. (Smith, Elder and Co. 1874.)

THIS volume gives, in a collected form, a series of papers published originally in the *British Medical Journal.* Its object, the author states, is to give "an account of the most ordinary sanitary defects in dwelling-houses and public institutions, in respect to drainage, water-supply, ventilation, warming, and lighting;" and "to set forth,' what he believes, "the most simple and effective means of *preventing* or *remedying* such defects." He thinks it necessary to say further:—"The purpose of this small work is to point out, in the plainest language, what ought to be done to render ancient and modern houses healthy. I will eschew all extraneous matter, as much as possible, and will not fall into the common practice, better honoured in the breach than the observance, of heading the chapters, or interlarding the matter, with lines from the poets." It is but due to the author to say that he has faithfully avoided this tendency "to drop into poetry" on the subject of house-drains, sewers, &c.; on the plainness of the language, however, we cannot speak very highly. Many householders, it is to be feared, will find some difficulty in recognising an S-shaped pipe under the name of a "sigmoid"; or in appreciating the beauty of a description in which the overflow sewage from a cesspool is said to "debouch into the fields."

The greater part of the book is occupied with a description of the various sanitary appliances for buildings which have from time to time been proposed, or which have been brought into actual use: such as drain-pipes, of which twenty-two different kinds are figured and described; traps, of which thirty-six are given; fire-grates and stoves, &c. In many places, indeed, it reminds us of nothing so much as a manufacturer's or tradesman's catalogue. On the whole, however, this work contains much useful information and many excellent suggestions. On the subject of house-drainage, we are glad to see that Mr. Eassie has adopted and advocates the principle of leading all house-drains into one collecting drain, outside the house if possible, and placing in this main drain an efficient trap, properly ventilated, so as to prevent any of the sewer gases finding their way into the house through the drains or pipes.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Robert Brown and Sprengel

IN the notice of Mr. Darwin (vol. x. p. 80, bottom of 2nd col.) a mishap has somehow occurred which blunts the point intended to be made prominent and renders the statement untrue. I supposed that I had written "*And* we know from another source that he (Mr. Brown) looked upon Sprengel's ideas as *by no means* fantastic. Yet instead," &c. The object was to show how very near Mr. Brown came to reaching the principle that Nature abhors close-fertilisation in plants, and yet did not reach it at all. The authority for the statement I wished to make will be found in a footnote in Mr. Darwin's book on the "Fertilisation of Orchids," p. 340. ASA GRAY

Cambridge, Mass., June 19

On the Physical Action taking place at the Mouth of Organ-pipes

THE most interesting, and perhaps the most important, fact disclosed in the experimental study of the organ-pipe on the air-reed theory is this—that the aeroplastic reed has a law of its own, unique amongst the phenomena heretofore observed in musical vibrations. It may be stated thus—*As its arcs of vibration are less, its speed is greater.* All our knowledge of rods and strings, of plates and membranes, would lead us to expect the usual manifestation of the law of isochronism, that in the air-reed considered as a free rod fixed at one end and vibrating transversely, the law would be observed, "though the amplitude may vary, the times of vibration will be the same." Yet here we meet with its absolute reversal, viz.—*the times vary with the amplitude.* This information does not rest on theory; every eye may verify it. A principle so strange, when first its action was observed, might well lead to disbelief in one's senses, although the mind had by its reasonings led up to the fact and sought for it as the one thing needed to give consistency to theory and make it a perfect whole. Familiar as the air-reed had been to me, the one secret had been hidden from my eyes; seeing, they saw not. Faith in the known mode of activity of the transversely

vibrating rod had blinded me, and it was only after long reasoning, forced upon me by the presence of independent harmonics, not upon any theory belonging to a reed (whose first harmonic would be higher than an octave twelfth), that my faith was shaken. Then, conceiving the idea of this principle of action, I looked, hoping to find my reasoning confirmed; yet, let me confess it, the first sight of the reality startled me not a little with self-confusion. Here was an every-day fact, constantly before me it had been, beautiful in its simplicity, waiting to be acknowledged, and I so stupidly blind as not to see it. Vary the experiment, repeat it again and again, and the fact will be confirmed beyond possibility of doubt, that, the length of reed remaining unaltered, if by extraneous influence the pitch of the note is lowered whilst the pipe is speaking, correspondingly with the changing sound the path of the air-reed will be lengthened; or conversely if the pitch be raised, simultaneously with the quickened velocity, the air-reed will be seen to shorten its stroke; no swelling of tone gaining power with gain of amplitude; not the counterpart of a metallic reed, nor acting as a tuning-fork. The creature of air, it times itself to the element that sustains it. This aero-rhythmic law provides the only way possible to the air-reed to work out the transmutations of energy essential to its functions; the constitution of air necessitates the conformity in mechanical relations.

Another remarkable demonstration falls to this theory—that the note of every open organ-pipe is not single but is a concord, always consists of a duality of tone; the two distinct tones of the air-reed and of the pipe may be separated and again blended at pleasure.

Also that the harmonics or over-tones may in favourable pipes be brought on at will without alteration of the pressure of blowing; that likewise, when a pipe, instead of continuing to sound its fundamental, is unsteady, and gives its harmonic, the pipe being said to "fly off to its octave," the notion implied is erroneous; it can be rendered visible that the air-reed leaps back to its octave speed, and by its superior strength compels the pipe to follow in accord. The expression "leaps back," is deliberately used, for the native pitch of the air-reed is far higher than the harmonics of the pipe.

Add to these the still more singular feature of three different velocities concurring to produce in an open organ-pipe the one fundamental tone, which we call its pitch, the super-nodal wave having one velocity, and the sub-nodal wave having for its course and recourse two differing rates of progression. *The motion of vibration is an activity tempered by rests.* In every wind-instrument we perceive intimations that the period of rest is originally governed by the special structure of each, and experiment shows that we can arbitrarily limit or prolong it; this variable ratio of rest to activity is to be taken into account in all calculated times and velocities. In forming a true conception of the behaviour of musical reeds, and in tracing out the process of tone-making in organ-pipes and other wind-instruments, the modifying influence of the "rest" between the vibrations announces itself as of vital importance. If the doctrine is strange, it is not unnatural. The action of the heart furnishes a parallel instance—contraction, dilatation, pause—the three making up the rhythmic period of the heart's beat, and their relative duration varying with the individual organisation.

The foregoing affirmations are preparative. It will not be possible to condense into one letter the evidence and arguments supporting them, but if they are borne in mind during the progress of the exposition, the bearing of each new fact on theory will be more readily seen, and the aim and purpose of the reasoning be apprehended even in its incomplete stages.

There is one significant question which it occurs to me has never yet been asked; that the node is to be found in all longitudinal vibration of rod or pipe is undoubted; that there is a displacement of a node in an open organ-pipe is an accepted fact—but why, in rod or pipe, why is there a node at all? The question will wait.

Now to the experimental pipe. Suppose we have before us an open diapason organ-pipe, of section rectangular, length 7 ft. 6 in., interior breadth $4\frac{1}{2}$ in., depth 6 in., area of mouth $4\frac{1}{2}$ in. by 4 in., pitch C.C.—the half wave-length for this pitch is 8 ft. 8 in. in the atmosphere. The wind-way is a narrow fissure, barely the twenty-fourth of an inch wide; on the inner margin of this wind-way we place a card or plate, covering interiorily the whole area of the embouchure, and then we admit the wind-current at the foot of the pipe from the organ-bellows.

Premising that the swift sequence of action is delayed for convenience of our analysis, we notice that the stream of air, and as yet it is nothing more, is directed slightly diverging from the vertical, and sufficiently to cause it to glide up the inclined plane of the lip. This stream is the life-force of the sound. "That everybody knows." True they may. But how many ever think, if they know, that its force is that of a storm-wind driving along at the rate of sixty miles an hour. The anemometer or wind-gauge proves it to be so, and that moreover in some stops of large organs the pressure per foot given by the bellows is equal to that of a hurricane.

If now the plate be removed from the back of the embouchure, the stream is instantaneously transformed into an air-moulded reed. There is gradation in the change, the order of which may be worked out, leaving the sound as Shelley says "waiting to be born."

The velocity *of passage* is to become endowed with a new power, the velocity *of vibration*. How is this investiture accomplished? How afterwards does the transversal vibration of the aeroplastic reed call into existence the longitudinal vibration of the air-column of the pipe?

The isolated reed, before any change takes place, has no innate tendency to swerve from uprightness, of itself it can neither blow in nor out, nor can the atmosphere influence it, for that is equal on both sides; the air-column within the pipe is at rest, it has no self-stimulating power of vibration, and to disturb its equilibrium some internal exciting cause is needed which shall produce, with determination of priority, condensation or rarefaction. It is obvious that the reed as it now stands has no power to produce a condensation, it does not strike against the sharp edge, it simply asserts its own upward-rushing force. The reed must be bent before it will vibrate. To cause this flexure the only alternative is rarefaction. The act of rarefying occupies time, it takes place within the pipe, is not spontaneous, but is induced by some previous act, therefore the provocation belongs to the reed. In velocitous rush over the mouth, its dense stream making around itself a rarefied atmosphere, it causes the approach of the quiescent column, carries off all the particles of air lying in the nearest layers, and would go on abstracting indefinitely if there were no counterbalancing causes coming into operation, but it brings down upon itself the power that bends it; *suction by velocity* has created a partial vacuum; the air-column, pressing outwards with the impetus of expansion, begins to bend the reed over, the excited air-particles of the interior not only press forward to fill the places of the lost, but eagerly crowd out upon the top of the reed, irresistibly sucked into the zone of rarefaction around the mouth, a region where velocity has ensured least pressure, and through this same "law of least pressure," there is a loss of support to the under surface of the reed, favouring the curve of flexure, the pressure varying and diminishing from the root upward.

As yet we have no vibration, for simultaneously with the exterior action the interior rarefaction is extending high upward, the air-particles are rallying from further distances, awakened by the agitation of those in advance, throughout the whole length and breadth of the pipe, uneasy as bees in a hive; whilst the particles are swarming toward the mouth, they are drawing away from the main body of their supports, their own elastic energy is diminishing, they are more and more thinned in numbers, and the new levies come up to the front exhausted of their early vigour. Now is the supreme moment of the reed's advantage, its watchful ally, the external air, pierces the weakest line just under the sharp edge of the lip, and dashing in as a wave of condensation with cumulative pressure, drives back the outflowing wave, and would restore equilibrium but that the air-column, still advancing, and pressed forward in consequence by the inroad of the upper air, meets it in full shock ere it has reached midway; meanwhile the air-reed, rising with vigour to recover its upright position, and following after its ally in the wake of the retreating column, slightly overpasses its own line, enters the pipe momentarily to be cast out again, for the wave of rarefaction is returning and vibration is established. The invading wave has been repulsed at the spot hereafter memorable as *the node*, and the conflict renewed and continued will chronicle no victory to either unless other and foreign forces are brought in, for, as I shall show, we have resources within command enabling us to sway the equipoise and give supremacy to the reed.

"I do suppose," as Dr. Hooke says in his talk on "springy bodies," "I do suppose the particles" behave, and that the action takes place in the manner I have described; the analogy is not strained, nor have I used one phrase in association of ideas which I do not think fully justified by the physical relations of

the process. Therefore do not dismiss this as the sketch of a fancy battle. Watch for yourselves; place within the pipe at the back of the mouth some fine filaments of cotton, or fluff or down; advance them from the interior to the inner edge of the windway, and you will see them shot with energy not upward into the pipe, but outward full in your face with an unmistakeable trajectory. Do we not bring into activity the same force, "suction by velocity," when we blow through one little tube over another tube leading down to a well of perfume and draw up thereby scent-laden globules caught in the belt of wind passing over the tube's orifice, dispersing fine odour-sprays into the atmosphere? When a train of carriages loosely coupled is starting out of a railway station, should the engine suddenly back a little we see the hindermost portion of the train with its acquired momentum meeting the foremost portion advancing to it with reversed direction of impetus, and the central carriages receive a double compression, a rude kind of node is thus formed starting a reaction of bufferage in opposite directions; so when trains come into collision or are suddenly stopped in career, the distribution of weight, the gradients and relative velocities determine which portion feels most the influence of the shock. Again an analogy. There is a country custom, when the bees swarm to dredge them with flour as a means of identification, if the flour *travels* you will know the bees have journeyed likewise. Take a piece of white tissue paper (a bank-note answers it admirably), fold it so that a portion will occupy very nearly the space of the embouchure of the diapason pipe, by using a card it may be held level on the outer edge of the windway, it is in fact a paper reed but flaccid and inanimate; as you advance it to the windway no sooner is it caught in the current than it darts upright and becomes incorporated with the air-reed,

"Grows with its growth and strengthens with its strength."

This same crisp little bit of paper will reveal to your eyes the treasured secret of the organ-pipe, tell you how its wealth of varied tone is wrought, show you its fine arcs of flexure, how it bends less for its inward than for its outward stroke, and how its free curves are moulded to your will; listen, and you shall hear the domestic wrangle of the reed and pipe; look, and you shall witness how in its high caprice it transmutes in a flash to harmonic speed and leaps exultant to its octave. Truly an Ariel imprisoned, endowed with form, and clothed with a white vesture making it in all its motion visible as bees.

On the supposition that the theory herein advanced is justifiable, the work of the aeroplastic reed is to be considered, specifically, *to abstract*. By reason of abstraction rarefaction ensues, condensation correlates therewith, the latter springing out of the former, and the product is vibration. The reed is the generator of the power and the node is the fulcrum of vibration, the place of reaction, with this peculiarity that it affords an elastic fulcrum sensitive to the encroaches of the column of air above it; in the stopped pipe on the contrary there is a stable unyielding fulcrum, and the results of this difference are very remarkable, as will be seen in another paper necessary to complete this exposition, but at present I can only allude in passing to one of these results which it seems desirable not to omit here. Admitting my affirmations so far as they can be proved by other eyes, objections will be taken to the imaginary description of the action of air-particles and waves in the interior of the pipe, as opposed to received doctrine. Novelty is often held to be outrage. It is an essential feature of my hypothesis that the initial movement, or prelude to vibration in the pipe, is distinct from successive movements both in its course and character; it extends throughout the pipe, is continuous but diminishing in degree, and is without a node, which is only fully established at the second course. Without entering now into further details it is important to notice that this interval between the first effort or gasp of the pipe and the full possession of its power, is distinctly perceived by the ear. All musicians acquainted with organs are conscious of this, and it is matter of usual comment with them how that stopped pipes are on the contrary remarkably quick of speech, instantaneous in articulation. They feel this without reasoning of why or wherefore. As in stopped pipes there is no supernodal column, no requirement for an effort similar to that awakening motion to perfect vibration in open organ-pipes, the verdict of the ear is in both cases consistent with and corroborative of the hypothesis. Experiments with a very peculiar pipe called the "German Gamba" will throw invaluable light on the process of tone-making in organ-pipes.

HERMANN SMITH

The Degeneracy of Man

WITH regard to the culture of savages in Brazil the evidence of facts will be more esteemed by Mr. Tylor than the opinion of Dr. Martius, for Mr. Tylor has brought together a wealth of facts on the history and conditions of culture.

There is one class of facts which to my mind bears particularly on this question of the tribes of Brazil and the Amazons, and that is language.

The Kiriri and Sabuyah of Bahia as also the Ge have affinities with the Shoshoni and other dialects of the Rocky Mountains, and it is difficult to believe a language of this kind can belong to an epoch of high culture.

The dialects of the Tocantius have affinities of a like character with the Ankaras and Wun of Africa, and with that of the Akka pigmies just discovered in the Nile region.

The Purus, Coroado, and Corope of Rio Janeiro appear to belong to the Carib directly, and thereby also to Africa.

In the present state of our materials and information it is impossible to define exactly the members of each class. Thus the two groups last mentioned appear to be connected by the Baniwa and the Carib.

The main body of the population of Guarani, Tupi, Omagua, have by me been long since pointed out as having a language similar in roots and grammar to the Agaw of the Nile region. This is the highest development of language known to me in Brazil.

If the tribes of Brazil have fallen from a higher estate it is strange they should have become endowed with languages of the Prehistoric epoch.

HYDE CLARKE

June 29

THE gradual degeneracy of savage man from a higher type is a fact which an eminent author states in his letter in NATURE (vol. x. p. 146) to be difficult of belief. He wonders that Dr. Martius should say "the Americans are not a wild race, they are a race run wild and degraded."

The following facts seem to me to support the view held by Dr. Martius, Alex. von Humboldt, Abp. Whately, the Duke of Argyll, and others.

In the Ilium now laid bare by Dr. Schliemann, the lower strata contain more copper and fewer stone implements than the upper. "In other words, we have the very 'unscientific' fact of an 'age of stone' above an 'age of copper'" (Quart. Rev., April 1874). "The newly opened mound of Hissarlik stands as a lasting witness to a progressive decay of civilisation, industry, and wealth, among the successive races of its inhabitants" (Quart. Rev.).

Among the forest tribes of Brazil Dr. Martius found traces of the village community with its tribe-land common to all, while huts and patches of tilled ground were treated as acquired property, the recognised owners not being individuals but families. This may be well explained as a custom brought by Asiatic immigrants into the American continent. The Chinese anciently divided the land of a village into nine parts. The division was made by two perpendicular and two horizontal parallel lines. The middle square was common land. The eight remaining squares were assigned to eight heads of families, who cultivated the common square, giving the produce to the Government: they constituted a village. This principle of revenue collection based on land distribution existed for many centuries in ancient China, and was afterwards changed for a grain tax in kind about the time of the building of the Great Wall. Agricultural emigrants to America at any date before 200 B.C. would be familiar with this mode of doing things, and would naturally carry with them the knowledge of this and other customs existing at the time in eastern Asia. The appearance of a principle of land distribution resembling that of the old Teutons, among American tribes, cannot then be taken as proof that they were progressing and not degenerating, for it may, when our knowledge of ancient America becomes more accurate, be seen to be one of the lingering remains of an older civilisation which in a tropical climate favourable to indolence would easily decline. The religious beliefs and social customs of Asiatic and American races are in many respects so similar that there is abundant ground for questioning the originality of any civilised custom found among American tribes. Why should not comparative ethnology one day find the key to solve all such questions?

This fact, looked at from the eastern Asiatic point of view, is so far then from supporting the theory of progressive development, that it may rather be used as an additional buttress for the theory of degeneracy.

Names of number among Malayan and Polynesian tribes may be referred to as a proof of degeneracy. The sound "man" is 10,000 among the natives of Samoa and Tonga, as it is in Chinese, but it is 4,000 in the Sandwich islands, and 1,000 in New Zealand. Islanders avoid high numbers, and allow the significance of a name of high numbers to sink. This is proof of degradation. The reason why the arithmetical faculty among the New Zealanders has become weaker than elsewhere is because of their enormous distance from the continent of Asia. Samoa and Tonga are much nearer, and accordingly in those islands the religious traditions, *e.g.* circumcision, resemble those of Asia very closely. The Polynesians formerly had a decimal arithmetic, now it has sunk in Australia to quaternary or quinary arithmetic. In Ponape, one of the Caroline group, and comparatively near to the continent, *apuki* is 100 of men, trees, or yams, but 1,000 of eggs, cocoanuts, or stones. In Chinese *pak* is 100. After centuries of use high numbers fluctuate in value, because the intellect of islanders declines in power as the effect of long-continued isolation. The ideas, names, and usages of civilisation are gradually lost, and with them the human intellect becomes dwarfed.

Prof. F. Müller, after showing that the Polynesians could originally count to 100, adds, "Dies ist gewiss ein Zeugniss für die nicht geringe geistige Begabung und frühzeitige Entwicklung dieser Völker." * The Polynesians, then, have sunk in power, and were, when visited by Capt. Cook, in a state of progressive degradation.

The question raised by Mr. Tylor was only—"Did Dr. Martius change his opinion about the degeneracy of Brazilian tribes?" Dr. Peschel thinks he did, but has not yet given sufficient proof. While I venture to think that the question—"Is savage man a degenerated being?" can be solved in the affirmative by the careful comparison of facts, without our needing to know that each scientific traveller holds this view, it would be most interesting to be assured that all such men are agreed upon it.

JOSEPH EDKINS

Disuse as a Reducing Cause in Species

IN a letter of mine (NATURE, vol. ix. p. 361), entitled "Natural Selection and Dysteleology," there occurs a footnote upon the above subject. As this footnote was rather carelessly written, I wish to explain my meaning more clearly.

In the first place, it is evident that the fact of disuse causing atrophy in individuals is no proof that it likewise causes atrophy in species; for if it does so, the laws under which it operates in the two cases must be quite different—the one set being as exclusively related to Inheritance, as the other set are independent of this principle. The primary question therefore is: Does inheritance here reproduce the character of immediate ancestors, as in congenital atrophy, &c.; or of distant ancestors, as in mutilations, &c.? I think there can be no reasonable question that it does the former, and so have no doubt that disuse is a cause of atrophy in species. The question as to degree, however, remains.

One sentence in the footnote I am explaining may be taken to imply that the effects of disuse are exhausted in a few generations. Nothing can be further from my meaning. If disuse acts at all in species, its *modus operandi*, as just stated, must be that of *causing* variations which are capable of being inherited; consequently, if disuse acts thus at all, it is impossible to assign limits to its operation in time. The question, however, is, In what proportion are the effects of disuse in the parents reproduced in the offspring? Variations caused by disuse certainly differ from congenital variations, in that they are not fully inherited; and it is the degree in which they are inherited that must determine the rate at which disuse here operates. This degree, however, is unknown: we only know that it is something very small. Now as disuse is in competition with other reducing causes, the rapidity of its action is an important factor in the estimation of its probable effects.

By the omission of the word "proportional" near the end of the footnote, I appear to institute an absolute comparison between the effects of disuse in wild and in tame species. This, of course, would be absurd. What I mean is, that supposing disuse to be the chief cause of atrophy in wild species, it has not produced so much effect in tame species as we should antecedently expect; for, although the facts are very scanty, so far as they go they tend to prove, that when an organ is disused for several generations only, the rate of its reduction is much greater than it ought to be, supposing disuse to be the main cause of atrophy in our domestic animals, and supposing the action of this cause to be uniform.

It will be asked, If we thus in part reject this cause, what other have we to substitute? This, of course, is a collateral issue; but as it is an important one, it may here be discussed. I would suggest the cessation of selection (see NATURE, vol. ix. p. 440) as a co-operating cause, for it seems to me that this *must* have acted here to some extent, and if no other causes have been at work, this extent must be the complement of the effects due to disuse. For the sake of definition, therefore, we shall assume disuse to be in abeyance. Now, on this assumption, we should expect to find that atrophy proceeds more rapidly during the initial stages of reduction than subsequently. But without dwelling upon this point, what may we infer from the existing degree of atrophy in the affected organs of our domestic animals? Supposing the cessation of selection to be the only cause at work, what degree of atrophy should we here expect to find? Before I turned to the valuable measurements given in the "Variation," I concluded (Cf. NATURE, vol. ix. p. 441) that from 20 to 25 per cent. is the maximum of reduction we should expect this unassisted principle to accomplish, in the case of natural as distinguished from artificially-bred organs. Now on calculating the average afforded by each of Mr. Darwin's tables, and then reducing the averages to parts of 100, I find that the highest average decrease is 16 per cent., and the lowest 5; the average of the averages being rather less than 12. Only four individual cases fall below 25 per cent., and of these two should be omitted (Cf. "Variations," p. 272). Thus, out of eighty-three examples, only two fall below the lowest average expected. Moreover, we should scarcely expect disuse alone to affect in so similar a degree such widely different tissues as are brain and muscle. The deformity of the sternum in fowls also points to the cessation of selection rather than to disuse. Further, the fact that several of our domestic animals have not varied at all is inexplicable upon the one supposition, while it affords no difficulty to the other. We have seen that disuse can only act by causing variations; and so we can see no reason why, if it acts upon a duck, it should not also act upon a goose. But the cessation of selection depends upon variations being supplied to it; and so, if from any reason a specific type does not vary, this principle cannot act. Why one type should vary, and another not, is a distinct question, the difficulty of which is embodied by the one supposition, and excluded by the other. For, to say that disuse has not acted upon type A, because of its inflexible constitution, while it has acted on a closely allied type B, because of its flexible constitution, is merely to insinuate that disuse having proved itself inadequate to cause reduction in the one case, it may not have been the efficient cause of reduction in the other. But the counter-supposition altogether excludes the idea of a casual connection, and so rests upon the more ultimate fact of differential variability, as not requiring to be explained. Lastly, it is remarkable that those animals which have not suffered reduction in any part of their bodies are likewise the animals which have not varied in any other way, and conversely; for as there is no observable connection between these two peculiarities, the fact of the intimate connection between them tends to show that special reduction depends upon general variability, rather than that special variability depends upon special reducing causes.

Dropping, however, our argumentative assumption, it will be remembered that I deem it in the last degree improbable that disuse should not have assisted in reducing the unused organs of our domestic animals; and the effect of this remark is to show that the cessation of selection is not able to accomplish so much reduction as I antecedently expected. On the other hand, it seems to me no less improbable that the cessation of selection should not have here operated to some extent; but in what degree the observable effects are to be attributed to this cause, and in what degree to disuse, I shall not pretend to suggest.

No doubt the above considerations are of a very vague description; but this only follows from the scarcity of the data at our disposal, and it is to this very scarcity that I am principally desirous of calling attention; for although it is with reluctant diffidence that I venture thus, even in part, to dispute the doctrine of one whom most of living men I venerate, yet, for the reason just given, I cannot help feeling that the time has not yet arrived for a final quantitative decision upon this subject. However, as before remarked, "the question thus raised is of no practical importance; since whether or not disuse is the principal *cause* of atrophy in species, there is no doubt that atrophy *accompanies* disuse."

GEORGE J. ROMANES

* "Reise der Novara." Linguistischer Theil, 1867, p. 287.

Longevity of the Carp

LAST autumn, being at Fontainebleau, I was told by the servant of the Palace there that the German soldiers while in occupation of the place during the last war caught many of the carp in the pond of the Palace garden called "Jardin Anglais," and that some of these carp carried, attached by silver wire to their gills, little silver plates bearing inscriptions purporting that the plates were attached to the fish in the time of Francis I. and Henry II.—*i.e.* about 300 years ago.

Some of your German readers could easily ascertain by inquiry of the corps in occupation whether such fish were in fact caught. If it should turn out that they were, then, although the well-ascertained proof desired by Mr. Suffield (NATURE, vol. x. p. 147) would not of course be given, yet the fact would be evidence worth noting. F. G.

Cannes, June 28

THE "CHALLENGER" EXPEDITION*

V.

INACCESSIBLE AND NIGHTINGALE ISLANDS

THE first of these islands, the area of which is about four square miles, is situated about twenty-three miles W. by S. of Tristan d'Acunha. The cliffs rise to the height of about 1,000 feet in a perpendicular range on the north-east side. The tract beneath the cliffs is covered with *débris* of fallen rocks. On the cliffs themselves the plants are similar to those found in the same situation in Tristan. On the lower land are dense thickets of *Spartina arundinacea* Carm., a tall, reed-like grass, which here forms an extensive penguin rookery; patches of *Phylica arborea* Th. also grow on the summits of slight elevations; and under the shelter of the cliffs the trees attain a height of twenty feet, or even more. The trunks are seldom or never straight, but mostly lean over, or become partly procumbent, starting upright again towards the top. The largest trunk seen by Mr. Moseley measured a foot in diameter, but the trees on the upper plateau are said to measure 18 inches across, they do not, however, grow so high, being stunted by the force of the gales. The wood of the *Phylica*, though brittle, is said to be useful when properly dried, but in exposed situations it rapidly decays. Underneath the trees are ferns, mosses, and sedges, also *Acæna sanguisorbæ* Vahl., the leaves of which are used in New Zealand both as a tea and as a medicine. *Chenopodium tomentosum* Th., the tea-plant of Tristan, also grows in abundance, forming bushes with woody stems. A species of *Sphagnum*, *Carex insularis* Carm., and *Hydrocotyle capitata* Th. grew in a swamp near the penguin rookery. From the two Germans who were discovered on the island a good deal of information was obtained about the vegetation, more especially of that of the higher land, to which it was found impracticable to ascend from the side of the mountain where the ship anchored. The plants found there were similar to those which grew below, but in addition grew the species of *Empetrum*, found on the other islands, *Lomaria boryana* Willd., which in some instances attained a height of four feet, *Lycopodium insulare* Carm., and *Lagenophora commersonii* Cass., a small Composite plant with a daisy-like flower. The Tussock grass, which appears closely similar to *Dactylis cæspitosa* Forst., of the Falklands, grows in patches of considerable size on the upper plateau, and straggles up the cliffs to the summit. *Nertera depressa* Banks also grows on the plateau, and its berries form a favourite food of the *Nesocichla eremita*, the native thrush of the Tristan group; while the Bunting (*Emberiza brasiliensis*) feeds on the fruits of the *Phylica*.

The two Germans had cultivated the ground in the neighbourhood of their dwelling, growing potatoes, cabbages, and other European vegetables. Two species of clover also introduced by them were spreading rapidly, and a convolvulus was growing in quantity on the cultivated ground.

The other island of the Tristan group is named Nightingale Island, and is distant $20\frac{1}{2}$ miles from Tristan d'Acunha, and 12 miles from Inaccessible Island. It is, comparatively speaking, a mere speck about one square mile in extent, and to the west are two small outlying islands covered with Tussock grass. A rocky peak 1,100 ft. high rises on the north side of Nightingale Island and is continued into a ridge stretching across the island, a valley separating this from a lower ridge which runs nearly at right angles. On the lower tract *Phylica arborea* occurs in patches, and on the high ground was seen *Lycopodium insulare* and a species of *Cotula* different from that found in Tristan and not seen at all in Inaccessible Island. *Sonchus oleraceus* L., which grows abundantly on the other islands, is, together with several other plants, absent from this. The Tussock grass forms a dense growth over nearly the whole island, growing in thick tufts or clumps to a height of five or six feet, and so matted together near the base of the clumps as to be almost impenetrable. The abundant growth of this grass causes the island to become an enormous penguin rookery, and the thick deposit of the excrement of the birds imparts a greater vigour to the plants, so that the lower parts or bases of the clumps become of a peaty character, beds several feet in thickness, of a black peaty richly-manured soil, being thus formed. It was with the greatest difficulty that a way was made through this thicket, the grass being too high to allow the planning of any definite track, and the screaming and biting of the penguins, together with the stench from the thick deposit of dung, being anything but agreeable. Indeed Mr. Moseley says that the specimens of Tussock grass which he gathered on Inaccessible and Nightingale Islands were lost in the continued fight with the penguins and the long grass. In one place a quantity of the trees of *Phylica arborea* had been blown down by the wind, and the trunks were lying dead on the ground. Lichens, as well as two fungi, were found on these dead trunks.

A dark green ulva forms a thin coat on the rocky shelves of the coast near the caves of the seals, which, when dry, as was the case during the *Challenger's* visit, has a peculiar metallic appearance. The island is never visited except during the sealing season.

Though it has been stated that the vegetation of the Tristan group knows no change of seasons, it is proved that some of the plants mentioned in these notes have their periods of flowering; thus the *Pelargonium* is said to flower in the middle of the summer, when a large number of the flowering plants are at their best, and the shore is covered with the fallen petals. At the time of the *Challenger's* visit in October few plants were in flower, but the phylica trees all bore fully developed green fruits.

From the geological as well as the botanical similarity of the three islands forming this interesting group, it may be surmised that a former connection existed between them. The different currents which sweep the Tristan group bring with them many foreign seeds, which are cast up on the shore. Amongst them was seen those of *Guilandina*, which are sometimes washed up on the Irish coast by the Atlantic current. These seeds are known in Tristan d'Acunha, as well as in Bermuda, where they are also occasionally cast up, as the sea-bean, the popular belief in the islands being that they are the seeds of a plant which grows at the bottom of the sea.

* These Notes are founded on letters addressed to Dr. Hooker by Mr. H. N. Moseley. Continued from vol. ix. p. 486.

THE FIGURE OF THE EARTH IN RELATION TO GEOLOGICAL INQUIRY

THE elevation and depression of different parts of the surface of the earth above or below a mean ocean level has frequently formed the subject of communications to NATURE, but in no instance, as far as I am aware, have any of these changes been referred to the remarkable shape of the equatorial circumference of the earth, and to the changes which it is not improbable are constantly but slowly taking place in the position of the major and minor axes of the equatorial circumference. On p. 98 of the second edition of "The Heavens," by Amedée Guille-

min, edited by J. Norman Lockyer, F.R.S., the following note is introduced in brackets by the editor :—

"The most recent results arrived at by geodesists have taught us that the earth is not quite truly represented by an orange, at all events, unless the orange be slightly squeezed, for the equatorial circumference is not a perfect circle, but an ellipse, the larger and shorter equatorial diameters being respectively 41,852,864 and 41,843,896 ft. That is to say, the equatorial diameter which pierces the earth from long. 14° 23′ east to 194° 23′ east of Greenwich is two miles longer than that at right angles to it."*

The history of these "results" may be briefly stated as follows :—

Capt. Clarke, R.E., in a communication to the Royal Astronomical Society, read April 6, 1860, and published in vol. xxix. of the "Memoirs," investigates the figure of the earth resulting from the best existing data. He concludes :—

"The result of our investigations then is this : that the ellipsoid which best represents the existing meridian measurements has its major (equatorial) axis in longitude 13° 58′·5 east from Greenwich."

The greatest and least values of the meridian compression are—

$$\frac{a-c}{c} \quad . \quad . \quad . \quad . \quad \frac{1}{286{\cdot}779} \text{ in longitude } 13^\circ\ 58'{\cdot}5 \text{ E.}$$

$$\frac{b-c}{c} \quad . \quad . \quad . \quad . \quad \frac{1}{309{\cdot}364} \text{ in longitude } 103^\circ\ 58'{\cdot}5 \text{ E.}$$

and the length of the polar semi-axis, 20,853,768 ft. "The difference of the equatorial semi-axis is 5,308 ft., or, in round numbers, just one mile."

The investigation from which result the above figures was undertaken by Capt. Clarke, in consequence of remarks by the Astronomer Royal in the "Monthly Notices" of the Royal Astronomical Society, vol. xx. p. 104 (January 1860), on General Schubert's "Essai d'une détermination de la véritable figure de la terre." The results arrived at in General Schubert's memoir is that the earth is an ellipsoid, whose elements are—

Polar semi-axis	20,855,605 ft.	
Maximum compression . .	$\frac{1}{292{\cdot}109}$	
Minimum „ . .	$\frac{1}{302{\cdot}004}$	
Longitude of major axis of equator . . .	41° 4′	221° 4′
„ minor axis of equator . .	131° 4′	311° 4′

the longitudes being measured from Greenwich eastwards.

For the dimensions of the earth on the elliptic hypothesis, Capt. Clarke prefers the following values, given at p. 773, of the "Account of the Principal Triangulation (Ordnance Survey)," viz.—

Equatorial . .	20,926,348 ft.	Compression $\frac{1}{293{\cdot}76}$
Polar . .	20,855,233 ft.	
Mean degree .	364,613·33 ft.	

The volume was published in 1858.

It appears, then, that somewhere between long. 13° and long. 41° east of Greenwich the major equatorial axis is about two miles longer at the present day than the equatorial axis at right angles to it ; and during earlier geological epochs, when the crust of the earth was in a more plastic condition, these differences may have been considerably greater, and the effect on the geological s ructure of the earth intensified.

The point to which I wish to draw the attention of those who have studied the successive variations in the level of certain parts of the earth's surface, relates to the effect which this equatorial "bulge" must have produced upon various geological phenomena, and particularly if the longitude of the bulge varies according to a determinable law.

* Mem. R.A.S. vol xxix 1860.

It will be readily seen that its influence will be felt—

1. On the elevation and depression of the land, especially near the equator.

2. On simultaneous elevation and depression on opposites sides of the earth.

3. On ocean currents, consequently on climate, &c.

4. On the thickening and thinning of formations to the east and west.

5. On the flow of rivers, hence on river and lake terraces, beaches, &c.

Observed facts, especially in North America, appear to show that the subsidence and subsequent elevation of that continent has always taken place very gradually and with a progressive motion from west to east and from east to west. In other words, these changes of level have assumed the form of a vast equatorial undulation progressing with extreme slowness, at one epoch in an easterly, and at another in a westerly, direction. This appears to be shown by the very gradual thinning out, or the very gradual thickening, of Tertiary, Cretaceous, and even Palæozoic formations. In Post-tertiary times, where we are brought nearer to the records of past changes, and may compare antipodal illustrations, it is apparently manifested by the stupendous escarpments which for 1,000 to 1,700 miles rear their wall-like fronts from 200 to 600 ft. above the Ontario, Red River, and Saskatchewan plains ; and it is further indicated by the symmetrical river terraces and lake beaches which are developed to a very remarkable extent throughout the whole of the northern part of North America.

These occur both on the east and west flanks of the Rocky Mountains, and are found in the various passes *through* that great range. To enumerate examples would be to select any large river issuing from the Appalachian Chain, the Laurentides, or the Rocky Mountains, at elevations varying from 400 ft. to 4,000 ft. above the present level of the sea. I hope that some of your correspondents may supply illustrations of similar geological phenomena occurring as near as it may be possible to find records on opposite sides of the earth and during the same geological period of time.

To the supposed motion of the equatorial bulge may also be partly attributed the changes in the direction of the flow of certain rivers, and the elevation of an axis across the North American continent from east to west between lat. 35° and 45° N., by which the drainage of the great Canadian Lakes (excepting Ontario) was diverted from the Gulf of Mexico into the Gulf of St. Lawrence. The ancient river channels through which the great lakes sent their waters to the sea are now filled with drift to a depth varying from 200 ft. to 600 ft. During the period of depression the great lakes were in direct communication with the sea, and their waters were brackish or salt. The dredging operations which have been conducted in Lake Michigan show the former marine character of the fauna of the waters of this lake.

The origin of beaches and terraces appears to be intimately connected with an easterly or westerly progress of elevation simultaneously with a northerly and southerly elevation, such as would be produced by the slow movement of an equatorial bulge in an east or west direction. In North America, where terraces and beaches exist in perfection at altitudes varying, as already stated, from 400 ft. to 4,000 ft. above the ocean, the phenomena may be studied with some prospect of elucidation.

I have been credibly informed that data do not at present exist which would enable astronomers to state definitely that the bulge in the equatorial circumference of the earth between longitudes 13° and 41° east of Greenwich is stationary, or whether it has an easterly or westerly motion, and thus partakes of the character of an undulation. Perhaps, on consideration of the causes which produce this ellipsoidal form of the equatorial cir-

cumference of the earth, we may assume that the longitude of the major axis is constantly changing and progressing from west to east within certain limits, and then returning from east to west; in other words, oscillating through a determinable space.

I have ventured to bring this interesting subject under the notice of the readers of NATURE in the hope that it may receive the attention which it appears to merit, and that satisfactory illustrations will be forthcoming to show that the differences between the equatorial major and minor axes of the earth are competent to explain or throw light on many disputed points in geological inquiry, and to lead to a rational solution of some difficult problems. On the other hand, it does not appear unreasonable to suppose that known geological facts may serve to point out a line of investigation which may lead to a more correct knowledge than we appear to possess at present of the figure of the earth, the probable changes which are slowly taking place, and the relation which these bear to geological inquiry. HENRY Y. HIND

Windsor, Nova Scotia

REPORT OF PROF. PARKER'S HUNTERIAN LECTURES "ON THE STRUCTURE AND DEVELOPMENT OF THE VERTEBRATE SKULL" *

V.

WHEN the investing bones, mentioned in the last paper, are removed, the chondro-cranium of the axolotl is seen to have a far lower structure than that of the salmon. The hinder part of the skull-floor is constituted by a flat plate of cartilage (Fig. 13, B.O) formed from the investing mass, and answering to the basi-occipital, but unossified. From this rises up on each side a narrow cartilaginous pedicle, which, uniting above with its fellow, forms the occipital ring inclosing the foramen magnum. An ossification—the exoccipital—is formed on each side of this arch where it bears the occipital condyles; but, as in all amphibia, the supra-occipital, like the basi-occipital region, remains cartilaginous.

From the front edge of the basilar plate proceed two cartilaginous rods, uniting between the nose capsules as an expanded inter-nasal plate (I.N) and rising up to form the walls of the brain-case, but leaving its floor and roof to be covered in by the investing bones—the parietals and frontals above and the para-sphenoid below. These rods are, clearly, the very slightly altered trabeculæ; they bear a single pair of ossifications, placed considerably in front of the optic foramen, and answering to the lateral elements of the "os en ceinture" or "girdle-bone" of the frog. The nasal capsules, situated immediately outside the expanded cornua trabeculæ (hypo-trabeculars), are as far apart as in the ray.

The auditory capsules are largely cartilaginous, but contain three bones—the prootic, the epiotic, and a small ossicle nearly filling up a membranous space in the capsule between the prootic and opisthotic regions; the space is the first appearance of a *fenestra ovalis*, the bone of a *stapes*, so that in the tailed Amphibians is seen the earliest foreshadowing of the delicate apparatus by means of which vibrations of the air are communicated to the membranous labyrinth. The apparatus is, however, in a very rudimentary condition, there being neither tympanic membrane nor external meatus, and the stapes being connected, not with a chain of ear-bones, but with a band of fibres, the stapedio-suspensorial ligament (s.s.l), which unite it with the hinder part of the suspensorium.

The upper end of the mandibular arch is not let down to a considerable distance from the skull like that of the salmon, but forms the whole of the suspensory apparatus of the lower jaw, thus taking on the function performed in the fish by the proximal portion of the hyoid arch. The suspensorium is a stout cartilage sloping downwards and forwards, rounded below into an articular surface for the jaw, and divided above into three processes, the pedicle (p) or true apex of the arch, the ascending process (a), and the otic process (o). The two former are coalesced with the hinder ends of the trabecula, the latter with the auditory capsule; the first division of the fifth nerve passes out between the pedicle and the ascending process. A granular deposit of calcific matter (Qu) in the lower part of the suspensorium is the only representative of the bony quadrate of the fish, the meta-pterygoid region remains wholly unossified.

The pterygo-palatine arcade is very rudimentary, being represented only by a thin bar of cartilage (Pl.Pt) passing forwards from the front edge of the suspensorium, but not coming into contact with the ethmoidal region. Two bones are, however, developed in connection with this cartilage—the small tooth-bearing palatine, and the enormous triangular pterygoid.

As in the salmon, the lower jaw, stripped of its investing bones, consists of an articular and Meckel's cartilage; the latter, however, is large and stout, and not reduced to a more slender root on the inner side of the dentary.

The hyoid apparatus (Fig. 12) is a strong bar of cartilage connected by ligament with the suspensorium and mandible; it is divided into cerato- and hypo-hyal, but is entirely unossified, and never comes into relation with the auditory capsule. The branchial arches are four in number; the two hinder are split up into a long epi-branchial, a short cerato-branchial, and a small wedge-shaped basi-branchial.

One of the most important points to be noted in the development of the skull is the formation of the stapes; this was formerly believed to be the apex of the hyoid arch, but its true nature—as a separated portion of the wall of the ear capsule—has been demonstrated in the frog, and confirmed in the newt, axolotl, and other forms. In the axolotl of about an inch long a crescentic slit is seen in the auditory capsule, formed by the degeneration of its cartilage into fibrous tissue; the ends of this slit extend and meet, and thus cut off a circular plug of cartilage set in a ring of fibre, producing at once the stapes and the fenestra ovalis.

The investing mass remains long in the condition of indifferent tissue, and even after chondrification has set in the two halves remain separate until a very late period, thus approximating to the state of things found in Menobranchus and Proteus, in which the two parachordals are permanently united only by fibre.

The trabeculæ are at first parallel with the post-oral arches, and only at a comparatively advanced stage come to lie almost at right angles to them, as in the first stage of the salmon. The pterygo-palatine process is very late in its development, arising as a bud from the mandibular arch, and growing forwards towards the trabeculæ, with which, however, it never actually unites. The minor changes which the arches undergo will not be described here, as they have been worked out at far greater length in the frog.

VI. *Skull of the Frog* (Rana temporaria).—As far as its general aspect is concerned, the skull of this well-known Batrachian is by no means unlike that of the axolotl: it presents, however, many important differences, and shows a marked advance towards the sauropsidan and mammalian type.

Among the most important of these characters may be mentioned the backward slope of the suspensorium (see Fig. 14), the large size of the maxilla and its connection, through the intermediation of a small separate bone (the quadrato-jugal, Q.Ju), with the quadrate, the union of the palato-pterygoid cartilage with the ethmoidal region, the disappearance in adult life of the branchial arches, and, most important of all, the separation of the upper end

* Continued from p. 108.

of the hyoid arch as a chain of auditory ossicles, for the purpose of communicating the vibration of the tympanic membrane to the stapes.

Certain noteworthy peculiarities may be mentioned, with regard to the investing bones, the chief being the fusion of the parietal and frontal into a single bone (Fr.Pa), the dagger-like form of the para-sphenoid, and the addition of a horizontal bar to the upper end of the squamosal which

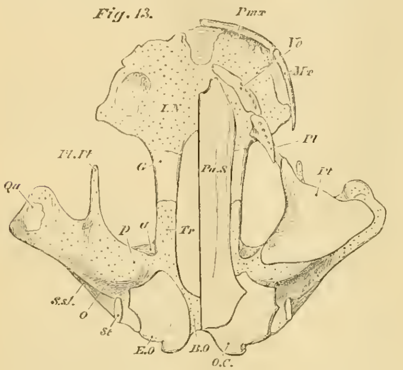


FIG. 13.—Skull of fully adult Axolotl, under view (× 2 diam.), the investing bones being removed from the right side. I.N, inter-nasal plate; p, pedicle, a, ascending process, and o, otic process of the suspensorium.

seems to answer to one of the bony plates developed in ganoids in the temporal region, while the vertical portion is clearly the homologue of the pre-opercular. An extremely small membrane-bone is also developed in connection with the external nasal opening: this is the septo-maxillary (S.Mx), which is interesting from its reappearance in lizards, snakes, and birds.

In the cartilaginous brain-case the form of the trabeculæ is entirely lost by the complete union of those arches below, so as to form a solid floor of cartilage within the para-sphenoid, and by the formation of a roof of like character beneath the fronto-parietals: the latter is interrupted by a large anterior and a pair of small posterior fontanelles. Just behind the inter-nasal plate a stout dice-box-shaped ossification is developed (G) overlaid above

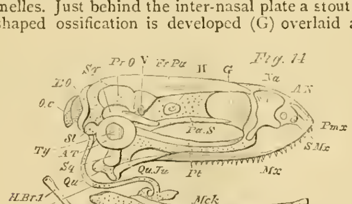


FIG. 14.—Skull of Common Frog (× 2). Ty, tympanic membrane; A T, annulus tympanicus; M Mck, mento-meckelian.

by the frontals and below by the para-sphenoid; this is the girdle-bone ("os en ceinture" of Cuvier), and answers to the hinder part of the ethmoid, the fore part of the pre- and orbito-sphenoids, and the pre-frontals. In its posterior half this bone contains a single cavity, in which are lodged the olfactory lobes of the brain, but in its anterior moiety a vertical partition (mesethmoid) divides it into two chambers, through which the nerves of smell pass to the nasal sacs.

Only a single bone occurs in the auditory capsule—the prootic, which extends backwards, so as almost to meet the exoccipital; the opisthotic, epiotic, and stapes remain entirely cartilaginous.

The palatine (Fig. 15, Pl) is a slender bone not provided with teeth; the pterygoid is 3-ranged, having an anterior process coming into relation with the palatine, a posterior articulating with the auditory capsule, and a descending bar which runs along the inner side of the suspensorial cartilage; the two latter help to inclose the eustachian opening (Eu). The suspensorium does not present that clear

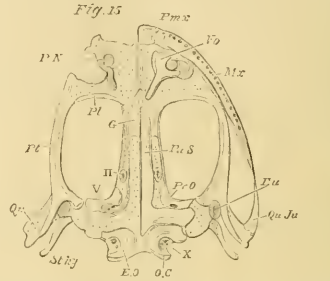


FIG. 15.—Skull of Frog, under view (× 2). the investing bones removed from the right side. P.N, posterior nares; Eu, aperture of eustachian tube.

division into pedicle, ascending process, and otic process which is observable in the axolotl; the second of these is, in fact, represented only by fibrous tissue, while the pedicle and the otic process are completely fused with the auditory capsule.

There is no articular bone in the mandible, but an interesting ossification (M.Mck) of Meckel's cartilage takes place at the point of union of the two rami. This is the symphysial ossification or "mento-meckelian" bone; it has been found in the sturgeon and also in early stages of the human subject.

The hyoid arch is divided into two portions, an upper, which subserves the function of hearing, and a lower, which supports the tongue. The first of these (Fig. 16) is a hammer-shaped apparatus, partly cartilaginous, and partly bony, the handle of which articulates with the stapes (St), while the head is fitted into the drum-membrane (Fig. 14, Ty).* The parts of this ossiculum auditûs have been named by Prof. Huxley, in their relation to the stapes, inter-, medio-, extra-, and supra-stapedial; taken together they answer to the hyo-mandibular and symplectic of a fish. The medio-stapedial (M.St) is ossified; the other portions of the apparatus are

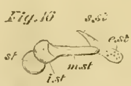


FIG. 16—Ear-bones of Frog (× 4). i,st, inter-stapedial; m.st, medio-stapedial; e.st, extra-stapedial; s.st, supra-stapedial.

cartilaginous. The tongue-cartilage is a shield-shaped plate consisting of basi-hyal in its anterior and basi-branchial in its posterior part, and connected with the skull by two slender, spring-like rods, the stylo-hyals (St.Hy), which are fused with the auditory capsule; these answer to the anterior or lesser horns of the hyoid bone of man, the greater horns being represented by the ossified first hypo-branchials or thyro-hyals (H.Br. 1) which embrace the larynx.

* The annulus tympanicus (A.T), or ring of cartilage which supports the drum-membrane, would seem to answer rather to the external ear of a mammal than to the tympanic bone.

FERTILISATION OF PAPILIONACEOUS FLOWERS—CORONILLA

IN NATURE, vol. vi. pp. 478 and 498, you inserted a paper of mine in which an attempt was made to draw certain general conclusions concerning the fertilisation of papilionaceous flowers from the examination of a few genera, chiefly English: and in that paper I stated that the foreign genus *Coronilla* presented peculiar difficulties. I have since then been stimulated by Mr. Darwin's kind interest to examine *Coronilla* more carefully, and now send you the results.

The ultimate result of these generalisations was that in all the following particulars, viz. the position and motion of the flowers and the peduncle, the cohesion of the petals, the cohesion of the stamens (so remarkable a feature in this tribe); the structure and character of the filaments, of the anthers, and of the pollen, the structure of the style and stigma; and the place where nectar is secreted; the parts and functions are so organised and correlated as to induce and compel insects, generally bees, in visiting the flowers for nectar, to carry away with them pollen from one flower and bear it to another.

One, perhaps the most striking, of the generalisations in question was as follows:—

"The degree to which the cohesion of the stamens is carried, so remarkable a feature in this tribe, seems to depend on the necessity for access to nectar. In those

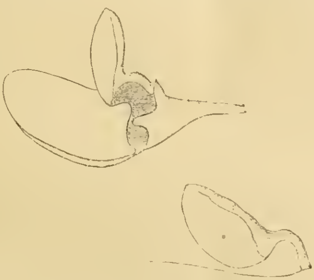


FIG. 1.—Coronilla varia.

flowers in which the stamens are monadelphous, viz. Ulex, Sarathaumus, Genista, Cytisus, Ononis, Lupin, there is no symptom of nectar within the staminal tube, no space for it, and no access to the interior. In some, at any rate, of these, viz. Ulex, Ononis, and Lupin, the bees certainly resort to other parts of the flower. On the other hand, where the tenth stamen is entirely free or where it is separated from the others at the base, so as to give an insect access to the interior of the staminal tube, there is nectar within this cavity."

To this generalisation the two species of *Coronilla* which I had examined, viz. *C. varia* and *C. glauca*, seemed to form an exception. In them the tenth stamen was always separate; but there was no aperture at the base of the staminal tube, no nectar within the staminal tube, and no space for it, the base of the staminal tube fitting as closely round the pistil as it does in those papilionaceous flowers in which the tenth stamen is not separated from the rest.

I have since had an opportunity of examining several species of *Coronilla*, and of watching large plants of *C. varia* (Fig. 1) and *C. emerus* (Fig. 2) in full flower. In all these flowers there is a peculiar structure of the petals. The claw of the vexillum is thin, sometimes prolonged and straight as in *C. emerus;* sometimes shorter and curved as in *C. varia.* The claws of the other petals cohere so as to form a channel, in which the staminal tube lies. But in all cases there is, immediately above the calyx, a large open space between the claw of the vexillum and the claws of the other petals so as to have free access from the outside to the inside or the inside to the outside of the flower.

One hot day last August I watched a bee rifling the flowers of *C. varia* in the regular way. He settled as usual on the lower flowers of the crowded umbel first, resting on the wings and keel, and went rapidly round and up the umbel. The plant was a large one, and he must have been there more than half an hour. He did not seem to be taking pollen. What could he be doing? for there was no semblance of nectar either inside the base of the petals or calyx or inside the staminal tube. On examining the flower carefully with a glass the *outside* of the calyx, which is thick and fleshy, appeared to be covered with shining glands or vessels, sometimes I think moist, but always yielding copious liquid on very slight pressure. Could this be what the bee was seeking? On a subsequent day I again watched a similar bee rifling the flowers, and at last distinctly saw his proboscis, which had entered as usual by the front of the flower, protruded outwards through the gap between the claws of the petals and sweep the outside of the calyx. Here then was an answer to my difficulty. The nectar for which the bee sought the flower, and in getting which he benefited the plant by carrying pollen from flower to flower, was not in any of the usual places inside the flower, but outside the calyx, while there was a very peculiar construction of the petals giving access to it. Instead of proving an anomalous exception to the generalisations I have quoted above, it turns out to be another curious illustration of the various ways in which the same

FIG. 2.—Coronilla emerus.

function of secreting nectar and of attracting the bee to it in the manner requisite for fertilising the flower is effected by different organs. That the outside of the calyx should secrete nectar and that there should be a peculiar window, out of which the bee, having entered by the regular door, and having in so doing dusted himself with pollen, should be able to get at the nectar, is surely a remarkable specialisation, and also a remarkable confirmation of the result of generalisations I had previously made.

Since then I have examined some other species or varieties of *Coronilla*, viz. *Coronilla emerus*, a very pretty free flowering garden shrub or creeper, a variety of this named *Coronilla emerus lutescens*, *C. montana*, and *C. minima*.

In *Coronilla emerus* the claws of the petals are much prolonged, so as to make the whole flower much longer than in the other species (see Fig. 2). The structure of the staminal tube is like that of Pisum, Lathyrus, Robinia, &c., in having a large cavity at the base filled with water, and large apertures on each side of the base of the tenth stamen, by which the bee's proboscis can reach the nectar. The long tube or channel formed by the claws of the petals is such as to lead the bee's proboscis directly to these apertures; and I have this spring distinctly seen a humble-bee getting the nectar in this way. The aperture between the claws enabled me to see the bee's proboscis going right down to the base of the staminal tube. On the other hand there is no appearance whatever of nectar or of glands containing nectar outside the calyx.

In *C. emerus lutescens* the structure is the same, except that there is a curious little excrescence on the inside of the claw of the vexillum just above the calyx. Does it

guide the bee's proboscis to the apertures in the staminal tube, which it is to be remembered are on each side of the central tenth stamen? Mr. F. Darwin has suggested a function of this kind for a somewhat similar structure on the free tenth stamen of Phaseolus.

C. montana is a small plant, very like *C. glauca* in structure. The flower forms compact umbels; the claws of the petals are short, with a wide opening above the calyx; the tenth stamen is free, but the staminal tube is close-fitting, and there is no nectar inside the flower. *Per contra*, there are distinct glands or bubbles of liquid on the outside of the calyx, which is much infested by aphis.

C. minima is similar in structure; and both these species or varieties are similar to *C. glauca*.

We have then in this genus a number of species or varieties, all of which have their tenth stamen free, but which differ widely in other respects.

1. In *C. emerus* and *C. emerus lutescens* the nectar is in the base of the staminal tube, and is accessible by the separation of the tenth stamen in the usual manner.

2. In *C. varia*, *C. montana*, *C. glauca*, and *C. minima* the staminal tube is barren of nectar, but the nectar is secreted outside the calyx, and the access to it is provided for by a special gap between the petals.

In both cases, however, the flower is so constructed that the bee in getting the nectar which he wants dusts himself with and carries from flower to flower the pollen.

Some questions remain. The separation of the tenth stamen and the gap between the petals and the separate stamen both exist in all the species; where one is of use the other is useless. Why do they co-exist? Did one exist before the other? and is one of them now useless and rudimentary? If so which was the earlier and which the later in development?

A further observation arises. These *Coronillas* are foreign plants, and in many gardens and greenhouses have only been introduced recently. In my own garden in Surrey I have introduced *C. varia* and *C. emerus* from London within these last four years, and I am not aware of any other plants in the neighbourhood. But the bees seem quite to understand how to get the nectar from both. In *C. emerus* this is not surprising, for there are many other common flowers—Robinia, Pisum, Vicia, Lathyrus, &c.—similarly constructed. But I know of no flower common in England which is like *C. varia* in having the nectar outside the calyx, with the peculiar access to it through a gap in the petals. And yet the Surrey bee found his way to it at once. Does not this look as if the bee had sufficient intelligence to adapt his doings to a perfectly new and unknown structure?

T. H. FARRER

LENZ'S DOCTRINE OF OCEAN CIRCULATION

A VERY elaborate memoir was presented to the Royal Society at its last meeting, by Mr. Prestwich, containing a digest of all the observations made upon deep-sea temperatures previously to the *Lightning* cruise of 1868, which was the starting-point of all those recent researches that have excited so strong and general an interest. Of these observations, some of the most important were quite unknown to the scientific men of the present day, until brought to light by Mr. Prestwich's patient research; and I would take the earliest opportunity of particularly calling attention to those of Emil. Lenz, an eminent German physicist, formerly settled in St. Petersburg,* who accompanied Kotzebue in his second Circumnavigation Voyage in 1823–26. Of this voyage, the obtaining of deep-sea temperatures was one of the special objects; and, with a view to accuracy of observation, experiments were previously instituted by Parrot upon the influence of pressure on self-registering thermometers, of the same kind as those made by Mr. Casella under the late Prof. W. A. Miller and myself in 1869. And the St. Petersburg professors satisfied themselves by their experiments (as we did by ours nearly fifty years later), that any observations taken by sending down ordinary thermometers to great depths must be seriously vitiated by the pressure of the superincumbent water.

Instead of attempting, however, to improve his thermometers by the protecting outer bulb* which made our instruments thoroughly trustworthy, Lenz devised a method of obtaining deep-sea temperatures, which must have been very difficult to work, and which required a good deal of mathematical computation to bring out its results; yet this in his able hands gave temperatures which prove to be in close accordance with the thermometric observations of the *Challenger*. He also made throughout the voyage a careful series of observations on the temperature of the ocean at the surface and at moderate depths below it, which proved to be of the greatest value in the establishment of his general doctrine. And he further made an important series of observations on the salinity of ocean-water as indicated by its specific gravity. The increase of the density of sea-water with the reduction of its temperature down to the freezing-point, was known to Lenz through the experiments of Dr. Marcet in this country, and of Erman in St. Petersburg; and he was consequently free from the influence of the "dominant idea" that the deep water of the ocean, like that of the Swiss lakes, would have the uniform temperature ($39\frac{1}{2}°$ F.) of *fresh* water at its greatest density; which obviously influenced the conclusions subsequently drawn from their own observations by D'Urville and Sir James Ross, and led to the general adoption of those conclusions.

The whole series of these observations, with the mathematical computations required for the determination of the real bottom-temperatures, are contained in a most elaborate memoir, entitled "Physikalische Beobachtungen, angestellt auf einer Reise um die Welt, unter dem Commando des Capitains von Kotzebue, in den Jahren 1823-26," presented to the St. Petersburg Academy in 1829, and published in vol. i. of its "Transactions" (1831). No one can examine this memoir without being impressed with the remarkable ability it displays; a peculiarly competent judge, Prof. Debus, whose attention I have directed to it, assures me that it is a model of admirable physico-mathematical investigation.

It was not until 1845, however, that Lenz gave forth the general conclusions to which he was led by his own observations and those of others (so far as known to him) in his admirable "Bemerkungen über die Temperatur des Weltmeeres in verschiedenen Tiefen," published in the "Bulletin" of the St. Petersburg Academy for 1847. He there shows that his own conclusions as to the low temperatures obtained at great depths are not invalidated by the observations of others, indicative of higher temperatures taken with ordinary thermometers; but may still be taken as indicating the presence of glacial water on the bottom of each of the great oceans, even under the equator. And from a discussion of the numerous temperature-observations taken at the surface and at small depths beneath it, Lenz deduces the important conclusion *that there is at and under the equator a belt of water cooler than the water to the north and south of it*. Of this striking phenomenon, he says, the explanation flows directly from the form of the isothermal curve which represents it; and this explanation I shall presently reproduce in his own terms, which will be found singularly accordant with those used by myself in the notice I

* The list of Lenz's papers occupies four columns of the Royal Society's Catalogue. A large proportion of them consist of original researches, both experimental and mathematical, in electricity and magnetism. And I am assured by Sir Charles Wheatstone that these are of the highest merit, and were greatly esteemed by Gauss and Jacobi, the two great masters in this department of investigation.

* It is right to recall the fact that this "protection" was first devised by Admiral Fitzroy, and was practically worked out by Messrs. Negretti and Zambra, as far back as 1857.

gave of the *Challenger* observations in the *Athenæum* of May 16.

As I have never claimed any originality in regard to the doctrine of oceanic circulation, which I have advocated solely as an important scientific truth, it has afforded me nothing but the most unalloyed satisfaction to find that the doctrine which appeared to me, as to Sir John Herschel (when I brought the case fully before him), the "common sense of the matter," was put forward nearly thirty years ago by one of the most eminent physicists of his day, as a necessary deduction from the facts of observation. That Lenz's Doctrine of Oceanic Circulation (for so it should now be termed) did not then obtain the general acceptance which I now confidently anticipate for it, seems principally due to the little attention formerly paid to Ocean Physics; it being only in recent years that the relation of deep-sea temperatures to the distribution of animal life on the ocean bottom, and the consequent importance of this knowledge in geological research, has made the inquiry one of general interest. This is the point of view in which the study of the subject has been pursued by Mr. Prestwich, whose exhaustive memoir will constitute a most valuable preface to the full discussion of the *Challenger* observations, when these shall have been brought to a conclusion two or three years hence.

"The mass of water in the tropics," says Lenz, "warmed down to a certain depth by the sun's heat, cannot maintain its equilibrium with the colder water of the middle and higher latitudes; a flow of the warmer water from the equator to the poles must necessarily take place on the surface, and this surface-flow must be supplied at the equator by a flow of colder water from high latitudes, which would at first flow in an almost horizontal direction, but which under the equator must rise from below to the surface. In this manner, in the northern hemisphere, a great vertical circulation takes place in the ocean, which has its direction above from the equator to the pole, and below from the pole to the equator. Since these flows, moving in opposite directions, are distinguished by their different temperatures, we observe in the submarine isotherm an indication of the lower portion of this flow. A corresponding flow, but moving in the opposite direction, takes place in the southern hemisphere; so that *in a zone surrounding the equator, where the two flows meet, the water flows almost in the direction from below up to the surface.*"

Lenz further adduced the low salinity of the surface-water of the equatorial belt, compared with the high salinity of tropical water, as an additional indication of the continual ascent of polar water from the bottom. And after remarking that water moving in the north and south direction must have its course influenced by the rotation of the earth, he continues, "It is a point which has been determined by Humboldt, John Davy, and others, that the water of the ocean is colder at the surface over shallows, than at some distance beneath over very great depths. This phenomenon, the explanation of which hitherto has not been found to be satisfactory, is a simple consequence of the movement of deep cold water from the pole to the equator. For if this runs against any obstruction, such as a shallow would present, it will rise along it, as upon an inclined plane, and approach nearer the surface, which in this manner will be cooled down." Thus Lenz explicitly propounded the principle on which I have explained the "cold band" between the Gulf Stream and the United States sea-board, the similar cold band on the east coast of Japan, and the cold stratum on the east side of the Dogger Bank. And I venture to believe, therefore, that here, too, the "common sense of the matter" has led me to a right conclusion.

I learn also, from Mr. Prestwich's memoir, that Arago, in 1838, in his instructions for a scientific expedition to Africa, not only distinctly recognised the existence of an underflow of glacial water from the poles towards the equator as the cause of the reduction of oceanic temperature with depth, and explicitly repudiated the doctrine of the uniform deep-sea temperature of $39\frac{1}{2}°$; but also remarked upon the comparatively high temperature of the deeper stratum of the Mediterranean (first ascertained by D'Urville) as indicating that the polar flow does not find its way into that basin through the Strait of Gibraltar; thus anticipating the argument which I have based on my own investigations into the comparative thermal conditions of the Atlantic and the Mediterranean, as to the existence of a polar underflow in the former.

WILLIAM B. CARPENTER

NOTES

WE greatly regret to announce that Prof. Ångström died on the 21st ult.

MR. JOSEPH PRESTWICH, F.R.S., F.G.S., has been appointed to the office of Professor of Geology in the University of Oxford, as successor to the late Prof. Phillips.

THE Chair of Human Physiology in University College, London, in future to be called the Jodrell Professorship, after the name of its endower, has been filled by the appointment of Dr. J. Burdon Sanderson, F.R.S., who is now Professor of Physiology, including Practical Physiology and Histology. We have reason to believe that Mr. E. A. Schäfer will be appointed Assistant Professor under Dr. Sanderson.

M. A. DE CANDOLLE has been elected a Foreign Associate of the French Academy in the place of the late Prof. Agassiz.

THE death, at the early age of 28, is announced of Mr. Charles Tyrwhitt Drake, one of the officers in charge of the survey of Palestine. He succumbed to a second attack of malarious fever.

ENTOMOLOGISTS generally, and Coleopterists in particular, have experienced a great loss in the death of Mr. George Robert Crotch, M.A., of St. John's College, Cambridge. Mr. Crotch graduated in 1863, obtaining honours in the Natural Science Tripos. Until 1872 he was one of the Under Librarians at the University Library, when, besides his excellent work in that Institution, he devoted his spare time to his favourite subject. Mr. Crotch sailed for America in 1872, *en route* for Australia, for the purpose of studying the entomology of parts which he considered incompletely known, and on several occasions he has transmitted collections to England. He had added considerably to our knowledge of the entomology of California, Vancouver's Island, Oregon, and other districts; and on two occasions the Senate of Cambridge, recognising the importance of his work, voted him a sum of money from the University chest to aid him in sending collections to the University Museum.

TWO scientific expeditions are to set out from Archangel next summer—one into Russian Lapland, for the purpose of exploring the traces of ancient glaciers; the other, to the shores of the White Sea, has for its object zoological investigations. Dr. Yarjinsky, *La Revue Scientifique* states, who explored the district two years ago, discovered in the White Sea and the glacial ocean fishes and crustaceans till then quite unknown.

MR. JAMES LICK, of San Francisco, California, having in the course of his life accumulated a large fortune, has recently concluded a deed by which he conveys all his property to seven persons upon trust to be applied to various worthy objects. Among these, 700,000 dols. are to be applied to the construction of a more powerful telescope than any yet made, to be erected at an observatory in California, and 300,000 dols. to found, in California, a school of the mechanical arts.

THE last but one of the Government expeditions for observing the transit of Venus sailed from Plymouth for Christchurch, New Zealand, in the clipper ship *Merope*, on Saturday. The party consists of Major H. S. Palmer, R.E., chief astronomer in charge; Lieut. L. Darwin, R.E., assistant-astronomer and photographer; Lieut. H. Crawford, R.N., assistant-astronomer, and three non-commissioned officers of the Royal Engineers trained in the use of the photoheliograph.

A CORRESPONDENT writes that he has tried, with almost complete success, Prof. Helmholtz's remedy for Hay Fever, referred to in the paper (NATURE, vol. x. p. 26) sent us by Prof. Tyndall. Our correspondent gives the details of his treatment in a letter to the *Manchester Examiner* of the 30th ult., which also contains a letter from another sufferer who has tried Helmholtz's remedy with success. Our correspondent also asks,—"Could any of your readers give any information as to Weber's nose douche?—a more effective method of administering the remedy than by means of the pipette is desirable."

MR. SAVILLE KENT, Curator of the Manchester Aquarium, seems resolved to do his best to make that institution subserve the purposes of scientific instruction. Last Friday he gave the first of a series of lectures on subjects connected with aquaria to a fairly numerous audience; it is intended, we believe to continue the lectures on Friday afternoons during the summer.

DR. JOHN KIRK has received a letter from Lieut. Cameron dated Ujiji, Feb. 25, reporting his safe arrival at that place; he was just about to start for Unyanyembe. He heard from the people of Ujiji that the Lualaba from Nyangwé goes into the Mwootawzige or Bahari Unyoro, "so that," he says, "it must be the Nile after all."

MR. FORSYTH, the leader of the Yarkund Mission, arrived at Leh on the 17th. ult. all well. He is expected in Calcutta about the 15th inst. Dr. Stoliczka is reported to have died on the 19th ult. at Shyok, above the Saser Pass.

THE prospectus is issued of a series of Positivist publications, *La Bibliothèque Positiviste*, to be written by M. André Poëy, having for its object the popularisation of the positive philosophy. The prospectus is mainly an eloquent eulogy of the Positivist doctrines, and an attempt to show that since Comte began to write they have gradually penetrated everywhere. The *Bibliothèque Positiviste* will consist of 30 monographs, to be published at intervals, in which the principles of Positivism will be expounded in relation to every sphere of human thought and action. The first part is entitled "La Bibliographie Positiviste," and will contain a list of 750 publications in favour of or opposed to Positivism, all of which have been published since Comte began to write. The publisher is Ernest Leroux of Paris.

THE Turners' Company, unlike most of the antiquated City guilds, seems to be alive to the fact that there are other kinds of merit worthy of honour besides the distinguished one of being a prince of the blood, a foreign potentate, a conquering hero, or one of her Majesty's ministers. It requires distinction of a very blazing kind indeed to attract the attention of most of our obtuse City Companies. The above Company is, however, a creditable exception in this respect to most of the others. Shortly before his death it conferred its freedom upon the late Prof. Phillips, and last week it did itself the honour of marking in a similar way its appreciation of the work which has been done by Sir Charles Lyell, Bart., F.R.S. The Turners' Company is evidently awake to the fact that after all the Useful Arts, Manufacture, and Commerce may derive some benefit from the results of non-utilitarian scientific research. The arts represented by the Turners' Company use, as part of their material, various sorts of stones, and Mr. Jones, the Master, showed in his really eloquent and well-informed address last week, that these arts have been greatly indebted to Sir Charles Lyell for having done much in their behalf by spreading a knowledge of the materials with which they work. Sir Charles, in his reply, spoke of the storm of opposition raised against many of the geological doctrines propounded in his first work, half a century ago, as compared with their almost universal acceptance at the present day.

WE have received a copy of a very able address delivered by Dr. Julius Haast, F.R.S., before the Philosophical Institute of Canterbury, New Zealand, in which he comments on several points connected with the geology of that country, maintaining his own theory as to the glacial origin of the Canterbury Plains in opposition to that of their marine formation, as supported by Capt. Hutton. In speaking of the extinct Struthious birds whose remains are so abundant, he is disposed to divide them, contrary to Prof. Owen, into two main families: the Dinornithidæ with a long metatarsus, no hallux, and a bony scapulo-coracoid bone; and the Palapterygidæ with a short metatarsus, with a fully-developed hallux, and no ossified scapulo-coracoid bone; the last-named character being one of particular interest, and supported by several arguments, the strongest of which depends on the absence of any coracoid articular grooves on the anterior margin of the sternum.

A RATHER strong shock of earthquake was felt at Constantinople on Friday, lasting two seconds. No accident is reported.

THE French Government has recently voted the sum necessary for the formation of a great inland sea in Algeria, 190 miles long by 36 broad, to the south of Biskra. A chain of chotts (*Chott* implying the bed of a lagoon) considerably below the level of the Mediterranean, is to be utilised for the purpose. A full account of the project is given in the first June number of the *Revue des Deux Mondes*.

THE meeting which was to have been held this month in London in connection with the Edinburgh University Buildings Extension Fund, has been postponed until November next.

MR. SANDERSON, from Lancing College, has been elected to a Natural Science Scholarship in Worcester College, Oxford. Messrs. Hugh Brocas-Price, from University College, London, and Mr. Henry H. Robinson, from Magdalen College School, have been elected to Natural Science Demyships in Magdalen College.

MR. W. J. NOBLE, of Epsom College, has been elected to a Natural Science Scholarship in Keble College, Oxford.

A MEANS of preventing the spread of the vine-pest, the *Phylloxera vastatrix*, is said to have been found, in the spreading of a layer of fine sand on the ground round the stems of the plants. The sand is said to be too loose for this insect to pass through, and the consequence is that it is intercepted in its passage from one plant to another. We are sorry to hear a report that this plague has found its way into Australia. The vine-growing districts of our Australian colonies are becoming so important that we trust this report may be unfounded. At all event steps should be taken to prevent its introduction into any of our colonies: such a measure will be easier than its destruction, should it ever gain a footing in them.

IN view of the scarcity and high price of oysters in this country it is alarming to hear that the celebrated beds of Arcachon, Concarneau, and other places in the west of France, are thought to be less productive than formerly. The want of accurate knowledge concerning this bivalve is probably at the root of this scarcity, and it may also be possible that the changes which are constantly taking place in the position and even in the nature of the sea-coast, may have a serious effect on the productiveness of

the oyster beds all over the world. It is a well-known fact that oysters will not grow in certain localities where the conditions are apparently exactly similar to other localities where they will thrive; and the gradual change wrought by the sea in certain parts of the coast may account, quite as much as overfishing, for the gradual extinction of oysters. All beds are, however, fished much more extensively now than they were a few years ago, and whenever one is discovered, it is quickly worked out, without any consideration being given to the question of its extent, and whether it is a newly-established bed or not. America now largely supplies us with oysters either in a fresh state or preserved in tins, and it is calculated that in Maryland State alone, 5,282 persons are employed in dredging, and 10,947,803 bushels of oysters were taken in 1870-71; while the waters of Virginia are said to be equally productive. In the great oyster markets of Baltimore, where immense quantities of oysters are tinned, over 10,000 hands are employed in this branch of the trade.

A VALUABLE contribution to zoology is furnished by a paper published by Mr. Dall, on the birds of the Aleutian Islands, especially of that portion of the region to the west of Oonalaska, embracing the result of observations made during 1873 on board the U.S. Coast Survey vessel, the *Yukon*. As might have been expected, the great majority of the species are water-birds, particularly *alcadæ*, upon the natural history of which Mr. Dall throws much light, having been the first to collect eggs of several of the species, and observe their habits during the breeding season. The land-birds on this island are very few in number, consisting of two kinds of hawks, one owl, a swallow, and a wren, five finches, the raven, and ptarmigan. The total number of species enumerated is forty-five.

WE have received the prospectus of a work entitled "The Dominion of Canada; comprehending a General Description of the Confederated Provinces of British North America, and the North-west Territories," by Henry Youle Hind, M.A. (Montreal: John Lovell.) The following are the leading subjects:—I. Physical Geography of the Dominion. II. Climate and Climatic Effects. III. Geological Features. IV. Travel and Transportation. V. Agricultural, Forest and Mining Industries. VI. Commerce, Manufactures, and Fisheries. VII. The Inhabitants. VIII. Government. IX. Social Status. X. Miscellanea. The illustrations will consist of upwards of 250 engravings on steel, chromoxylographs, woodcuts, &c.

AT present the principal source of income to the United States from its acquisition of Alaska, and that which pays the larger part of the interest on the original investment of 7,000,000 dols. in its purchase, is derived from the fur-seal islands of St. Paul and St. George, which constitute the Pribylov group, in the Behring Sea. It is from these islands that the greater number of the skins of the fur seal as known in commerce are derived, the animals resorting to them in immense numbers every spring for the purpose of bringing forth their young. In 1870, an Act was passed by Congress limiting the number to be killed at 100,000. The Alaska Commercial Company secured the lease of the fishery, and has carried out the contract in apparent good faith. The condition of the islanders has been considerably improved. Congress has authorised the appointment of a commission to investigate the natural history and geographical distribution of the fur seal.

FROM the *Monthly Notices* of the Royal Society of Tasmania for June, July, and August, 1873, we learn that the Society has been making an inquiry in reference to the stone implements of the Tasmanian aborigines, especially as to whether the natives made use of these implements fastened to handles, after the manner of axes or tomahawks. All inquiries on the subject tend to prove that no true tomahawks were known to or fabricated by the natives; they merely used sharp-edged stones as knives. These were made sharp, not by grinding or polishing, but by striking off flakes with another stone till the required edge was obtained. As a very general, if not invariable, rule, one surface only was chipped in the process of sharpening. They were made from two different kinds of stone—the one apparently an indurated clay rock, the other containing a large proportion of silex.

A WRITER in the *Times* complaining of the want of labels in the Bird Gallery of the British Museum, states that "A young and active Naturalist has been appointed specially to look after this part of the collections." It is hoped that he will see that all the specimens are furnished with labels.

SOME experiments of particular interest physiologically have been undertaken by Dr. Worm Müller, and are described by him in Ludwig's *Arbeiten* (vol. viii. p. 159), an abstract of which paper will be found in the *London Medical Record* for last week. The author finds that the transfusion into the circulatory system of an amount of blood three times as much as that normally contained in the system does not cause any rise in the arterial blood pressure, though the pulse-rate is reduced. The reduction of the quantity of blood after transfusion, however, causes a rapid fall in the blood-pressure, even when only half that added has been removed. We think that the former of these results is not difficult to explain, for the heart, being an engine with only a limited capacity for work, it can only maintain a certain determinable blood-pressure, depending on the bulk of its muscular parietes. The introduction of an excess of blood to be circulated can therefore act only in filling the system at the expense of the velocity of the current, with a diminution in the rapidity of the cardiac action.

IT may be of some interest with reference to the demand of ladies to be admitted to the ordinary degrees of the University of London, to note that at the recent distribution of prizes at University College the first and second places in the mixed class of Jurisprudence were both occupied by ladies, Miss E. Orme, who two years ago took the prize in the class of Political Economy, coming out first, while in the mixed class of Political Economy a lady this year took the fourth certificate.

DR. W. G. FARLOW has published in the *American Journal of Science and Arts* an account of some investigations carried on in the botanical laboratory of the University of Strasburg, illustrating a remarkable asexual development from the prothallus of *Pteris serulata*. In the centre of the cushion or thickest part of the prothallus were a number of scalariform ducts, the prothallus bearing a number of antheridia, but no archegonia. From these ducts a leaf is developed directly, after which a root is also developed, and last of all a stem-bud. A comparison was drawn between this growth, which was observed in this species only, and the buds produced in the ordinary way from the protonema of a moss. Normally the prothallus of a fern is entirely destitute of vascular tissue of any kind.

DR. McKendrick (*Brit. Med. Journ.*, June 27, 1874) has made a contribution to the subject of the physiological antagonism of medicines which has been so elaborately illustrated by the works of Fraser and Crum Brown. He finds that while Bromal causes an excessively copious secretion of saliva, Atropine quickly arrests it, in rabbits. Possible practical applications of this discovery in the treatment of various kinds of ptyalism in man are at once thought of, and already cases of so-called success in the salvation of pregnancy are recorded.

IN the Bulletin of the Buffalo Soc. Nat. Sci. No. 4, vol. i., will be found a paper by Prof. Hartt on the geology of the Lower Amazons. He determines, on palæontological evidence, that the great plain of the Serra of Ereré is of Devonian age.

AMONG recent additions to the Manchester Aquarium are the following:—1 Smooth Hound or Skate-Toothed Shark (*Mustelus vulgaris*); 2 Topers or White Hound (*Galeus canis*); 2 Picked Dog-fish (*Acanthias vulgaris*); 4 Lesser Spotted Dog-fish (*Syllium canicula*); 4 Greenland Bullheads (*Cottus grœnlandicus*); 3 Gemmeous Dragonets (*Callionymus lyra*); 5 Cat or Wolf-fish (*Anarhicus lupus*); 2 Tadpole Fish (*Raniceps trifurcus*); Zoophytes—*Actinoloba dianthus*, *Sagartia bellis*, *S. nivea*, *S. viduata*, *S. miniate*, *Tealia crassicornis*.

THE additions to the Zoological Society's Gardens during the past week include a Black-backed Jackal (*Canis mesomelas*) from South Africa, presented by Captain Webster; two Rhesus Monkeys (*Macacus erythræus*) from India, presented by Mr. W. Dunn; a Chinese Turtle Dove (*Turtur chinensis*), from India, presented by Major F. Gildea; a Canadian Beaver (*Castor canadensis*) and a Virginian Deer (*Cervus virginianus*), born in the Gardens; a Lanner Falcon (*Falco lanarius*), from east Europe, purchased.

SCIENTIFIC SERIALS

Transactions of the Norfolk and Norwich Naturalists' Society, 1873-74 (Norwich: Fletcher & Son).—This Society is now in the fifth year of its existence, and is in a satisfactory condition as to members. The chief features of the present number of its "Transactions" are Parts IV. and V. of the "Fauna and Flora of Norfolk," which the Society has undertaken to publish. Part IV., by Dr. John Lowe, embraces a list of the fishes known to occur in the Norfolk waters; and Part V. (forming a separate supplement), the Norfolk Lepidoptera, by Mr. C. G. Barrett. Both lists appear to have been done with great care and caution, and we should think that Dr. Lowe and Mr. Barrett have left very little to be added. The catalogues reflect the greatest credit both upon the compilers and on the Society, a few of the wealthier members of which have contributed the greater part of the expense of printing the present supplement. The next instalment of this important work of the Norfolk Society will contain the flowering plants, by Mr. H. D. Geldart. The president's address gives a *résumé* of the year's work of the Society, and discusses the question of Biogenesis.—Mr. F. D. Wheeler contributes a paper On breeding Lepidoptera in confinement, giving the results of the author's own experience; and Mr. F. Kitton one On Empusca and other micro-fungi.—In a short paper by Mr. J. B. Bridgman On the nidification of the Prosopis, the author concludes that this bee forms its "nest in any suitable situation, whether in soft earth or wood, not even despising ready-formed holes, and that it collects and carries home pollen in its mouth, after working it up in a pellet."—Mr. John Quinton contributes notes On the meteorological observations recorded at Norwich during the years 1870 73.—A variety of interesting miscellaneous natural history notes conclude the number. Altogether this Society must be congratulated on its year's work; its first object is "the practical study of natural science," which it seems to be carrying out with considerable faithfulness.

Proceedings of the Bath Natural History and Antiquarian Field Club, vol. iii. No. 1. 1874. This Society, to judge from this number of its "Proceedings," seems to devote itself mainly to antiquarian research, "Natural History," though it comes first in its title, seeming to find but small favour among the members. This defect the secretary animadverts strongly upon in his "Summary of Proceedings," stating, moreover, that the club was originally started for the purpose of botanical research. We do not undervalue antiquarian research, but we think it a pity that a club containing so many intelligent and well-educated members should fritter away almost its entire time and strength in a department that could be very satisfactorily worked by a small proportion of its members, to the almost entire neglect of the rich field presented by the district around Bath for Natural History investigation. We hope that the next number of its Proceedings will show that the suggestions of the secretary have been adopted. The only two natural history papers in this number are by Mr. C. E. Broome, F.L.S., On some of the fungi found in the Bath district, the present paper including Order 10, Myxogasters, and a short note by the Rev. Leonard Blomefield, F.L.S., On the occurrence of the Land Planaria (*Planaria terrestris*) in the neighbourhood of Bath. Dr. Bird was the first to discover this animal (supposed to be the only species of Land Planaria in western Europe) in the Bath district, and Mr. Blomefield is inclined to believe it to be carnivorous, making a prey of the smaller land molluscs. The secretary gives an extremely interesting summary of the meetings and excursions of the Society during 1873-74.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, June 1.—The observations of M. Marié Davy on the diminution of certain river waters in France are here closed with a discussion on the influence of different kinds of vegetation growing in their basins. It is shown that waste open land evaporates the least amount of rain-water, and forests less than corn or other farm produce. The increase of high farming and artificial meadow-land, absorbing and evaporating much moisture, must diminish the size of streams by robbing them of part of their supply, and to keep up the summer flow of a river it might be thought desirable to plant its upper basin with forests. Comparison of different rivers shows, however, that no valuable addition would thus be gained. Whatever be the origin of the river, geological conditions are alone effective. Therefore, although as a measure of national economy, for fixing soil on slopes, mitigating floods and changes of level, and providing cheap fuel, the maintenance of forests would be beneficial, we must look forward to a time when the art of storing some of the excess of winter rainfall to supply the needs of summer will be adopted in agriculture.—Among the "Kleinere Mittheilungen," Prof. Prestel deduces from twenty years' measurement of ozone a result similar to that of Herr Karlinski at Krakau, showing a minimum in November or December and a maximum in the spring.—The work of Herr Edlund on the mean temperature of Sweden, and a delicate form of Goldschmidt's aneroid, are here noticed.

Schriften der Naturforschenden Gesellschaft in Danzig, 1873.—The history of the population in the eastern provinces of Prussia is still involved in much obscurity, while that of the remaining provinces is pretty accurately known. In one of the papers in this volume Dr. Marshall considers the evidence obtainable from early writers—Pliny, Tacitus, &c.—from names of persons and places, and more especially from the archæological collections, of which there are two, imperfectly arranged, in Königsberg. From a study of grave-relics, Dr. Marshall is led to the conclusion that, at one time, in these eastern provinces two distinct races lived together. Several races having come from the east and settled in the coast-lands of the Baltic, more than 1,000 years B.C., this land was, later, overrun by Goths from central Russia, many of whom pressed on to Scandinavia and the Danish Islands, and to western and southern Europe; but a number remained on the amber coast, especially in the Weichsel region, and became fused with the Aestian or Wend race, already there; they were together known as *Pruzzen*.—Among the papers is another giving an account of a chemical analysis (made by direction of Dr. Friederici) of certain empty grave-urns of the ancient Prussians, the significance of which has not been clearly ascertained. Dr. Friederici thinks they were in themselves sacred vessels; they are made not from clay, but from ashes, firmed probably with blood of animals killed in sacrifice. In heating, the blood and the carbon particles at the surface had been turned to ashes, presenting a reddish-yellow appearance, while the internal substance was merely carbonised, and darker in colour.—Dr. Lissauer gives an account (with excellent photographs) of some more of those curious face-urns that have been found in large numbers in certain parts of Pomerania; and M. Kasiski describes a number of antiquities of various kinds discovered in Pomerania during 1872.—Dr. Lebert, who has been experimenting on the fluorescence of some specimens of Sicilian amber, finds the phenomenon in these much more marked and frequent than in Prussian amber; in the case of the latter he has observed, with strong sunlight, not only the existence, but the manifold character of the cone of light.—A valuable paper on new and extended employment of the level for astronomical and geodetic measurements is contributed by M. Kayser, and M. Menge continues a list and description of Prussian spiders.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 18.—On the Forces caused by Evaporation from and Condensation at a Surface, by Prof. Osborne Reynolds, of Owens College, Manchester.

It has been noticed by several philosophers, and particularly by Mr. Crookes, that, under certain circumstances, hot bodies appear to repel and cold ones to attract other bodies. It is my object in this paper to point out and to describe experiments to prove that these effects are the results of evaporation and condensation; and that they are valuable as evidence of the truth of the kinetic theory of gas, viz. that gas consists of separate molecules moving at great velocities.

The experiments of which the explanation will be given were as follows:—

A light stem of glass, with pith-balls on its ends, was suspended by a silk thread in a glass flask, so that the balls were nearly at the same level. Some water was then put in the flask and boiled until all the air was driven out of the flask, which was then corked and allowed to cool. When cold there was a partial vacuum in it, the gauge showing from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch pressure.

It was now found that when the flame of a lamp was brought near to the flask the pith-ball which was nearest the flame was driven away; and that with a piece of ice the pith was attracted.

This experiment was repeated under a variety of circumstances, in different flasks and with different balances, the stem being sometimes of glass and sometimes of platinum; the results, however, were the same in all cases, except such variations as I am about to describe.

The pith-balls were more sensitive to the heat and cold when the flask was cold and the tension within it low, but the effect was perceptible until the gauge showed about an inch, and even after that the ice would attract the ball.

The reason why the repulsion from heat was not apparent at greater tensions was clearly due to the convection currents which the heat generated within the flask. When there was enough vapour, these currents carried the pith with them; they were, in fact, then sufficient to overcome the forces which otherwise moved the pith. This was shown by the fact that when the bar was not quite level, so that one ball was higher than the other, the currents affected them in different degrees; also that a different effect could be produced by raising or lowering the position of the flame.

The condition of the pith also perceptibly affected the sensitiveness of the balls. When a piece of ice was placed against the side of the glass, the nearest of the pith-balls would be drawn towards the ice, and would eventually stop opposite to it. If allowed to remain in this condition for some time, the vapour would condense on the ball near the ice, while the other ball would become dry (this would be seen to be the case, and was also shown by the tipping of the balance, that ball against the ice gradually getting lower). It was then found when the ice was removed that the dry ball was insensible to the heat, or nearly so, while that ball which had been opposite to the ice was more than ordinarily sensitive.

If the flask were dry and the tension of the vapour reduced with the pump until the gauge showed $\frac{3}{8}$ of an inch, then, although purely steam, the vapour was not in a saturated condition, and the pith-balls which were dry were no longer sensitive to the lamp, although they would still approach the ice.

From these two last facts it appears as though a certain amount of moisture on the balls was necessary to render them sensitive to the heat.

In order that these results might be obtained it was necessary that the vapour should be free from air. If a small quantity of air was present, although not enough to appear in the gauge, the effects rapidly diminished, particularly that of the ice, until the convection currents had it all their own way. This agrees with the fact that the presence of a small quantity of air in steam greatly retards condensation and even evaporation.

With a dry flask and an air-vacuum, neither the lamp nor the ice produced their effects; the convection currents reigned supreme, even when the gauge was as low as $\frac{1}{4}$ inch. Under these circumstances the lamp generally attracted the balls and the ice repelled them, *i.e.* the currents carried them towards the lamp and from the ice; but by placing the lamp or ice very low the reverse effects could be obtained, which goes to prove that they were the effects of the currents of air.

These experiments appear to show that evaporation from a surface is attended with a force tending to drive the surface back, and condensation with a force tending to draw the surface forward. These effects admit of explanation, although not quite as simply as may at first sight appear.

Although there must always be reaction corresponding to the visible motion, whenever vapour is driven off from a surface, this visible motion is too small to account for the forces under consideration. But, although it appears to have escaped notice so far, it follows as a direct consequence of the *kinetic* theory of gases that whenever evaporation takes place from the surface of a solid body or a liquid, it must be attended with a reactionary force equivalent to an increase of pressure on the surface, which force is quite independent of the perceptible motion of the vapour. Also condensation must be attended with a force equivalent to a diminution of the gaseous pressure over the condensing surface, and likewise independent of the visible motion of the vapour. This may be shown to be the case as follows:—

According to the kinetic theory the molecules which constitute the gas are in rapid motion, and the pressure which the gas exerts against the bounding surfaces is due to the successive impulses of these molecules, whose course directs them against the surface, from which they rebound with unimpaired velocity. According to this theory, therefore, whenever a molecule of liquid leaves the surface henceforth to become a molecule of gas, it must leave it with a velocity equal to that with which the other particles of gas rebound—that is to say, instead of being just detached and quietly passing off into the gas, it must be shot off with a velocity greater than that of a cannon-ball. Whatever may be the nature of the forces which give it the velocity, and which consumes the latent heat in doing so, it is certain, from the principle of conservation of momentum, that they must react on the surface with a force equal to that exerted on the molecule, just as in a gun the pressure of the powder on the breech is the same as on the shot.

The impulse on the surface, from each molecule which is driven off by evaporation, must therefore be equal to that caused by the rebound of one of the reflected molecules (supposing all the molecules to be of the same size), that is to say, since the force of rebound will be equal to that of stopping the impulse from a particle driven off by evaporation will be half the impulse received from the stopping and reflection of a particle of the gas. Thus the effect of evaporation will be to increase the number of impulses on the surface; and, although each of the new impulses will only be half as effective as the ordinary ones, they will add to the pressure.

In the same way, whenever a molecule of gas comes up to a surface and instead of rebounding is caught and retained by the surface, and is thus condensed into a molecule of liquid, the impulse which it will thus impart to the surface will only be one-half as great as if it had rebounded. Hence condensation will reduce the magnitude of some of the impulses, and hence will reduce the pressure on the condensing surface.

This explanation is then put in a mathematical form, and the paper proceeds.

Applying these results to steam, we find that at a temperature of 60° the evaporation of 1 lb. of water from a surface would be sufficient to maintain a force of 65 lbs. for one second.

It is also important to notice that this force will be proportional to the square root of the absolute temperature, and consequently will be approximately constant between temperatures of 32° and 212°.

If we take mercury instead of water, we find that the force is only 6 lbs. instead of 65; but the latent heat of mercury is only $\frac{1}{30}$ that of water, so that the same expenditure of heat would maintain nearly three times as great a force.

It seems, therefore, that in this way we can give a satisfactory explanation of the experiments previously described. When the radiated heat from the lamp falls on the pith its temperature will rise, and any moisture on it will begin to evaporate, and to drive the pith from the lamp. The evaporation will be greatest on that ball which is nearest to the lamp, therefore this ball will be driven away until the force on the other becomes equal, after which the balls will come to rest, unless momentum carries them further. On the other hand, when a piece of ice is brought near the temperature of the pith it will be reduced, and it will condense the vapour and be drawn towards the ice.

The reason why Mr. Crookes did not obtain the same results with a less perfect vacuum was because he had then too large a proportion of air or non condensing gas mixed with the vapour, which also was not in a state of saturation. In the experiments the condensable vapour was that of mercury, or something which required a still higher temperature, and it was necessary that the vacuum should be very perfect for such vapour to be anything like pure and in a saturated condition. As soon, however, as this state of perfection was reached, then the effects were more

apparent than in the corresponding case of water. This agrees well with the explanation; for, as previously shown, the effect of mercury would for the same quantity of heat be three times as great as that of water; and besides this, the perfect state of the vacuum would allow the pith (or whatever the ball might be) to move much more freely than when in the vapour of water at a considerable tension.

Of course the reasoning is not confined to mercury and water; any gas which is condensed or absorbed by the balls when cold in greater quantities than when warm would give the same results; and as this property appears to belong to all gases, it is only a question of bringing the vacuum to the right degree of tension.

There was one fact connected with Mr. Crookes' experiments which, independently of the previous considerations, leads me to the conclusion that the result was due to the heating of the pith, and was not a direct result of the radiated heat.

In one of the experiments exhibited at the Soirée of the Royal Society, a candle was placed close to a flask containing a bar of pith suspended from the middle; at first the only thing to notice was that the pith was oscillating considerably under the action of the candle; each end of the bar alternately approached and receded, showing that the candle exercised an influence similar to that which might have been exercised by the torsion of the thread had this been stiff. After a few minutes observation, however, it became evident that the oscillations continued instead of gradually diminishing, as one naturally expected them to do; and, more than this, they actually increased, until one end of the bar passed the light, after which it seemed quieter for a little, though the oscillations again increased until it again passed the light.

The explanation given is that, owing to the slowness with which the pith takes in and gives out heat, its ends will on the whole be hotter while receding from than while approaching the candle, and hence the force, as a mean, will be greater on that end which is receding, and there will be a continual oscillation.

Since writing the above paper, it has occurred to me that, according to the kinetic theory, a somewhat similar effect to that of evaporation must result whenever heat is communicated from a hot surface to gas.

The particles which impinge on the surface will rebound with a greater velocity than that which they approached, and consequently the effect of the blow must be greater than it would have been had the surface been of the same temperature as the gas.

And in the same way whenever heat is communicated from a gas to a surface the force on the surface will be less than it otherwise would be, for the particles will rebound with a less velocity than that at which they approach.

It is then shown mathematically, that for every English unit of heat communicated to steam at a temperature of 60°, the reaction on the surface is equivalent to ·38 lb. acting for one second; and in the same way for air the force is equivalent to ·55 lb. It is also pointed out that since the diffusion of heat within a gas is inversely proportional to its density, the amount of heat communicated from a surface to the surrounding gas is independent of the density of the gas, and hence, that the reaction on the pith in Mr. Crookes' experiments would remain constant as the vacuum improved, while the counteracting forces would diminish and leave the balls more free to move. It is therefore assumed that the results obtained in those experiments might have been at least in part due to such forces.

Linnean Society, June 19.—Dr. G. J. Allman, F.R.S., president, in the chair.—Mr. D. Hanbury, treasurer, exhibited branches of olive grown in the open air at Clapham, some bearing flowers, others nearly ripe fruit; also a specimen of *Rheum officinale* Baill., now grown in this country for the first time, the source of the true medicinal Turkey rhubarb, and pointed out the characters in which it differs from other species of the genus.—Dr. Hooker made a communication on the subject of some India *Garcinias* to the effect:—(1) That the *G. indica* Chois. (*purpurea* Roxb.), had been placed in a wrong section in Anderson's review of the genus in the "Flora of British India." (2) That the plant described in the same work as *G. griffithii* is proved to be the true Gamboge plant of Siam, *G. pinella*, var. *pedicellata* of Hanley, which Dr. Hooker regards as a distinct species, and proposes that the name of *G. hanburyi* should be given to it. (3) That the *G. brevirostris* of Scheffer is identical with *G. eugeniæfolia* of Wallich. (4) That the name of *G. ovalifolia* Hook. f., must give place to the previously published *G. ovalifolia* of Oliver's "Flora of Tropical Africa;" and the Indian plant must take the name of *spicata*, it being a form of *Xanthochymus spicatus* W. et A.—Prof. Thiselton Dyer exhibited a young oak-plant with three cotyledons, which had been sent to him by Mr. Cross, of Chester; also a pitcher-like development of a leaf of the common cabbage, from Harting, Sussex, sent by Mr. H. C. Watson to the Kew Museum.—Mr. A. W. Bennett exhibited drawings of the style, stigma, and pollen-grain of *Pringlea antiscorbutica* Hook. f., describing the remarkable manner in which the pollen of *Pringlea* differs from that of other nearly allied Crucifers, being much smaller and perfectly spherical, instead of elliptical with three furrows. This he considered a striking confirmation of Dr. Hooker's suggestion that we have here a wind-fertilised species of a family ordinarily self-fertilised, a hypothesis which is again confirmed by the total absence of hairs on the style of *Pringlea*.—An extract was read of a letter from Mr. Harry Bolus to Dr. Hooker, F.RS., dated Graaf Reinet, April 4, 1874, in which he comments adversely on some of the reasonings contained in Grisebach's "Vegetation der Erde" in favour of the theory of "independent centres of creation." Grisebach, relying chiefly on an observation of Burchell's, makes the Orange river the boundary between the Cape and Kalahari provinces, a boundary which Mr. Bolus shows to be untenable, at least in certain portions. Grisebach unites the Kanoo flora with that of the Cape province; while Mr. Bolus doubts whether it does not differ more from this than from the Kalahari. The Roggeveld, and indeed the whole Kanoo, by its predominance of shrubby Compositæ, seems to incline more to the desert type of plants than to the richer Cape flora.—The following papers were then read, viz.:—On the resemblances between the bones of typical living reptiles and the bones of other animals, by Harry G. Seeley.—On the Auxemmeæ, a new tribe of Cordiaceæ, by J. Miers.—A revision of the sub-order Mimoseæ, by G. Bentham, LL.D.—On some fungi collected by Dr. S. Kurz in Yomah, Pegu, by F. Currey.—Notes on the letters from Danish and Norwegian naturalists contained in the Linnean correspondence, by Prof. J. C. Schiödte, of Copenhagen.

Geological Society, June 10.—John Evans, F.R.S., president, in the chair.—The following communications were read:—On the occurrence of Thanet-beds and a crag at Sudbury, Suffolk, by William Whitaker. After referring to some passages in papers by Mr. Prestwich, in which the probable existence of Thanet-beds in North Essex is mentioned, the author described certain sections near Balingdon, on the right bank of the Stour, which exhibit sands belonging to this series. The crag-beds described by the author are found on the left bank of the Stour, in Suffolk, and consist of ferruginous dark reddish brown sand, with layers of ironstone, slightly false-bedded, with here and there light-coloured grit with broken shells.—Notes on the phenomena of the Quaternary Period in the Isle of Portland and around Weymouth, by Joseph Prestwich, F.R.S. Commencing with the oldest drift-beds, the author showed that the remains of one, formerly more extensive, had been found in the Isle of Portland at a height of 400 ft. above the sea; that it contained the remains of the *Elephas antiquus*, *Equus fossilis*, &c.; and that he found in this bed a number of pebbles of sandstone and ironstone of Tertiary age, and of chert from the Greensands, whence he inferred that, as such pebbles could not now pass over the plain of Weymouth, they must have done so before that area was denuded, and when bridged over by the Portland and Purbeck beds; for the pebbles are derived from beds which are only *in situ* to the north of the Weymouth district, and at a distance of eight to ten miles from Portland. Further, this transport must have taken place before the elevation of the north end of Portland, and when the slope from the Bill to the Ridgeway was uniform and gradual. The anticlinal line, which has elevated the intermediate area, must be of later date than the drift-bed. The author next proceeded to notice the raised beach at the Bill of Portland, in which he had, with the assistance of Mr. Jeffreys, determined twenty-six species of shells, two of them not now living in the British Channel, and one new. This beach contains pebbles of the Devonshire and Cornwall rocks. The raised beach Mr. Prestwich found to abut against an old cliff that had been swamped at a later geological period by a land-wash, which had levelled it and the old sea-land with the adjacent land-surface. The mass which had thus swamped the cliff and buried the beach consisted of loam and angular *débris*, the latter being in larger proportion at top. In the loam he found several species of land and fresh-water shells and fragments of bones. The angular *débris* consisted of pieces of the local rocks, together with a number of specimens, which by their organic remains were

shown to belong to the Middle Purbecks, a part of the series not now existing in Portland. A similar bed, but much thicker, was then described at Chesilton, in the north of the island. It is there 60 ft. thick, and contains large blocks of Portland stone and Portland chert, the greater number of which are in the upper part of the deposit, which is here on the sea-level, and 400 ft. lower than the Portland escarpment which rises above it. This loam and angular *débris* the author was disposed to attribute to a temporary submergence of the land to a depth exceeding the height of Portland, and by which the land as it emerged was swept, and its *débris* carried down to the lowest levels, with the remains of its land-animals and land and fresh-water shells, which latter, where protected by large masses of loam and suddenly entombed, have been preserved uninjured. To this deposit, which is common over the raised beaches on the south coast, the author proposed to apply the term "land-wash." The paper concluded with a short notice of the drift-beds formed subsequently to the denudation of the Weymouth district, and therefore never on the high-level Portland drift.—On the character of the diamantiferous rock of South Africa, by Prof. N. Story Maskelyne, F.R.S., Keeper, and Dr. Flight, Assistant, of the Mineralogical Department, British Museum. In this paper the authors confirmed certain statements made by one of them from a superficial examination of specimens brought to this country by Mr. Dunn. The specimens examined and analysed by Dr. Flight were obtained from various diggings and from different depths, down to 180 ft. in the case of one mass from Colesberg Kopje. Their characters throughout are essentially the same. The rock consists of a soft and somewhat pulverulent ground-mass, composed of a mineral (soapy to the touch) of a light yellowish colour in the upper, and of an olive-green to bluish-grey colour in the lower parts of the excavations. Interspersed in the mass are fragments of more or less altered shale, and a micaceous-looking mineral of the vermiculite group, which sometimes becomes an important constituent of the rock, which also contains bright green crystals of a ferruginous enstatite (bronzite), and sometimes a horn-blendic mineral closely resembling smaragdite. A pale buff bronzite occurs in larger fragments than the green form of the mineral; and in the rock of Du Toit's pan an altered diallage is present. Opaline silica, in the form of hyalite or of hornstone, is disseminated through the greater part of the rock-masses, and they are everywhere penetrated by calcite. The analyses of the component minerals (given in detail in the paper) show that this once igneous rock is a bronzite rock converted into a hydrated magnesium silicate, having the chemical characters of a hydrated bronzite, except where the remains of crystals have resisted metamorphism. Except in the absence of olivine and the small amount of augitic mineral, it might be compared with the well-known Lherzolic rock. The diamonds are said to occur most plentifully, or almost exclusively, in the neighbourhood of dykes of diorite which intersect the hydrated rock, or occur between it and the horizontal strata through which the igneous rocks have been projected. The authors compare the characters of the diamonds found in different positions, and come to the conclusion that their source is not very remote from that in which they are now found. The mineral above-mentioned as resembling vermiculite is described by the authors as a new species under the name of Vaalite.—Note on a modified form of Dinosaurian ilium, hitherto reputed scapula, indicative of a new genus, or possibly of a new order of reptiles, by J. W. Hulke, F.R.S. The author re-examines Mantel's "Scapula of an unknown reptile" = Owen's "Scapula of Megalosaurus?" and adduces reasons for considering it to be a modified Dinosaurian ilium. He describes two new examples of the bone in Dr. Wilkins's collection, contrasts them with undoubted scapulæ of sundry Dinosaurs and existing reptiles, and proves their essential correspondence with the ilia of known Dinosaurs.—Note on a reptilian tibia and humerus (probably of *Hylæosaurus*) from the Wealden formation in the Isle of Wight, by J. W. Hulke, F.R.S. In this communication the author describes two saurian limb-bones, remarkable for the great expansion of their articular ends, and the shortness and smallness of their shaft. The features of the tibia are more like those of the tibia of *Hylæosaurus* than of any other Dinosaur. This resemblance, and the suitability of the humerus to the very massive articular end of the Hylæosaurian scapula, dispose the author to refer the bones to this saurian.

Royal Horticultural Society, June 17.—Scientific Committee.—Dr. J. D. Hooker, C.B., P.R.S., in the chair.—Specimens of *Puccinia malvacearum* (the hollyhock disease) were exhibited from Mr. Fish.—Dr. Masters showed a large slab of the wood of the Encine (*Quercus humilis*).—Mr. Worthington Smith exhibited a woodcut block of ebony which he pronounced nearly as good as box, but objectionable on account of its dark colour.—Dr. Denny showed flowers of a scarlet Pelargonium raised by him, in which the petals were remarkably persistent. He had obtained this horticulturally desirable quality by continuous breeding and selection from a variety originally manifesting it in a smaller degree.

General Meeting.—W. A. Lindsay, secretary, in the chair.—Prof. Thiselton Dyer commented on the interesting series of lilies exhibited by Mr. Barr, which illustrated four distinct geographical races all belonging in a wide sense to the same species. *Lilium bulbiferum*. *L. bulbiferum* proper was wild in Austria and Sweden; *L. croceum* in France, Switzerland, and North Italy; *L. davuricum* in Siberia, *L. thunbergianum* in Japan. It could not be doubted that these were all derived from a common parentage, and had been gradually differentiated as they migrated in different directions and became isolated.—He also described the coffee blight of Ceylon and South India (*Hemileia vastatrix*). A dried bush exhibiting the effects of the disease was shown on the table.—Dr. Hooker illustrated in some detail the light which the theory of a common parentage threw on the geographical distribution of closely allied species, varieties, or forms. He pointed out as particularly striking cases the cedars and the 5-leaved pines. As to the *Hemileia* it could not be doubted that it was a most serious enemy for the planters to contend with. He thought, however, that there was some hope that particular kinds of coffee might be found to be less liable to its attacks than others, and at Kew he had been making great efforts to procure and raise from seed the remarkably large-seeded West African kind with a view to its transmission to Ceylon.

Anthropological Institute, June 23.—Prof. Busk, F.R.S., president, in the chair.—Mr. Robert Dunn read a paper On ethnic psychology. The author dwelt on the importance of carefully studying the cerebral organisation of the typical races as the only way of elucidating the psychological differences which exist among them. Notwithstanding the labours of Gratiolet in that field of inquiry, a vast deal remained to be done. The author's convictions rested on the postulate that the brain is the instrument of the mind, and the consequent corollary was that the distinguishing psychical differences existing between various peoples depend greatly, if not altogether, on the structural differences of their brains.—A paper, by Mr. Rooke Pennington, was read, On the relative ages of cremation and contracted burial in Derbyshire in the Neolithic and Bronze ages. The object of the paper was to show that the impression that stone implements and contracted burial, bronze implements and cremation, are usually associated is quite erroneous as tested by the results of barrow-opening in the Peak of Derbyshire. The researches of Messrs. Bateman and Carrington on being tabulated proved that. Of "finds" containing stone implements, 65 per cent. were cases of contracted burial, 34 per cent. were burnt. In the Bronze, 58 per cent. were contracted, 38 per cent. were burnt. It was clear that those who deposited stone implements in the graves of the dead, and those who placed there articles of bronze, shared pretty equally the differences of custom in the interment of the body: so that out of 150 contracted entombments, 50 per cent. were accompanied by stone only, 12 per cent. by bronze; and out of 86 burnt cases, 46 per cent. afforded stone only, 14 per cent. bronze. The conclusion was fully borne out by examination of the contents of each tumulus. Several instances were given as showing that the Neolithic and Bronze peoples alike used both modes of burial.—A paper, by Miss A. W. Buckland, was read, On mythological birds ethnologically considered. The chief object of the author was to prove that in tracing the bird-legends to their sources, valuable ethnological results might be obtained, and a clue afforded to the migrations of man in Prehistoric times.—The president took the opportunity on this, the last ordinary meeting of the session, of announcing that the appeal of Council to the body of members at the anniversary had been so successful that the Institute was now out of debt.

Geologists' Association, June 5.—Henry Woodward, F.R.S., president, in the chair.—On the lower cretaceous beds of Folkestone, by F. G. H. Price, F.G.S. The town of Folkestone is situated upon the Folkestone Beds of the Upper Neocomian. These the author divides into four lithological groups, commencing with a sandy bed, which contains many phosphatic

nodules, and which he considers to form the true division between the Folkestone and underlying Sandgate beds. The *Rhynchonella sulcata* bed, an important fossiliferous zone, lies at the base of the latter. The general character of these Folkestone beds is that of a loose yellowish sand parted by seams of coarse calcareous sandstone. Masses of branching sponge are especially plentiful in these rocks. The last bed of the Folkestone series is a very remarkable one, consisting of an irregular seam of large nodular masses, composed of coarse grains of quartz, glauconite, jasper, lydian-stone, and phosphatic nodules. Four feet of loose sand succeeds, capped by a band of pyritous nodules; and then occurs a seam of dark greensand (containing two lines of phosphatic nodules), largely charged with *Am. interruptus*, and other fossils in the form of rolled casts. The argillaceous beds of the lower gault, which follow, are frequently very dark in colour, and more or less parted off by lines of nodules, marking certain zones of life. The thickness of this sub-formation is about 28 ft. From the grey marl or upper gault it is separated by a nodule or passage bed of much importance; as this nodule bed marks the extinction of lower-gault forms and the introduction of others. The base of the upper gault may be known by the large quantities of *Inoceramus sulcatus*. The upper fifty feet consists of a pale grey marl, of which the portion subjected to analysis yielded 26 per cent. of lime carbonate.—On a collection of fossils from the U.G.S. of Morden, Camb., by H. George Fordham, F.G.S.

Entomological Society, June 1.—Sir Sidney S. Saunders, president, in the chair.—Mr. McLachlan exhibited specimens of the White Ant (*Calotermes* sp.), recently bred at Kew from a sample of the wood of the tree (*Trachylobium hornmannianum*) that produces the gum-copal of Zanzibar.—Mr. Stainton read a letter he had received from the Rev. P. H. Newnham, of Stonehouse, Devon, stating that he had taken two living specimens of *Deiopeia pulchella* on the Cornish side of the River Tamar. Mr. Stainton remarked on the early period of the year when the insects were captured as very unusual.—Mr. C. O. Waterhouse sent for exhibition a living specimen of a Mantid (*Empusa pauperata*) in the larva or pupa state, brought from Hyères by the Rev. Mr. Sandes of Wandsworth.—Mr. W. D. Gooch communicated a detailed account of his experiences with regard to the Longicorn Coffee-borers of Natal. Dr. Horn, of Philadelphia, stated that European Conifers, Limes, &c., planted in a public park at Philadelphia, were all killed by the larvæ of native species, such as *Callidium antennatum* and *Monohammus dentator*, though apparently in a healthy condition, whilst the native trees were not perceptibly affected. He was inclined to believe that the insects attacked healthy trees, but Mr. McLachlan stated that, according to the observations of most European entomologists, the European species of Longicorns did not attack living wood in a perfectly healthy state.—Mr. Butler communicated a paper On new species and a new genus of diurnal Lepidoptera in the collection of Mr. Druce.—Mr. Smith read a revision of the Hymenopterous genera *Cleptes*, *Parnopes*, *Anthracias*, *Pyria*, and *Stilbum*, with descriptions of new species of the genus *Chrysis*, from North China and Australia.

PARIS

Academy of Sciences, June 22.—M. Bertrand in the chair.—M. Dumas stated, in the name of the *Phylloxera* Commission, that after the theoretical researches of the Commission this body had commenced a practical study of the subject in the field. Agricultural police had been appointed for the preservation of those parts of France not yet invaded by the scourge.—The following papers were read:—Researches on solution, by M. Berthelot; a continuation of thermo-chemical investigations.—Presentation of some specimens of photography obtained with an apparatus constructed for the Japanese expedition, by M. J. Janssen. The photographs presented were of the sun taken with an objective (of 5 in. aperture and 2 metres focus), constructed of flint and crown glass in achromatic combination.—A mechanical note was presented by M. R. Clausius, entitled "On a special case of the Viriel."—Theory of the collision of bodies, with consideration of the atomic vibrations, by M. A. Ledieu.—Communication on the bitter lakes of the Isthmus of Suez, by M. Ferdinand de Lesseps. The author exhibited a block of salt cut out from the salt bank still existing in the centre of the great basin. This bank is calculated to have contained 970,000,000,000 kilogrms. of salt, and has now dissolved away to the extent of $\frac{1}{15}$ since the admission of the water of the canal. The superficial area of the salt bank is about 66,000,000 square metres, and it is composed of horizontal layers varying in thickness from 5 to 25 centims. The bank is believed to have been formed by the evaporation of Red Sea water poured into the lake basin during successive Inundations; the amount of Red Sea water evaporated is about 21,000,000,000 cubic metres. The lake basin contains 2,000,000,000 cubic metres of water, giving an annual evaporation of 200,000,000 cubic metres. Twenty years ago rain hardly ever fell in the isthmus, but now tiles are obliged to be sent from France to roof the houses there. The author holds out great hopes of the practicability of filling a great basin in the interior of Algeria. A valuable table of numerical results accompanied the communication.—Geological topography of the environs of Aigues-mortes, a letter from M. Ch. Martins to M. Elie de Beaumont.—Observations on the subject of the reply of M. Faye to the criticism concerning his addition to Pouillet's memoir on solar radiation, by M. A. Ledieu. The author insisted that there was still a difference in the *principles* of thermodynamics between him and M. Faye.—Analysis of twenty-one samples of salt water from the maritime canal of Suez, sent by M. F. de Lesseps, by M. Durand-Claye. While Mediterranean water contains a solid residue of about 40 kilogrms. per cubic metre, the canal water contains, in some parts, 75 kilogrms., and never falls below 65 kilogrms. This fact is explained by the solution of the great salt bank before referred to. At Port Said the water is less salt than in the Mediterranean (24 to 26 kilogrms.) owing to admixture with Nile water.—On the employment of phenic acid for the preparation of wood, by M. M. Boucherie.—On the Cycadaceæ of the Paris basin, a note by M. Robert. Among a number of rolled flints from the confluence of the Nesle and Aisne between Ciry-Sermoise and Chasemy, the author found a number of stems which he considers to belong to the order named.—On the systems of quadratic forms, by M. C. Jordan.—M. G. Darboux made an addition to his note read on June 8, On friction in the collision of bodies.—Hydrographic map of Algeria, a note by M. E. Mouchez.—Phenomenon of mirage observed in Yffiniac Creek (North coast), by M. J. Girard.—Action of heat on the isomeric carbides of anthracene and their hydrides, by M. P. Barbier.—Chlorobromides of propylene: normal propyl-glycol, by M. E. Reboul. Only one chlorobromide of propylene has been known up to the present time, viz. $CH_2Br-CHCl-CH_3$ (Friedel and Silva). The author now makes known the four others, $CH_2Br-CH_2-CH_2Cl$ (normal), $CH_3-CClBr-CH_3$, $CH_3-CH_2-CHClBr$, and $CH_3-CHBr-CH_2Cl$.

BOOKS RECEIVED

COLONIAL.—Report of Progress of Geological Survey of Victoria, &c.: R. Brough Smyth (Melbourne).—Report upon the Rainfall of Barbados, and its Influence upon the Sugar Crops: Governor Rawson (Barbados).

FOREIGN.—L'Astronomie Pratique et les Observations en Europe et en Amérique: C. André et G. Rayet (Gauthier Villars, Paris).—Die neue Sternwarte der Wiener Universität: Carl von Lithow—Jahresbericht des Physikalischen Central Observatoriums for 1871-72: H. Wild (St. Petersburg)—Annalen des Physikalischen Central Observatoriums: H. Wild, 1872 (St. Petersburg)—Spectres Lumineux: M. Lecoq de Boisbaudran. 2 vols. 8vo. (Gauthier Villars).—Repertorium für Meteorologie Kaiserlichen Academie, Redigirt: Dr. Heinrich Wild. Band iii.—Bulletin de l'Academie Imperiale des Sciences de St Petersbourg, t. xviii, Parts iii. iv. v.—Bulletin de l'Academie Imperiales des Sciences de St Petersbourg, t. xix., Parts i. ii. iii.

CONTENTS

THURSDAY, JULY 9, 1874

THE COMET

TO those who are familiar with the triumphs which that most wonderful of modern instruments of research—the spectroscope—has achieved, the short time during which it has been at work will be most forcibly recalled by a reference to the circumstance that the comet which is now, astronomically speaking, a magnificent object in the northern sky, is the first one of any considerable brilliancy which has shown itself since the spectroscope has been adapted to the telescope.

The truly splendid comets which delighted us during the autumn of 1858, and for a brief space in the summer of 1861, made their appearance, in fact, during what we may term the pre-spectroscopic age; for, however little to the credit of modern science it might have been that the spectroscope was no employed in their investigation, the fact remains that they were allowed to pass away mere telescopic objects, and that two opportunities were thus lost such as, perhaps, may not offer themselves again to the present generation of men.

I propose, in the present paper, to state some points of inquiry regarding comets in which the spectroscope may help us, with a view of showing how much closer is our grip of celestial phenomena when physical astronomy, in its widest sense, is superadded to the older astronomy, and to indicate the numerous gains to knowledge which may be hoped for if adequate telescopes, properly armed with spectroscopes, are employed both here and in the southern hemisphere upon the present visitor.

Omitting all reference to the paths of comets round the sun, with which mechanical astronomy has to do, there are perhaps but few points in which the spectroscope cannot help us; somewhat unfortunately, however, there is one in which it appears powerless, and that precisely one of the greatest difficulty in cometary theory. I allude to the apparent sweep of the tail round the sun when the comet is at its perihelion point, which has suggested to Faye a theory of a repulsive force due to solar heat, and which perhaps is one of the most mysterious phenomena which we witness in the skies. Leaving this aside, however, there are many questions relating to what Sir John Herschel terms their "interior economy," in which, undoubtedly, the guesses of telescopic observers may be turned into hard, detailed fact.

Let us briefly refer to some of these points.

Generally speaking, as a comet approaches the sun it gets brighter and its tail lengthens, whether the nucleus is intensely stellar, as in the present case, or not; in some cases a violent action may be observed; *aigrettes*, or jets, make their appearance; and the nucleus, or head, is surrounded, or partly surrounded, by envelopes or shells, very obvious and with marked boundaries, and these are visible in some cases at the commencement of the tail.

Now, of course, if any or all of these luminous phenomena were due to the reflection of sunlight by masses of whatever kind not luminous in themselves, then the spectrum would be the same from all, differing only in intensity, and the spectrum would be the true solar spectrum if there were light enough, and a dim continuous spectrum if the part of the comet under examination were dim.

If, on the other hand, the masses were self-luminous and consisted of vapours not too dense, then we should get a characteristic spectrum proving first the existence of vapours driven into incandescence; and secondly, if the observations went far enough, the precise quality or nature of the vapour would be determined for us by the spectroscope. Thanks to the labours of Donati, Huggins, Secchi, Wolf, Rayet, Vogel, and others, the brightest portions of the comets which have appeared since 1864 have been examined with the undoubted result that they consist, in part at least, of not very dense incandescent vapour. I say in part, because in some cases the continuous spectrum, which may denote dense vapours, or perhaps vapours of relatively greater molecular complication, or again even glowing solid substances, has been so strong as almost entirely to mask the bright lines or bands by means of which the presence of the rarer or simpler vapours is determined.

Nor is this all. Not only have lines been seen, but their positions have been determined with some degree of accuracy, although it must be pointed out that the opinions of authorities do not coincide as to the actual materials indicated or as to the interpretation to be put upon the observations. This is not to be wondered at, considering the amazing delicacy of the research and the few opportunities there have yet been of making perfectly satisfactory determinations.

The most searching criticism of the results hitherto obtained appeared some little time ago in *Poggendorff's Annalen* from the pen of Dr. Vogel (NATURE, vol. ix. p. 193), and it will be well to briefly glance at some points which result from his inquiry. Donati, in the first observations of this nature made in 1864, determined the existence of three bright bands, but made no attempt to determine the substance from which the light proceeded. Huggins in 1866 made the first attempt in this direction, and came to the conclusion that, like the nebulæ, the comets might be composed of nitrogen, as in the spectrum of the comet visible in that year there was a single line which nearly, if not quite, coincided with one of the brightest lines of that element. In 1868, however, the idea of nitrogen comets was abolished, as the idea of nitrogen nebulæ has been since; and the three bands, which were again observed in the comets visible in that year, were found to coincide with those of olefiant gas. Hence it was suggested by Huggins that they consisted of carbon vapour. He writes:—"The great fixity of carbon seems indeed to raise some difficulty in the way of accepting the apparently obvious inference of these prismatic observations. Some comets have approached the sun sufficiently near to acquire a temperature high enough to convert carbon into vapour. Indeed, for these comets a body of great fixity seems to be necessary. . . If the substance of the comet be taken to be pure carbon, it would appear that the nucleus had been condensed from the gaseous state in which it existed at some former period. . . . If we were to conceive the comet to consist of a compound of carbon and hydrogen . . . other difficulties would arise in connection with the decomposition we must then suppose to take place . . ."

It is clear that Mr. Huggins' opinion is that a comet

consists of carbon; that the vapour is carbon vapour driven into incandescence by a temperature high enough to volatilise carbon, and not the vapour of a volatile hydrocarbon.

Such is not M. Vogel's view, and I confess it is not mine. After giving details of the observations of the nine comets examined between 1864 and 1871, M. Vogel thus analyses them:—

"Of these nine comets, there is only one (1870) for which we have no observations as to the position of the bright bands. Of the remaining eight, the spectra of five (1, 2, 4, 7, and 9) have shown *no* agreement with the hydrocarbon spectrum. As regards the Comet II. 1867 the supposition is offered that its spectrum was similar to the spectrum named; as to Encke's Comet III. 1871, it remains uncertain in which class it is to be reckoned (Huggins' observations being at variance with those of Young and myself). There remains only the Comet II. 1868, for which Huggins' and Secchi's observations assert a probability of coincidence of the lines in its spectrum with those in the spectra of volatile hydrocarbons.

"It thus appears a somewhat questionable view, that the comets consist of such matter; and we should, I think, content ourselves with the deduction that a portion of the light emitted by the comet is its own light, and very probably from glowing gas."

Hence, then, the whole question of the true material of which that part of the comet consists, the spectrum of which has been already observed, must be acknowledged as being still *sub judice:* and this is a matter of the first order of importance, on which the present comet may throw much light.

But one of the most hopeful points is this: the comets up to the present time have been either so small or so distant that the record of aigrettes or envelopes on the spectrum has not been determined; nay, the comets might have been deprived of those appendages, hence the statement concerning the spectrum is a very general one; there has been no sufficient opportunity of localising the spectrum-giving region or regions.

What a glorious harvest will be reaped should the jets appear as decided as in the comet of 1861, or in Halley's comet at its return in 1835; "jets, as it were, of flame, or rather of luminous smoke, like a gas fan-light," which, as described by Sir John Herschel, "varied from day to day as if waving backwards and forwards, as if they were thrown out of particular parts of the internal nucleus or kernel, which shifted round, or to and fro, by their recoil, like a squib not held fast."

Or again, suppose the system of concentric envelopes is developed to the same extent as in Donati's comet, in which the action at all points of the nucleus, to follow Sir John Herschel's reasoning, was probably more general, a result due to a more uniform chemical constitution.

Hence the comet may leave us a rich inheritance in the shape of "spectrum of jets," or "spectrum of envelopes;" and from what I have already seen dimly (for such observations are beyond my instrumental power), the former is the more probable, and in the nucleus we may have the equivalent of the sun, or the carbon pole of an electric lamp, with a continuous spectrum, and in the jets phenomena identical with those presented by solar storms, or the electric arc, that is, lines of various lengths indicating various vapours, shooting out or extending to various distances according to their volatilities, or vapour densities.

We seem, indeed, to have got a true physical approximation to this state of things in the comet of 1868, for Mr. Huggins observed that while some of the lines thinned out as one sees them do in the ordinary spark by using a lens, quite independently of the general visibility of the vapour, others did not so thin out, but retained their breadth till they disappeared altogether.

The extent to which this action will go on will obviously depend upon two things, first the temperature and secondly the materials of the comet; and this raises an important question, which perhaps is easier of solution than the determination of the materials ejected, should that phenomenon be spectroscopically recognisable.

I have already communicated to NATURE the fact that to me the continuous spectrum of the nucleus appears deficient in blue rays. The effect of this upon the colour of the nucleus would be to give it a yellowish tinge like that of a candle flame, and for the same reason.

Dr. Vogel, in the paper to which I have already referred, deals with this question of colour, stating that:—

"Dr. Zenker arrives at the conclusion that there must be water-vapour in the comets; since they have, according to Schmidt, a yellowish-red colour, and the sun's rays, when they pass through a considerable thickness of aqueous vapour, are coloured thus. But apart from the consideration that sunlight has a yellowish-red colour on passing through other vapours as well as aqueous, I would remark that we must take the proper light of the comet, which appears from spectral analytic observations to be generally more intense than the reflected light, as determining its colour. According to the observations made, we should expect that the comet is, on the whole, of greenish or greenish-blue colour, since all the spectra consist, as we have seen, of two or three bands of light, of which one is in the yellow, the second and brightest in the green, and the weakest in the beginning of the blue. Of the (generally very faint) continuous spectrum, only the brightest part—yellow, green, and commencement of blue—is visible. The entire image, therefore, even where the weak continuous spectrum appears, will seem of greenish colour. Colour-data have been furnished by other observers besides Schmidt; and the head of the Comet 1811, *e.g.* had, according to Herschel, a greenish or bluish colour; the nucleus was slightly red. The colour of Halley's comet, at its return in 1825, was a bluish-green (Struve). Winnecke says of the comet of 1862, 'The colour of the neck appears to me yellowish; the coma has bluish light.'"

It will be seen that these remarks are quite in accordance with the suggestion. Dr. Zenker attributes to absorption the effect which I ascribe to defective radiation, and if it should be determined that the spectrum of the nucleus is truly deficient in blue rays, then a great point will be gained, *for its temperature must be low.*

Angström, whose death the world of science is now deploring, lived to say that he conceded that different molecular arrangements of the same element might give us different spectra; and Roscoe and Schuster have recently placed beyond all doubt that, besides the well-known high temperature spectra of sodium and potassium, there are other spectra appertaining to the vapour of these elements at a lower temperature.

Now these spectra are *channelled-space spectra*, that is similar in character to the spectrum which has already been observed in the case of comets; and if such spectra be obtained for all elements (and I have already added to the list), if a comet be a body at a low temperature, it is

such spectra as these that we shall see, and not line spectra. Further, in the case of compounds in which the molecules which give us these new spectra enter into combination, we may possibly dissociate them and observe their spectra at a much lower temperature than we can drive the higher molecular arrangement of the solid into vapour,

Such considerations as these derive additional interest and importance from the beautiful researches of Schiaparelli, which connect comets with meteorites.

Modern science acknowledges that comets are individual members of meteor swarms—not that meteors are comets' tails, as some think; this idea is, one may say, impossible to reconcile with facts—that one difference at any rate between a comet and a meteor is that one is self-luminous, the other is not till it arrives within the limits of our atmosphere. If this be acknowledged, then to what is this difference to be ascribed? A possible cause is certainly a difference of chemical constitution—a difference between materials incandescent at a high temperature and materials incandescent at a low one. It is not necessary to stop to inquire how this temperature has been arrived at, but it is important to show that the question of temperature is one of the very first points to be attended to by those who can bring sufficiently powerful instruments to bear upon the present comet, and that the question of its actual chemical constitution is bound up with it.

But whatever be the temperature of the head there is another point which must not be lost sight of. Sir John Herschel writes concerning Halley's comet: "The bright smoke of the jets, however, never seem to be able to get far out towards the sun, but always to be driven back and forced into the tail, as if by the action of a violent wind rolling against them—always from the sun—so as to make it clear that this tail is neither more nor less than the accumulation of this sort of luminous vapour, darted off in the first instance towards the sun, as if it were something raised up, and as it were exploded by the sun's heat, out of the kernel, and then immediately and forcibly turned back and repelled from the sun." Here we have the question raised not only whether the envelopes consist of different materials, but whether the tail is not entirely or in part self-luminous: the present comet may show that this point is not so satisfactorily settled as it is supposed to be in favour of reflected light.

Such then are briefly some of the questions at issue. It is to be hoped that our beautiful visitor will answer some of them for us, and that when it leaves our northern skies the work may be carried on in the southern hemisphere.

J. NORMAN LOCKYER

THE CHANNEL TUNNEL

WE fear there are still many who fail to see that any good can come of scientific research unless it has some well-defined "utilitarian" object in view. Even in this and in other countries that are in the van of civilisation and in which education is comparatively wide-spread, the majority of mankind can appreciate a benefit only when it takes a concrete and tangible form. That love of knowledge for its own sake, that noble inquisitiveness which has been so fruitful in results during the last two hundred years, even yet belongs to comparatively few, who are still regarded by the many with a kind of impatient pity as mere unpractical hobby-riders. Still the people who talk in this way are proud enough of the glory which their great men have shed upon their country, and would not willingly, we believe, part with it for money were this possible; and indeed how would this country appear among the nations were she deprived of the inestimable inheritance which her great sons have bequeathed to her in every department of intellectual activity? Happily, however, the race of those who decry single-eyed scientific research is getting sensibly smaller; and we firmly believe that as education improves and as higher education spreads, carrying with it the results of this same scientific research, it will disappear.

Still, a little consideration might show those who are ever ready to cry "what's the good?" that since all so-called "practical" schemes are concerned either with man's own body or with the surrounding universe, an essential part of the basis of any scheme is a thorough knowledge of the material on which it is proposed to work. Such a knowledge it has over and over again been shown is only to be attained by abstract scientific research, by investigation conducted as if the only end in view were a thorough knowledge of the subject in hand in all its scientific aspects and relations. Many instances could be given, and indeed are every day occurring, of the highest practical results unwittingly following from such investigations; and to the sceptic we could not recommend a better example of how indispensable is thorough scientific research as a basis for the useful arts than the results of the investigation into the geology of the Channel which Mr. Prestwich (the newly elected Oxford Professor of Geology) presented to the Institution of Civil Engineers last December, and which, with the subsequent discussion and maps, has just been published in a separate form. This study of the strata which underlie the Channel, and which seems to us an almost perfect example of close and careful reasoning on physical facts, is now brought forward to enlighten the projectors of a tunnel between England and France as to the nature of the material with which they will have to work; but Mr. Prestwich distinctly states that the various formations are considered "irrespective of their relative merits in any other than a geological point of view."

Mr. Prestwich's plan is to discuss carefully all the strata which underlie the Channel, from the London clay down to the Palæozoic series, exhibiting distinctly their lithological characters, dimensions, range, and probable depth, and from these data deducing his conclusions as to the suitability of each formation for being pierced by a tunnel. The investigations of himself and others on which Mr. Prestwich's paper is founded were mostly undertaken from no practical point of view, and before a Channel tunnel was thought of. Mr. Prestwich, many will be glad to think—grateful, we hope, at the same time for this very practical result of pure scientific research—concludes that from a geological point of view it is quite practicable to construct a tunnel underneath the Channel, although to do so with safety it will be necessary to go very deep down. But an excellent idea of the results of the investigation will be obtained from the following clear summary with which Mr. Prestwich's paper concludes:—

"In the London clay there exists a perfectly impermeable bed of sufficient thickness, but nowhere between the two

countries, except probably at points where the distance presents apparently insuperable difficulties. The lower chalk or chalk marl affords a comparatively impermeable deposit, also of sufficient dimensions: but from its having a calcareous base, and from the possibility of fissures, with the absence of a protecting overlie, it has great uncertainty. In the gault there is another impermeable stratum, bút of dimensions too small. The lower greensand contains no beds sufficiently continuous and impermeable. The Weald clay ranges about half-way across the channel; and if a belt of it should possibly pass round at the north end of the Varne and range to Wissant, it might prove to be worth further inquiries. In the Kimmeridge clay there is again a deposit of sufficient dimensions, but with a subordinate band which may be sufficiently permeable to present difficulties, whilst, though it comes to the surface on the French coast, its depth on the English coast must be very considerable. There is, however, just a chance that the Kimmeridge clay may in mid-channel be overlapped unconformably, and at a slight angle, by the Weald clay, and in that case they might for all purposes be considered as continuous strata. The Oxford clay presents similar difficulties, in addition to its greater depth and inaccessibility. In the secondary strata the irregular lie of the strata, and the presence of faults, are contingencies important to be considered.

"On the other hand, the great mass of the Palæozoic rocks so protected by impermeable overlying strata, is of such great dimensions, and so compact, and holds its range so independently of the more irregular range of the secondary strata, that it offers the conditions most favourable for the secure construction of a submarine tunnel; and that such strata can be worked in safety and for considerable distances under great bodies of water, has been proved at Whitehaven and Mons. But, on the other hand, the depths of these old rocks below the surface is very great, and they are much more dense and harder than the overlying formations.

"There is another important problem in connection with the Palæozoic rocks which such an undertaking might help to solve. The great question of the range of the coal measures under the south of England has lately come prominently into notice; and it was, in fact, in inquiries connected with that question that the foregoing considerations presented themselves to the author. The rich coal basin of Mons and the north of France has been traced to within thirty miles of Calais, where it thins out; but, like the coal basins of Liege, Aix, and Westphalia, which form separate sections of the same great trough, to the eastward, so there is reason to suppose that other sections of the trough set in on the westward, forming other coal basins, which possibly range to the west of England (Somersetshire), passing under the north-eastern part of Kent and the Thames. Any such work, therefore, as a submarine tunnel in these Palæozoic rocks could not fail to throw much light on the subject; while, in case it were to hit upon the line of strike of the coal measures, and could be carried on along that line, the work might prove otherwise remunerative, and tend to solve the great problem which interests so largely both geologists and the general public.

"Such, briefly, are the conditions which bear on the construction of a submarine tunnel between France and England. The author is satisfied that, considered on geological grounds alone, it is in one case perfectly practicable, and in one or two others it is possibly so; but there are other considerations besides those of a geological nature, and whether or not they admit of so favourable a solution is questionable. In any case the author would suggest that, the one favourable solution admitted, it may be desirable, in a question involving so many and such great interests, not to accept an adverse verdict without giving all those other considerations the attention and deliberation which the importance of the subject deserves.

"Under any circumstances, the difficulties are formidable. Whether or not they are insuperable are questions which may safely be left to Civil Engineers. The many and great obstacles overcome by engineering science in late years lead the author to expect that, should the occasion arise, and the attempt be considered worth the cost, the ability to carry it out would not be wanting. Various preliminary trials are, however, indispensable, in order to clear up some of the geological questions before a balance of the comparative advantages presented by the different formations could be satisfactorily settled, and before the grounds for action could be accepted."

From this it will be seen that the possibility of a Channel Tunnel remains now only with the engineers to decide. Geology has told them all the natural conditions under which they will have to work, so far as these can be known without actually tunnelling; and since so cautious a reasoner as Mr. Prestwich thinks it possible to carry out the scheme from a geological point of view, we should think that if it could be proved that the undertaking would pay, our engineers would be eager to show that the resources of their art are quite equal to its successful accomplishment.

OWENS COLLEGE "ESSAYS AND ADDRESSES"

Essays and Addresses. By Professors and Lecturers of the Owens College, Manchester. (London: Macmillan and Co., 1874.)

THIS book is due to the natural desire of the teaching staff of the Owens College to have some memorial of an event of the first importance in their own history, and to give expression to the hopes that animate the institution. The Owens College was founded by a single legacy a quarter of a century ago—for the creation of a college in which Lancashire lads might study at home the "branches of learning commonly taught in the English Universities." It first became known in connection with its first Principal, Scott, a writer who has left nothing which explains the high rank he held among his contemporaries and especially the influence he unquestionably exercised over every young man with whom he was brought into contact. Under him, however, the College did not flourish—the number of the day students sank at one time as low as 25—and it was only after the appointment of the present Principal, Dr. Greenwood, that it began to take root in Manchester. It has now about 350 day students—not including the medical students, who have been added only this session—and nearly 800 evening students. Curiously enough, what happened in Glasgow to the disappointment of many of the well-wishers of the University, happened also in Manchester. When the new buildings, with all their increased convenience for study, were opened, it seemed natural to anticipate a great increase of students. Nothing of the kind took place. Students seem to come and go to college because they want to be taught, not because they are to have beautiful buildings to be taught in. The effect will certainly be considerable, alike on teachers and on taught, of the more commodious buildings recently erected in Glasgow and in Manchester, and it will be felt more and more as time goes on. The fact that it is not felt at first shows, however, that the wants that are satisfied by univer-

sity teaching lie so deep down that an external event like the inauguration of new buildings scarcely influences them.

The success which the Owens College has thus attained in a quarter of a century is due to much hard work—to careful and deliberate adaptation not merely to the wants of the time, but to the claims of real culture—and above all of course to the fact, which that success proves, that in Lancashire, or that portion of it of which Manchester is the capital, there is a real demand that the higher education may be brought home even to the doors. This book serves as a record of much of the work done—and an expression of the ideas of the teachers whose spirit has made and still makes the Owens College. No one who glances at the titles of the fourteen essays and addresses of which it consists can fail to be struck with the variety of the teaching. It accomplishes the task laid upon it by its founder, by teaching nearly everything commonly taught in the English Universities. We find two Professors of Classics, one of Oriental Languages and one of Modern Languages, two of Natural Philosophy, a Professor of Natural History, and a teacher of Geology, a Professor of Chemistry, a Professor of Engineering, a Professor of Jurisprudence and Law, a Professor of Physiology, and two gentlemen who seem to be three or four Professors rolled into one, the accomplished incumbents of the chairs of " English and History," and of " Logic, and Mental and Moral Philosophy, and Political Economy." Besides these, there are at least half a dozen more, the Professors of Mathematics, the Professors of three or four Medical subjects, the additional lecturers on Law, on Organic Chemistry, and so on, who put in no appearance in the volume. The College is in fact equipped with a staff of teachers which bears favourable comparison with that which is usually found in older Universities. The Medical department has been added only this session ; the Law and Jurisprudence department has recently made a considerable step in advance. Except that several of its members are evidently overburdened with subjects too large for any single man, the staff of the College is reasonably complete, and most things can be learned in it which are taught elsewhere.

We turn with interest to the volume before us to discover, in the choice of their subjects and in the manner of treating them, the aims and tendencies of the professors and lecturers. What is most noticeable, and it cannot fail to strike even the casual reader, is the caution, the moderation, we had almost said the conservatism which is characteristic of most of them. People are still tempted to associate the name of Manchester with everything that is "advanced," and we look in such a book as this for a daring championship of educational and scientific novelties. From the first words of the President's opening address to the last words of the essay which closes it, the tone of responsible thoughtfulness, of the wish to be just and true more than to be vigorous or startling, is never to be mistaken. The Duke of Devonshire the President, and Dr. Greenwood the Principal, unite in urging that the older class studies—those connected with literature—should not be pushed aside and comparatively disregarded, and that the newer studies should be taken up in their full depth and breadth, not in a fragmentary or superficial manner or with any supposed reference to their immediate application. These cautions are supplemented, indeed, but they are not contradicted, by Prof. Roscoe and Balfour Stewart, who urge, the one that original research is a powerful means of education, and that original research should be organised, as it has already been to some extent, especially in his own department ; the other that we should set about great national studies, establishing a watch, for instance, on the sun, "a creator of disturbances on the greatest possible scale, who is ever ready to afford us information about himself at the smallest possible cost." Mr. Reynolds follows them with a demand for a national commission to experiment on heat engines, and the conditions under which they could be practically worked, economically, or efficiently, or both, to higher pressures than we now attempt to use, so as to get more work out of our coal and our machinery, and perhaps some day to enable a lightweight jockey to fly at the rate of 200 miles an hour. After these speculations and demands, which are certainly significant of the modern age, follows Prof. W. C. Williamson's cautious and copious discussion of the theories of natural selection and evolution, as tested by primeval vegetation. We call it a conservative paper because the conclusion of the writer is that among the innumerable facts known and co-ordinated about the primeval vegetation, there is little sign that the laws of natural selection and evolution have operated to a large extent in transforming the vegetable species of the pre-carboniferous strata to those with which we are now familiar. But Prof. Williamson is absolutely frank in his admission of the new laws, and singularly candid in accepting any explanations which they seem to offer. He admits " that by the help of natural selection man has brought into existence many new varieties of pre-existing plants and animals, most, if not all of which, were his protecting hand withdrawn, would soon revert to their primal forms. We have no evidence that unaided nature has produced a single new *type* during the Historic period. We can only conclude that the wonderful outburst of genetic activity which characterised the Tertiary age was due to some unknown factor, which then operated with an energy to which the earth was a stranger, both previously and subsequently." It is in a bolder spirit that Prof. Bryce speaks of the new Judicature Act, a measure which throws us back in principles and in practice many centuries, and which is, in his view, " a reform in English law greater in some points of view than we have had since English law itself began to exist." The note of conservative caution returns on our ears in the two last essays on the Relation of the Railways to the State, by Prof. Jevons, and on the Peace of Europe, by Prof. Ward. The conclusion of the former is emphatic, and altogether hostile to the movement party who advocate the State purchase of our railway system. There are few questions deserving to be more seriously studied by politicians or likely to need more serious study, for in the changes and chances which affect our governments, some new men may some day drift with us into schemes which would be in themselves imprudent, and which would be foolish except by way of preface to a more comprehensive measure. We could not take the railways over, Prof. Jevons thinks, for less than a thousand million sterling, which is about double their commercial value. The attempt might be all but ruinous to the nation, and the results would be altogether disappointing. But among

the middle and upper classes, who own the railways, there is certain to be a considerable feeling in favour of a scheme which would be fruitful of so much pecuniary benefit to themselves, and it is well to have it discussed beforehand as thoroughly and as thoughtfully as it is discussed here. It is in useful conservatisms such as these that Universities often do their greatest services. They are mints at which the coinage that is passing current in the commoner exchanges of the world may be thoroughly tested. Prof. Jevons offers statesmen and politicians an admirable discussion, luminous with the most practical good sense. Like his colleagues, Prof. Ward is conservative in the sympathies of his essay. We have been engaged for many years in breaking down the venerable theory of the Balance of Power in Europe, and we have been attempting to build up in its stead a sort of Temple of Doctrinairism—sacred to a goddess of international arbitration, who is to be capable of the cure of all international ailments. Prof. Ward applies the touchstone of his comprehensive historical knowledge to both. He is utterly hostile to the doctrine of Spinoza that, as the natural state of man is a state of war, no nation is bound to observe a treaty longer than the interest or danger that caused it continues. But the old treaty basis of the peace of Europe having broken down, "the remedy for the danger accruing with new force to the peace of Europe is to be sought, not in an abandonment of the principle of joint action, but in an enlargement and elevation of it, and in the progress of that enlightenment which, instead of enfeebling, strengthens the common action of men and of states. For it is with nations as with individuals. The cultivated, and by culture enlightened, mind is and must be on the side of progress and peace against that of darkness and conflict. The obscure men, like the unformed nationalities, are at once materials and causes of that which disturbs, unsettles, and retards personal and national and international life. Where the education, and more especially the higher education, of a country is fostered, there lie the best promises of progress and of peace."

We do not attempt any detailed criticisms of the several essays. The subjects chosen by fourteen professors on which to address the world are likely to be reasonably well chosen, and the addresses delivered on them are pretty sure to reward the attention of the reader. They strike us as very well chosen; they sufficiently represent the real variety of teaching and of manner of teaching in the institution; they contain complete and occasionally brilliant discussions of subjects of very considerable general interest. They are the expressions of the inner spirit of a seat of learning in which science holds a higher place than she has usually done, but in which there is the most emphatic and continual protest against the degradation or neglect either of literature or of science. They show a body of teachers full of modern life, and at the same time singularly moderate, truthful, and reverent. Several of the essays are historical studies, and in these cases the reputation of the writer is a sufficient guarantee of completeness. In their collected form the "Essays and Addresses" warrant high hopes of the future of the Owens College. In a sense—perhaps a somewhat too literal sense—it is what it was once called in a journalistic epigram, the University of the Busy. With its present staff it will certainly continue the tradition which connects the older Universities with the highest learning of the time.

W. J.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Sir John Herschel's Letters

It is known to many through the numerous applications I have made, that a collection of the letters of Sir John Herschel is in progress. For the many and valuable contributions, as well as for the kind and sympathetic expressions which I have been favoured with, I cannot be too ready to express once more my sincere acknowledgment; and when I recall these to mind I hesitate to take any less private step to further the end in view, or, by venturing on a public appeal, to forego the advantage of more direct communication. Several considerations however—which not even your courtesy in allowing this letter to appear in the columns of NATURE would justify me in dwelling upon—forbid me to depend solely on the activity of a single importunate pen. The correspondence in question covers more than half a century. Many of the correspondents were of a former generation, and their present representatives are known to but few. I may instance the names of Davy, Young, Wollaston,—not to mention many continental savans—in illustration of this. Many others, less eminent, but not the less recipients of letters which the student of scientific history will prize as containing the germs of much of the force whose impetus we now feel, were hardly known by name beyond their own immediate circles. Many more, as I would fain believe, who either themselves corresponded with my father, or knew him in his letters to their relations, are even now in possession of such letters, and may not be unwilling to let them be seen. Lastly, I hear too much of autograph collectors not to feel a keen desire to make their instant acquaintance. Have they not devoted themselves to preserving individual letters, no matter how trifling, from the fate which has—alas too often—overtaken others, no matter how numerous, or how valuable!

In my applications hitherto I have been constrained to repress the expectation of immediate publication. I am not at liberty to depart from that now. But that the materials which I may now be permitted to store up *will* eventually help to form the foundation of such a monument as may be fitting—this requires no student of history to tell us. That it may be amply provided for now, before it is too late, is my chief anxiety. For my time is limited, and I have drawn too many blanks not to feel that every year increases their number, let who will take my place.

I apologise for so long a story, and will only add in the most general terms that I appeal to all who possess, or know of the existence of, autograph letters of Sir John Herschel—no matter how insignificant they may seem, for collation with others can alone supply a true test—but of course with due regard to personal consideration—to communicate with me at once. It is hardly necessary to say that all autograph letters will be returned, and that any restrictions will be attended to.

21, Sumner Place, Brompton, S.W. J. HERSCHEL

Coggia's Comet

YOUR readers may be interested to learn that the light of the comet is by no means strongly polarised. On the 2nd and 4th instant I examined it with a double-image prism, but could not with certainty detect any difference between the brightness of the two images. I also examined it with a plate of right- and left-handed quartz in the principal focus of the 4-inch telescope and a Nicol's prism packed among the lenses of the eyepiece, but could not detect any traces of colour. With a Savant placed between the eyepiece and the eye no bands were detectable. But on the 6th, about midnight, when the comet was shining very brightly, I could perceive a difference in the brightness of the two images with the double-image prism, indicating polarisation *in* the plane passing through the sun's estimated place. But I was still unable to detect any traces of polarisation either with a Savant or Biquartz, or with a plate cut from a natural crystal of right- and left-handed quartz giving a band across the field in which the two crystals overlap; a form of polariscope which has been found on other occasions very delicate for faint lights.

If the tail of the comet consisted of a *fine* dust not in a state of incandescence reflecting or dispersing the sun's rays, we should expect its light to be completely polarised. We seem, therefore, driven to assume, either, 1, that the tail consists of fine incandescent particles; or, 2, of particles whose diameter is not small compared with the wave-length; or, 3, of incandescent gas; or, 4, possibly of all three of these states combined.

A. COWPER RANYARD

Photographic Irradiation

IN a letter to NATURE, vol. ix. p. 183, I gave a short description of some experiments on photographic irradiation. The conclusion to which these experiments pointed was that there is a kind of photographic irradiation, caused either by the bright light producing an intense state of chemical activity, which has the power of extending itself in every direction; or what seems more probable, the parts of the collodion on which the bright light is falling become luminous and reflect light to the surrounding parts of the sensitive film, and thus extend the chemical change on each side of the true optical boundary line. As the subject is at present under discussion, I send you the results of the following experiments, which seem to support the above conclusion. In a darkened room a vertical opening 18 in. by 5 in. was made in the shutter; over the opening was fixed a piece of paper thick enough to stop most of the light, and only allow as much to pass as would give a decided but not deep photographic impression. Three long, narrow, parallel openings were cut in the paper, one opening was left clear to the sky, the next was covered with one thickness of tissue paper, and the third with two thicknesses of tissue paper. There was thus produced three parallel bars of different brightness on a uniform and darker ground. Sensitive wet plates were prepared in the usual way on glass and opaque black plates; across the front of the plates, and almost in contact with the collodion, was fixed a horizontal bar of thin blackened metal in such a position that it would cross the image of the luminous bars in the camera. The photographs, after exposure, were developed in the usual way, and it was found that the shadow cast by the horizontal opaque bar was not bounded by straight lines, but the ends of all the bright bars projected into the shadow, and the brighter the bar the farther it projected. I had no means of measuring accurately the bar and its shadow, but there seems but little doubt that the bright bars extended underneath the opaque bar, whilst the edge of the darker ground at the side of the bright bars gave the correct line of the shadow. Now this extension of the bright bars could not have been caused by the reflection from the back of the plate, as this result was always got whether glass or opaque black plates were used. Nor could it have been caused by the oblique pencils referred to by Lord Lindsay and Mr. A. C. Ranyard, because, the opaque bar being close to the collodion, these pencils could not get underneath. The natural conclusion seems to be, that this extension of the bright bars must have been caused by some molecular reflection taking place in the collodion. This form of irradiation can easily be distinguished from the irradiation produced by reflection from the back of the plate, as the latter is simply a sort of haze surrounding the bright object, extending some distance from it, and gradually fading away, whilst the former extends a very short distance and has a well-marked outline, though not so sharp as those parts of the image where there is no irradiation. The irradiation produced by reflection from the back of the plate, and some forms of irradiation due to the imperfections of the lens, though fatal to artistic photography, yet do not interfere much with its scientific value, as they do not affect the accuracy of outline, though they do affect the clearnesss of the photograph. Molecular irradiation, on the other hand, whilst it scarcely affects artistic photography, is fatal to scientific accuracy. The manner of preventing this latter form of irradiation has been already pointed out, namely, by reducing the intensity of the light falling on the sensitive surface to only that necessary to produce a distinct impression. In artistic photography this is almost never possible on account of the different amount of light on the different parts of the subject, while for scientific purposes this may almost always be done. The imperfections of the image due to the lens seem to be as various as the forms of lenses; one lens used in the experiments gave a curious double hazy-image of the bright object. When the image is near the centre of the "field" the double image fits over the true image, producing an effect somewhat similar to, and was at first mistaken for the effect of reflection from the back of the plate. At first this double image was somewhat puzzling, as it always made its appearance even when opaque plates were used. The two images were, however, afterwards separated by bringing the true image near the outside of the "field," when the true image and its double were photographed alongside of each other.

The following simple experiment illustrates this molecular form of irradiation, and shows how much the definition of the image depends on the nature of the surface which receives it. Take a camera obscura and throw the image on some translucent substance such as opal glass; paint a small part of the glass with some opaque white substance; bring into the "field" some brilliantly illuminated subject, such as branches of trees against the sky; examine the image from the lens side of the glass, when it will be found that the image over the opal glass is hazy and indistinct, whilst the part of the image on the paint shines out brilliant and sharp.

JOHN AITKEN

Darroch, Falkirk, N.B. June 16

Lakes with two Outfalls—A Caution

LLYN CREIGENEN (the larger of the two lakes of that name), situated about five miles S.W. by W. of Dolgelly, has *apparently* two natural outlets—one at the east, the other at the west end of the lake; both streams ultimately fall into the estuary of the Mawddach. The two outlets are on nearly the same level, the one at the east end being perhaps a trifle higher than that at the west end. The whole of the waste water at present passes through the western outlet in consequence of an artificial dam of turf having been made across the eastern channel. There are no indications on the ground which would lead anyone to suspect that either of the outlets had been artificially formed; the general contour of the surrounding country would rather favour the contrary view.

I was, however, informed last week by a man who had lived eighteen years in the district *that he had been told* that originally the only outlet was that at the west end of the Llyn, and that the other outlet had been made many years ago for the purpose of getting a better supply of water to some mills which then existed, but which do not now exist, on the stream to the east of the lake. If this story prove to be correct it shows how important it is to make full inquiries before stating positively that any lake has two natural outfalls.

From the ordnance map one would imagine that two streams issued from Llyn Arenig (five miles W.N.W. of Bala), but the one shown as starting from the extreme north end of the lake has no existence in fact.

GEORGE R. JEBB

Chester, June 3

FERDINAND STOLICZKA, PH.D.

A BRIEF telegram from India, which arrived just in time for notice in last week's NATURE (vol. x. p. 172), announced the death on the 19th ult., at Shayok, between the Karakorum Pass and Leh in Ladak, of Ferdinand Stoliczka, Palæontologist to the Geological Survey of India, who was returning from Kashgar and Yarkund with the other members of Mr. Forsyth's mission.

Thus has passed away, at the early age of thirty-six, a naturalist who, if his life had been spared, would certainly have attained a very high position amongst the leaders of science. Few men have accomplished an equal amount of work in the same brief space of time. A glance at the Journal and Proceedings of the Bengal Asiatic Society, and the publications of the Geological Survey of India, especially the "Palæontologia Indica," will show the wonderful variety of subjects treated by Dr. Stoliczka. In the course of the last ten years, besides geological memoirs on parts of the Western Himalayas and Thibet, he has published numerous papers on Indian mammals, birds, reptiles, amphibia, mollusca, bryozoa, arachnida, coleoptera, and actinozoa; and these papers are no lists of names or mere descriptions of new species, but they abound with accounts of the life history of the different animals, details of their anatomy, and remarks on classification, and show that their author was as good an observer in the field as he was patient and accurate in the cabinet. His greatest work is undoubtedly his account of the fossil fauna discovered in the Cretaceous rocks of Southern India, in which he proposed the most complete

general classification of Gasteropoda and Pelecypoda (Lamellibranchiata), including both fossil and recent forms, which has hitherto been attempted. This classification was largely supplemented by original anatomical research, and it has been adopted in one, at least—we believe in two—of the principal museums in Germany.

Dr. Stoliczka was born in Moravia in May 1838. After completing his university course he joined, whilst quite young, the Imperial Geological Institute of Austria, where he soon distinguished himself by his palæontological work, and became especially known for researches amongst the Bryozoa, fossil and recent. The collection of specimens belonging to that class obtained by the Novara expedition was intrusted to him for description. Amongst his principal early contributions to palæontology were papers on the fossil fauna of the Hierlatz and Gosau beds.

In 1862 he joined the Geological Survey of India, and at once commenced the study of the magnificent series of Cretaceous fossils obtained by Messrs. H. F. Blanford, C. Oldham, and the other officers of the Survey engaged in the Madras Presidency. The descriptions of these fossils have only recently been completed, and extend altogether to about 1,500 quarto pages illustrated by 178 plates. There can be no doubt of the rank of this work; it is one of the most complete monographs ever published of any fossil fauna whatever. The numerous duties connected with the post of Palæontologist to the Survey occupied so much of Dr. Stoliczka's time that he was only able to devote a few months in three different years to field-work. To this field-work we owe valuable reports on the western Himalayas, Thibet, and Kachh, the last not yet published. In the year 1868 he accepted the honorary secretaryship of the Asiatic Society, and during the five years he held the post he raised the natural history portion of the Society's journal to a position it had never approached before, this improvement being due no less to his own contributions than to the aid he was always ready to afford to all engaged in zoological inquiry.

When, last year, a mission was despatched by the Indian Government to Yarkund and Kashgar, Dr. Stoliczka was selected to accompany it as naturalist and geologist. It would have been impossible to have found anyone more competent for the post, but many of his friends knew the risk he ran, and he was well aware of it himself, for his health had been seriously affected by exposure in former years in the higher regions of the Himalayas, and he needed rest and a change to Europe. His life has been a sacrifice to the study to which he had devoted it. He was seriously ill at one time when crossing the high passes on his way to Yarkund, but recovered, and his letters from Kashgar gave glowing accounts of his discoveries, and now when returning loaded with the spoils and notes of nearly a year's research in one of the least-known parts of Central Asia he has fallen, just as his friends were in hopes of welcoming him back amongst them. This is not the place to speak of his many amiable qualities, but few men were more widely known in India or more universally beloved and esteemed, and the gap he has left in the little band of Indian naturalists and geologists, as well as amongst the far wider circle of his private friends, will be long unfilled. W. T. B.

OBSERVATORIES IN THE UNITED STATES

ONE of the most salient points in the scientific progress of America is undoubtedly the marvellous multiplication of first-class observatories during recent years. The genius of her people, the skill of her artists, and the wise liberality of states and individuals have combined to bring about a state of things which those interested in Astronomy in any country on this side of the Atlantic may regard with the intensest envy. Undoubtedly our own observatories are already distanced in everything except activity. In number, instrumental equipment, breadth of design, the American institutions are unsurpassed; and although the Americans themselves say they want men with such world-wide names as Peirce, Winlock, Newcomb, Young, Peters, and many others that we might mention, who know no resting on old laurels, it is difficult for an Englishman to acknowledge that the idea is well founded.

A very interesting and well-illustrated article on United States Observatories appears in a recent number of *Harper's Monthly*. Some of the illustrations, which we are enabled to give by the courtesy of the Editor, give a good idea of the scientific wealth to which we refer, and of the progress that has been made, for while little more than thirty years ago it could not be said that there was one astronomical observatory in the United States, to-day it is safe to place the number of all classes, public and private, beyond fifty.

Cincinnati Observatory.—One of the most strenuous advocates for the establishment of public observatories in the United States was John Quincy Adams, who had made astronomy a favourite pursuit. He had very just conceptions of what ought to be the character and aims of a true observatory. It must steadily labour for *discovery*. It must be fully equipped for this, and be provided with a *personnel* who could give their whole energies to that series of observations, running through many years, which alone can secure valuable additions to astronomical knowledge and insure its benefits to men. For the establishment of such an institution he had made his well-known appeal to Congress in 1825. He was ridiculed; but he remained as strenuous an advocate as ever for the establishment of observatories of the first class both at Washington and at Cambridge. In the very year before this address at Cincinnati he had urged, in his place in Congress, the perpetual appropriation of the whole interest of the then unappropriated Smithsonian fund for an observatory for the people.

"The express object of observatories," said he, "is the increase of knowledge by new discovery. It is to the successive discoveries of persevering astronomical observations through a period of fifty centuries that we are indebted for a permanent standard of time and for the measurement of space."

The year 1843 was, however, an era in the history of United States observatories, and Cincinnati was their birthplace. Her institution and those of Cambridge and Washington sprang up, and the enthusiasm of the era started others, whose equipment has been secured largely by their success.

As early as 1805, Cincinnati may be said to have had a practical working observatory. In that year the first Surveyor-General of the United States, Colonel Jared Mansfield, received, after a delay of at least three years in their construction and transportation from London, astronomical instruments ordered by Albert Gallatin, Secretary of the Treasury, and paid for by President Jefferson out of his *own contingent fund*, "since no appropriation for them had been made by law." The instruments, which were said to have been excellent of their kind, were a 3-foot reflecting telescope, a 30-inch portable transit instrument, and an astronomical pendulum clock. Years afterward, they were placed in the philosophical department of the Military Academy at West Point. In the house of the Surveyor-General, at Cincinnati, they were used in making numerous and interesting astronomical observations. The orbit of the comet of 1807 was calculated, eclipses of different kinds were observed, the longitude of the observatory determined, and other observations of importance made from 1807 to 1813, all of them outside of the usual duties of the mere surveyor.

Our next date is at the end of the lapse of forty years. We are brought then to the marked era in astronomical interest already referred to, and to the labours of those

who awakened that interest, especially of Ormsby M'Knight Mitchell.

Mitchell was a native of Kentucky. He graduated with honour at West Point, in 1829. Resigning from the army, and practising law in Cincinnati, he was made professor in the City College. He was an enthusiast in astronomy. He gave a series of lectures to the citizens in 1842, which created their Astronomical Society.

As the astronomer of the Society engaged for a ten-years' work, Prof. Mitchell sailed for Europe to purchase a telescope superior to any then in America. In the optical institute of Merz and Mähler, successors of the great Fraunhofer, at Munich, he found an object-glass of 12-inch aperture, which, after Lamont's test in his own tube, was pronounced superior to that of the Munich telescope. It was mounted, purchased for about 9,400 dols., and arrived in Cincinnati in 1845.

The Astronomical Society of that town meanwhile had secured from their fellow-citizen, N. Longworth, the gift of four acres of ground on one of the beautiful and commanding hills on the east of the city, and a fund of 11,000 dols. in shares of 25 dols. each.

Prof. Mitchell, on his return, devoted his whole energies to the erection of an observatory. Its corner-stone was laid November 10, 1843, on the site given by Longworth, on Mount Adams.

The observatory presented a front of eighty feet, ornamented with a Grecian Doric portico, and a depth of thirty, showing a basement and two storeys, with a central dome, covering an equatorial room twenty-five feet square, the roof being capable of entire removal when observations were to be made. The object-glass of the telescope had, as we have said, an aperture of twelve inches; its focal length was seventeen feet.

The equatorial room received the Munich instruments in March 1845. Prof. Mitchell began his labours with the enthusiasm of hope. Other necessary instruments were received: a 5-foot Troughton transit, lent by the Coast Survey, an astronomical clock, presented by Mr. M'Grew, of Cincinnati, and a chronometer lent by Messrs. Blunt, of New York. At the request of Prof. Bache, the telegraph company connected the observatory with their stations for the determination of longitude, Cincinnati being then a central point in such work. The Astronomer Royal, under whose instruction Mitchell had passed three months in 1842, urged, in an encouraging letter, that "the first application of his meridional instruments should be for the exact determination of his geographical latitude and longitude, and that his observing energies should be given to the large equatorial." With this advice, he directed his attention largely to the remeasurement of Struve's double stars south of the equator.

Airy and Lamont had invited him to make minute observations of the satellites of Saturn, since in the latitude of Cincinnati the planet is observed at a more favourable altitude than at Pulkova, twenty degrees farther north. To these, and chiefly "to the physical association of the double, triple, and multiple suns," he gave his close attention. He made interesting discoveries in the course of this review. "Stars which Struve had marked as oblong, were divided and measured; others marked double were found to be triple." He proposed a new method for observing, and new machinery for recording north polar distances or declinations. Prof. Peirce reported favourably on this method at the meeting of the American Association in 1851, and Prof. Bache, as Superintendent of the Coast Survey, indorsed their approval in his report for that year, presenting also a full account of work done by the new method, in observations made by the enthusiastic astronomer and his patient wife, who assisted him through all. It was claimed that the results rivalled the best work done at Pulkova. Mitchell was the first "to prepare a circuit interrupter with an eight-day clock, and to use it to graduate the running fillet of paper;" and to invent and use the revolving-disk chronograph, for recording the dates of star signals. Profs. Bache and Walker had declined to adopt the first of these improvements in astronomical appliances, through an apprehension of injury to the astronomical clock. Mitchell's work proved the apprehension to be groundless. His revolving disk is an invaluable invention. To the perfection of such methods and instruments, together with the routine work of observation, he gave all the energies not of necessity employed in outside labours devolving on him for his support. Unhappily these, at an early date, became almost absorbing. For the Astronomical Society, having secured their observatory and their director, had failed to secure a basis for his support. Mitchell relied on his professorship in the Cincinnati College: in two years the college was burnt down. He then relied on publications and lectures. He published the *Sidereal Messenger*, a work of three volumes. He delivered lectures of rare power and beauty in the chief cities of the Union. He stirred up an enthusiasm by these lectures, which quickened the movements resulting in the establishment of some of the first observatories of this day in the United States. But for his support, unhappily for the observatory, he was compelled to accept the position of chief engineer of the Mississippi and Ohio Railroad from 1848-52; and finally, in 1853, that of director of the magnificent Dudley Observatory at Albany, New York. He did not, however, remove from Cincinnati till 1859. In 1861 his country claimed him from astronomy for her own service. The observatory remained in charge of Mr. Henry Twitchell, of Cincinnati, who was Mitchell's chief assistant for twelve years.

On February 1, 1869, Mr. Cleveland Abbe, formerly employed at the Pulkova Observatory, and more recently at the United States Naval Observatory at Washington, accepted the place of director. His first annual report submitted a plan of wide and useful astronomical and magnetic and geodetic investigations. On these he entered vigorously. He first adopted for the United States the issuing of daily meteorological bulletins, now so widely known as adopted and used by the United States Signal Service Bureau.

During the years since Prof. Mitchell's leaving the institution, its future had appeared dark enough. In taking charge of the Dudley Observatory in 1859 he announced his expectation that "the Cincinnati Observatory was soon to be placed on a permanent foundation, and that each observatory would be occupied on a star catalogue down to the tenth magnitude." But it is not surprising that the interval of the war should retard the plans he had formed, and prevent, under all circumstances, their subsequent execution by his successors.

But in 1870 a movement was originated by Abbe, which, at the time this article was written, promises by its development to secure results worthy of the noble founder of the observatory, and of the West. A tripartite agreement has been secured between Mr. Longworth's heirs, the Astronomical Society, and the city, by which the sale of the old site was permitted, and the city pledged to maintain the observatory in connection with the university; original investigations, and not mere educational uses being guaranteed as its object. On Mount Lookout, one, of the highest points in Hamilton County, adjacent to a park not likely to be built up to the injury of astronomical observations, the corner-stone of the new observatory was laid, August 28, by the mayor of Cincinnati. The observatory is to be 71 ft. by 56 ft., with an elevation of 60 ft. It will be built of brick, trimmed with freestone. The pier of the Munich equatorial is to be of solid brick, with like capping; its height 36 ft., and its diameter 17 ft. The iron revolving turret dome adds half a storey. The meridional instruments occupy the wings.

The whole new enterprise owes its success thus far to the munificence of Mr. John Kilgour, of Cincinnati, who granted the site and a liberal grant of money. Cincinna

holds that she has good ground of expectancy of success. What they need, what every observatory needs, is, first of all, an astronomer with provision for his maintenance, that he may be "free from other avocations and cares."

FIG. 1.—Ormsby McKnight Mitchell.

A true astronomer, then, first of all—before even the most imposing edifice or instruments. An astronomer with a true conception of his work, with the splendid objects before him, and the advantages of our day, may largely repay the benefactions of the liberal by the lasting benefits not of mere theory, but of the practical usefulness of discovery.

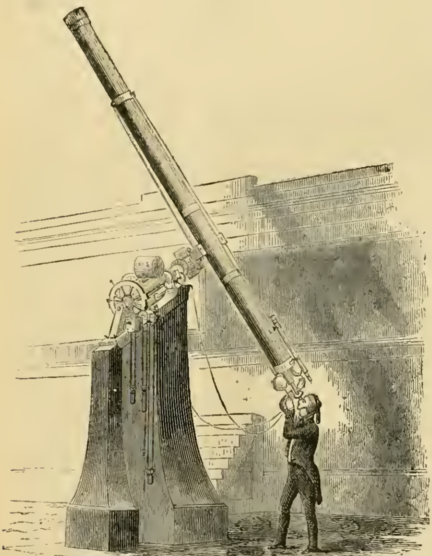


FIG 2.—The Equatorial of Cincinnati Observatory.

The U.S. Naval Observatory.—The history of this Observatory is not a little remarkable.

Close on the isle on which stood what was known as the "Washington property," near the old Capitol, stood, in 1833, an unpretending wooden building but 16 ft. square, erected at the expense of a lieutenant of the navy, and equipped with a 5-foot Troughton transit instrument. This was the United States Naval Observatory in embryo.

The transit was one of the instruments made for the Coast Survey, under the supervision of Mr. Hassler, its first superintendent, during his long detention in England, by the breaking out of the war. Returning only in 1815, and the survey itself being soon arrested by Congress, his instruments and the "fixed observatory," the establishment of which he was the very first in the United States to propose, rested quietly *in statu quo ante bellum.* In 1832 the Coast Survey was revived; but as an observatory was peremptorily forbidden by the law, the transit was lent to Lieut. Wilkes for his observations.

Lieut. Wilkes's observations were, however, at first only for obtaining clock errors, needed for determining the true time for rating the naval chronometers then under his charge. This testing of all the chronometers and other naval instruments used by the United States ships (begun in 1830 by Lieut. Goldsborough) had been at once found a wise and useful economy for the navy. The Secretary, therefore, established this little receptacle for charts and instruments by placing an officer in charge' permitting him to build his own little observatory and do his own work. The "Depôt" was the christening then given to the establishment. This was all that Wilkes or any one of his successors dared call it even as late as 1842, when establishing the present astronomical institution.

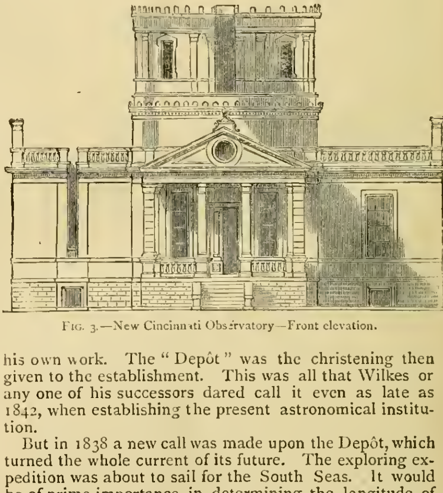


FIG. 3.—New Cincinnati Observatory—Front elevation.

But in 1838 a new call was made upon the Depôt, which turned the whole current of its future. The exploring expedition was about to sail for the South Seas. It would be of prime importance, in determining the longitude of places to be visited by the expedition, that corresponding astronomical observations should be made at home, to be compared on its return. Secretary Paulding gave the observations in the United States to Lieut. Gilliss, Wilkes's successor at the Depôt, and to Prof. Bond, of Cambridge. For the years 1838-42 Gilliss worked most accurately and unremittingly. With the help of an achromatic telescope, added by the Navy Department, and the transit before mentioned, he observed and recorded 10,000 transits; and his observations, afterwards tested by Prof. Peirce, were ranked by him among the highest then made. They are in the libraries of the astronomers of Europe. They procured, in fact, the founding of the present Naval Observatory.

For this, however, hard work in abundance was to be done. Gilliss urged the unsuitableness of his building erected alongside of Wilkes's wooden square room, and his want of space to erect a permanent circle. He won

over the old [Navy Commissioners and the indorsement of the Secretary to their recommendation for something better. He pressed the Naval Committees frequently and closely, but enlisted scarcely one, except Mallory, of the House. Almost to a man they kept away from the Depôt, although it was "so near," and no help seemed available. But a celestial visitant now appeared, as, singularly enough, another did in 1843 for the benefit of the Cambridge Observatory. It gained the day for Gilliss, and for an observatory at Washington. He had closely observed Encke's comet, and read a paper on it before the National Institute. When he made, shortly after this, his last intended visit to the Senate Committee, Preston of South Carolina asked, "Are you the one who gave us notice of the comet? I will do all I can to help you." In a week a bill passed the Senate; and, strangely enough,

FIG. 4.—The United States Naval Observatory, Washington.

passed the House also, without discussion, on the last day of its session. It appropriated 25,000 dols.; but still "for a Depôt of Charts and Instruments."

But the Secretary of the Navy was no longer officially bound by the name. The report of the committee, which secured the bill, was so expressly in favour of astronomical, meteorological, and magnetic objects, that Congress was justly understood to sanction them. Gilliss was sent abroad for instruments and plans for an observatory.

The site chosen by President Tyler for the building was fraught with historic interest. The square embraces a little more than nineteen acres in measurement. It is now tastefully laid out and ornamented. Nearly central within it stands the building represented

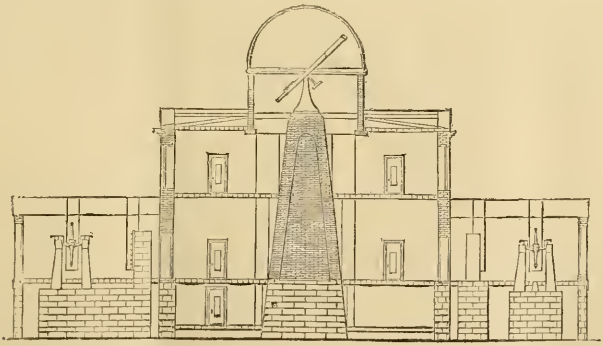


FIG. 5.—Section of Main building—United States Naval Observatory, 1844.

in Fig. 4. It is on the second highest eminence within the city limits, commanding the view of the public buildings, of the neighbouring cities of Georgetown and Alexandria, and of Arlington.

In 1844 Gilliss reported the completion and equipment of the central building. He had secured the excellent equatorial, the meridian circle, the transit, prime vertical, and mural circle on which so much valued work has been done. He had begun a library, to which nearly 200 volumes of the highest standard works were presented by the Greenwich, Paris, Berlin, and Vienna institutions. (*To be continued.*)

A MONUMENT TO JEREMIAH HORROCKS

AT the last meeting of the Royal Astronomical Society, Prof. Adams said that he had been requested to call the attention of the Society to a petition which was about to be presented to Dean Stanley. It would speak for itself, and he would therefore read it to the meeting. It ran thus :—

To the Very Reverend the Dean of Westminster.

Reverend Sir,

It appears to us that the approaching transit of Venus offers a fitting occasion for the erection of a memorial to Jeremiah Horrocks, curate of Hoole, in Lancashire, to whom the science of astronomy is indebted for the earliest observation of Venus upon the sun's disc. He predicted, by his own calculations, the transit of the year 1639, which he and his friend Crabtree had the exclusive privilege of witnessing. The labours of Horrocks in connection with this memorable occurrence, as well as the originality of his views on other astronomical subjects, have, by the unanimous consent of scientific men, assigned to him a high place in the roll of illustrious astronomers who adorned Europe in the seventeenth century.

We therefore venture to request your permission to place in Westminster Abbey a tablet or some other memorial of Jeremiah Horrocks.

We have the honour to be,
Reverend Sir,
Your obedient Servants,

(Signed) by the Astronomer-Royal, the President of the Royal Astronomical Society, and a number of the most distinguished Fellows of the Society.

Prof. Adams remarked that he need not say anything further to recommend the signature of the memorial to the Fellows of the Society. It was perfectly impossible to estimate too highly the credit due to Horrocks, especially when his age and opportunities were taken into account. Not merely had he been successful in observing the transit of 1639, but he had first corrected the tables of Venus, from his own observations, and had thereby rendered his prediction of the transit possible. Had he merely followed the tables which had been published by Kepler, he could not have predicted the transit, and it would probably have slipped by unobserved. And this was by no means the only astronomical service rendered by Horrocks. His discovery of the law of libration of the moon's apogee constituted an important advance in the knowledge of the lunar motions. In fact, Sir Isaac Newton, when nearly half a century afterwards he attempted to explain those motions on mechanical principles, could not find any more convenient representation of the motion of the moon's apse than that which had been given by Horrocks. He had, therefore, great pleasure in bringing this petition to the notice of the Fellows of the Society.

FRENCH PREPARATIONS FOR THE TRANSIT OF VENUS

AT the meeting of the French Academy of June 29, M. Dumas gave in the Report of the Commission charged with making the necessary preparations for observing the approaching transit of Venus.

The stations chosen by the commission are Campbell and St. Paul Islands, Houméa, Pekin, Yokohama and Saïgon. Each expedition is under the charge of a chief, the conduct of the first having been intrusted to M. Bouquet de la Grye, the second to M. Mouchez, the third to M. André, the fourth to M. Fleuriel, the fifth to M. Janssen, and the sixth to M. Hérault. The observers altogether number twenty-five, accompanied by twenty-five assistants. M. Bouquet de la Grye has already left; M. Fleuriel is on the point of setting out for Pekin. M. Janssen loses no time in leaving for Yokohama, from which he will not return directly to Europe, having undertaken to go to Siam to observe the eclipse which will be visible there.

As Campbell and St. Paul Islands are perfectly barren, the expeditions destined for them have been specially cared for, being furnished with fuel and provisions for six months.

A sum of 300,000 francs was allotted by the State for the whole of the expeditions ; but this sum having been found insufficient, the Minister of Marine has abundantly and generously provided for the wants which have been pointed out by the Commission. Indeed, the French Government has acted in the most handsome manner towards the various expeditions, which have been furnished with everything that is in any way necessary.

As to instruments, besides those which have been specially constructed for the enterprise, the depôt of Marine has placed at the disposal of the expeditions a large number of instruments, among which are thirty-one tested chronometers. Four of the expeditions have each received an equatoreal of 8 in. No expedition from any other country, the Report states, will be possessed of instruments so powerful. Equatoreals of 6 in. have been furnished to the six expeditions, and telescopes of the same power as those adopted by the various expeditions of other countries.

Various photographic apparatus and methods of observation have beer proposed. The Commission has decided in favour of the system of M. Fizeau, who has himself superintended the construction of instruments and initiated the operators in all the practical details which they ought to follow.

ON VAPORISING METALS BY ELECTRICITY

THE following simple results obtained by frictional electricity may be of interest, perhaps too of use in the investigation of certain minerals and the action of intense heat upon them.

The description of a characteristic experiment is all that will be necessary to explain the process and to show how similar results may be obtained from other substances. A very fine thread of sheet platinum, of about an inch in length, is placed between two microscopic slides of glass, and two pieces of thin sheet copper with rounded ends are placed in contact with the extremities of the platinum, the copper being any convenient length and breadth, so as to extend beyond the glass slides, but not to be as broad ; a charge of electricity from about eight square feet of Leyden jar is passed through the metals ; the effect of the heat from the charge is to vaporise the platinum, which is instantly condensed in a transparent layer upon the cold glass. The layer can be investigated by a microscope, and employed in various ways to determine the character of the metal and its effect upon reflected or transmitted light.

Copper, tinfoil, tinfoil amalgamated with mercury, gold and silver, can be used in a similar manner, but they produce layers very dissimilar in appearance. To act upon finely-ground substances, such as vermilion, sulphate of antimony, sulphur, &c., a line of the powder must be made and the charge be passed through in the same way as through the platinum.

Part of the vapour escapes from between the slides, but this can easily be condensed upon each of two pieces of glass placed in such a way as to intercept the vapour as it passes from between the two slides ; it is then condensed in a long but narrow line. The manner in which the glass is affected by the heat, and the concussion produced by the expansion of the vapour, are worthy of notice.

Considerable difficulty will be found in vaporising copper, doubtless from its being such an excellent con-

ductor. Some of the powdered substances appear to require a small spark to be passed through them before they allow a larger charge to pass, as if the particles needed polarisation.

G. H. HOPKINS

THE HERPETOLOGY OF NEW GUINEA*

DR. ADOLF BERNHARD MEYER, who, as most of the readers of NATURE will be aware, has lately returned from a very successful expedition to New Guinea, has published in the "Monatsberichte" of the Berlin Academy a short account of his herpetological discoveries, which present several points of interest. Previous investigators of the natural history of this wonderful land have paid more attention to its birds than to its reptiles and amphibians—a circumstance perhaps scarcely to be wondered at in the land of paradise-birds and so many other anomalous forms. Dr. Meyer, however, while he has by no means neglected the class of birds, as shown by his recent communications upon that branch of zoology to the Academy of Vienna, has likewise paid much attention to the representatives of the inferior orders of reptiles and batrachians which he met with in New Guinea and the adjacent islands. Although this branch of the Papuan fauna is well known to be comparatively poor, Dr. Meyer's labours have been by no means without result. Of sixty-three different forms belonging to these orders of which he collected specimens, thirty-four have turned out to be new to science; and of the remaining twenty-nine, the greater part were previously not known to occur in this locality.

Of tortoises, besides the marine *Chelone imbricata*, only one was obtained in New Guinea, which, however, was of a new species belonging to an Australian form. Of lizards, upwards of thirty species were collected, amongst which Australian types are again predominant. Amongst the sixteen serpents met with in New Guinea, Jobi, and Mysore, were several of special interest. The Australian carpet snake, *Morelia*, is represented by an allied form, proposed to be called *Chondropython*, besides which two other new genera are described, one belonging to the boas, and the other to the colubrine snakes.

Of batrachians, Dr. Meyer collected specimens of nine species in New Guinea and its islands, five of which he considers to be hitherto undescribed.

It will be thus evident that Dr. Meyer has made a by no means inconsiderable addition to our knowledge of this branch of the Papuan fauna. At the same time it cannot be supposed that we are, as yet, by any means perfectly acquainted with the herpetology of New Guinea when so little is known of the vast interior of this strange country.

* "Uebersicht der von mir auf Neu Guinea, und den Inseln Jobi, Mysore, und Mafoer im Jahre 1873, gesammelten Amphibien." Von Dr. Adolf Bernhard Meyer. (Berlin: Monatsb. Akad., 1874.)

COGGIA'S COMET

AN observation taken here on July 4, shows so close an agreement with the position calculated from my parabolic elements in NATURE (vol. x. p. 149), that it appears unlikely the comet can have so short a period as 137 years, and consequently that, notwithstanding similarity of orbits, it probably is not identical with the body observed by the French Jesuits in China in July 1737. Between April 17, the date of discovery, and July 4 it had traversed an arc of just 90° of true anomaly, and if any decided ellipticity existed, so wide an arc must have shown it, the stellar appearance of the nucleus having admitted of very exact observation throughout. On July 4, twenty-one days after the last position I employed in determining the orbit, the computed right ascension differs only 20″, and the declination 14″ from the observation. In all probability, therefore, the comet has not visited these parts of space within many centuries.

Measures of the diameter of the nucleus on July 4 gave nearly 14 seconds of arc, the distance of the comet at the time, by my elements, being 0·6016, which indicates a real diameter of about 3,750 miles; it has, perhaps, slightly contracted within the last fortnight.

This morning Mr. W. Plummer, at this observatory, found the comet equal in brightness to α Persei, a second magnitude star in Argelander's Atlas.

I may here mention that for calculation of actual dimensions or distances I take the sun's parallax, after M. Leverrier = 8″·86, which, combined with Capt. A. R. Clarke's value of the earth's equatorial semi-diameter, gives for the mean distance of the earth from the sun, 92,268,000 miles, a figure that I believe to be as probable as any now to be attained. The moon's mean distance from the earth, adopting Prof. J. C. Adams's parallax, is thus found to be 238,800 miles, or 60·273 equatorial radii of our globe.

J. R. HIND

Mr. Bishop's Observatory,
Twickenham, July 7

DE CANDOLLE'S PROPOSED "PHYSIOLOGICAL GROUPS" OF PLANTS

IN the *Archives des Sciences Physiques et Naturelles*, No. 197, M. de Candolle proposes a new classification of the vegetable kingdom, based on the physiological relations of plants to heat and moisture, which he believes affords a means of tracing the connections of recent and fossil floras in a way which neither botanical nor geographical grouping do. He makes six divisions altogether.

1. The first of his "physiological groups" consists of those which need much heat and much moisture, and to them he gives the name Hydromegatherm, or, for short, Megatherm. These at present live in the tropics, and sometimes as far as 30° N. and S., in warm and damp valleys, where the temperature is never below 20° C., and the rains never fail. The predecessors of the existing Megatherms were widely spread, but at the commencement of the Tertiary period they became confined pretty much to the equatorial zone. Their botanical characters vary considerably, and they are represented in almost all cases by different species in Asia, Africa, and America. The most characteristic families are Menispermaceæ, Byttneriaceæ, Ternstrœmiaceæ, Guttiferæ, Sapindaceæ, Dipterocarpeæ, Sapotaceæ, Apocinaceæ, Aristolochacæ, Begoniaceæ, Piperaceæ, &c.

2. His second group requires heat with dryness—Xerophiles he proposes to call them. Their present distribution is in dry and warm regions of from 20° or 25° to 30° or 35° on each side of the equator (their particular districts are carefully noted). The group includes a large proportion of Compositæ, Labiatæ, Boraginaceæ, Liliaceæ, Palmæ, Myrtaceæ, Asclepiadaceæ, Euphorbiaceæ; but the most characteristic are Cactaceæ, Ficoideæ, Cycadaceæ, Proteaceæ, and Zygophylleæ. There are few large trees, few annuals, and the aspect of vegetation is but meagre. The palæontology of the regions where Xerophiles now exist is too little known for us to be able to trace the former migrations of plants forming this group.

3. The third group includes those plants which require a moderate heat, 15° to 20° C., and moderate moisture, and are named Mesotherms. They are now found around the Mediterranean, in the slightly elevated regions of India, of China, Japan, California, Central United States,

the Azores, and Madeira, and in the plains and low valleys of Chili, Monte Video, Tasmania, and New Zealand. Their characteristic families are the Laurineæ, Juglandeæ, Ebenaceæ, Myricacæ, Magnoliaceæ, Aceraceæ, Hippocastaneæ, Campanulaceæ, Cistiaceæ, Philadelphiniæ, Hypericaceæ, mixed however with a large number of Leguminosa, Compositæ, Cupuliferæ, Labiatæ, &c.

4. The fourth group is of plants of temperate climates having annual means of 14° to 0° C., and these are named Microtherms. In Europe they occupy plains from the Cevennes and Alps to the North Cape, in Asia from the Caucasus or Himalaya, to 65°, in America from 38° or 40°, to 60° or 65°. They are also met with in Kerguelen, Campbell, and the Malonine Islands, and the mountains of New Zealand. No characteristic families are enumerated, as it is the absence of forms that are usually Mesotherms and above all of Megatherms or Xerophiles, which distinguishes this group.

5. The fifth group is of plants living in arctic or antarctic regions, or high on mountains in temperate regions. They need but little heat, and hence are called Hekistotherms. One of their important characteristics is that they can endure the absence of light during the time they are covered with snow. Though no family belongs entirely to this group, Mosses, Lichens, Grasses, Crucifers, Saxifrages, Roses, and Composites bear a large proportion to the whole. Some species of Betula, Salix, Empetrum, Vaccinium, and certain Conifers also are Hekistotherm.

6. The sixth group includes exceptional plants; those requiring a mean annual temperature of more than 30° C., for which the name Megistotherm is proposed.

After the description of his proposed groups, M. de Candolle at once faces an objection he sees is sure to be raised, and that is the difficulty of classing a species under any one particular group. His reply is that it is always possible to do so if due attention is paid to the conditions under which it lives, both by studying the climatal conditions of its native country, and by experimental culture. Fossil plants, he admits, can only be classed by analogy; but he very justly adds that in determining their botanic affinities in like manner there is generally nothing but analogy to rely on, flowers and fruits being wanting. In answer to the possible objection that there are transitions from one group to another, and that the limits are arbitrary, he is content to reply that though a classification based on botanical characters may be more precise, the limits of geographical groups and of geological periods are equally wanting in exactness.

The fact that his physiological groups in no way coincide with established botanical or geographical groups is worth notice. All families that are at all numerous in species are represented in more than one of these physiological groups, and sometimes in them all. To give only one instance, the Primulaceæ live in almost all cold and temperate regions, and yet the Myrsineaceæ, which are their woody representatives, are found in the tropics. Even in genera which have not many varieties of form, the same is the case. The Cassias, for example, are mostly Megatherms or Mesotherms, yet *Cassia marylandica* flourishes at Geneva, where the winter minimum is sometimes 25° C. Some willows flourish far north, yet *Salix humboltiana* is met with in the district of the Amazon, and *Salix safsaf* grows in Egypt.

Is there any connection between the physiological properties of plants and the form of their organs of vegetation? M. de Candolle thinks not. For example: there is no recognisable difference between the forms and tissues of ferns which we have to preserve in hot-houses and those which will grow in the open air. There are many facts such as these which seem to show that there is no direct relation of cause and effect between the form and those physiological qualities of plants which have reference to climatal conditions. There is rather a dependence on some common cause which has influenced both sets of phenomena, which M. de Candolle refers to heredity. A species has a particular form because its ancestors had a form more or less the same. It has certain physiological qualities with reference to climate because the exterior conditions which have been imposed on it through innumerable ages have prevented other qualities from being developed and have secured the heredity of those which have enabled it to live. This, he considers, is the key to the explanation why a flora of any particular climate does not present in the totality of its species any distinctive peculiarities. Arctico-Alpine plants are of different families, and it is impossible to point to any development of an organ which cannot also be met with in tropical plants. The ascendants of Arctico-Alpine plants have lived together, and only certain of them have lived together through changes of temperature. Physiological qualities may be changed in length of time when exterior conditions have not changed in such a way as to cause a species to perish. M. de Candolle lays great stress on the fact we learn from the experience of horticulturists, that it is much more rare to obtain any change in the power of a plant to endure modifications of climate than it is to obtain change of form. A period of greater length than the historic period of Europe seems to be needed for a modification of physiological conditions; witness the fact that for some 3,000 years the date has been grown in Greece and Italy without any success in getting the fruit to ripen. The fact that physiological conditions are so much more permanent than form is to M. de Candolle a strong argument in favour of his physiological groups. The impossibility of making geographical groups perfectly true, together with the fact that the climates of each region have changed from one period to another, is also claimed as additional argument in favour.

For the purpose of showing that these groups make the facts of geographical botany, both of geological and present times, more precise and more easy of discussion as regards general laws, their distribution in Europe since the commencement of the Tertiary period is taken as an illustration. The works of Gœppert, Heer, Unger, Garovaglio, Ch. T. Gaudin, Saporta, &c., have supplied M. de Candolle with his data, and on comparing the fossil floras with recent forms he has had no difficulty in classifying them according to his groups. He, of course, goes on the hypothesis that like forms have sprung from like antecedents possessing like hereditary physiological properties. As an illustration that any uncertainty there may be is within limits, he points out that though a fossil Ficus might be taken for a Megatherm or Mesotherm, it could never be mistaken for a Microtherm or Hekistotherm, since we do not now know any Ficus capable of resisting such cold. A fossil Betula may have been Microtherm or Hekistotherm, but not Megatherm.

Acting on these hypotheses he has reduced his results to tabular form, prefacing the remark that his great difficulty has been to class the different fossil floras according to geological periods that could be relied on; stratification and not palæontology being the only safe basis of relative age grouping.

Different climates prevailed in different parts of Europe during the Tertiary period as well as now, and he urges it must be recollected that when two fossil floras (faunas equally so) which are much alike are met with in widely separated latitudes, they cannot have been contemporaneous. In the same latitude, too, difference of elevation will have had a similar effect to difference of latitude. Floras of quite different facies may therefore have been contemporaneous.

In transcribing the following table and explanations we have given only the name of the author who has described the floras. M. de Candolle gives exact references to the works where the descriptions may be found.

Distribution of Physiological Groups in Europe since the Commencement of the Tertiary Period according to our present knowledge of Existing and Fossil Floras

Lat. N.	TERTIARY						QUATERNARY		Lat. N.
	Eocene			Miocene		Pliocene	Glacial	Recent	
	Lower	Middle	Upper	Lower	Upper				
90°–85								E	90°–85
85–80								E	85–80
80–75				? $C^{13}+D^4$			? E^4	E	80–75
75–70								E	75–70
70–65				$C^{14}+D^5$				D	70–65
65–60								D	65–60
60–55							E^1	D	60–55
55–50	A^6			C^9			D^3 E^2	D^1 D	55–50
50–45	A^5+C^{12}	? A^4 A^3+C^{11}		A^1+C	C^7 C^6	C^2	D^2 E^3	D	50–45
45–40			A^2+C^{10}	C^5	C^4		C^1	C+B	45–40
40–35								C+B	40–35
35–30						? C^3		B	35–30
30–25								B	30–25
25–20								B A	25–20
20–15								A	20–15
15–10								A	15–10
10–5								A	10–5
5–0								A	5–0

EXPLANATION OF THE TABLE

A.—*Megatherms.*

A. Existing Megatherms.
A^1. Beds of Monod, Paudeze (Heer). Mesotherms are mixed with Megatherms.
A^2. "Gypses d'Aix." Megatherms with Mesotherms C^{10}.
A^3. Chiavone and Salcedo (Massalongo). Mesotherms are mixed with Megatherms but the former are in large proportion.
A^4. "Sables supérieurs du Soissonnais" (Watelet), containing a large proportion of Megatherms. The stratigraphical position of these beds, it should be noted, is inferred from palæontological evidence rather than from superposition.
A^5. Bolca (Massalongo), although mixed with Mesotherms, Megatherms preponderate.
A^6. Sheppy (Bowerbank, Ad. Brongniart, Lyell).

B.—*Existing Xerophiles.*

The countries where fossil floras of this character are to be expected have not been worked geologically, and no bed containing Xerophiles is known.

C.—*Mesotherms.*

C. Existing and recent Mesotherms.
C^1. Many floras in the south-east of France worked out by Saporta.
C^2. Meximieux (Saporta).
C^3. S. Jorge, Madeira (Heer).
C^4 and C^5. South-east of France (Saporta). Some Megatherms occur in his lists, but they do not form a fourth part of each flora.
C^6. Piedmont (Sismonda).
C^7. Œningen (Heer).
C^8. Monod, Paudeze (see A^1).
C^9. Dantzig (Heer). The lower bed contains Sequoid, Smilax, Myrica, Ficus, Lauraceæ, Juglandaceæ, &c.
C^{10}. "Gypses d'Aix" (see A^2).
C^{11}. Chiavone and Salcedo (see A^3).
C^{12}. Bolca (see A^5).
C^{13}. Spitzbergen (Heer), mixed with Microtherms D^4.
C^{14}. Iceland (Heer), mixed with Microtherms D^5.

D.—*Microtherms.*

D. Existing and recent Microtherms.
D^1. Cannstadt alluvial deposits.
D^2. Laminated lignites of Durnten (Heer).
D^3. Cromer forest bed (Lyell, Heer).
D^4. Spitzbergen (Heer), mixed with C^{13}.
D^5. Iceland (Heer), mixed with C^{14}.

E.—*Hekistotherms.*

E. Existing Hekistotherms.
E^1. Southern Sweden, Denmark (Nathorst).
E^2. Mecklenburg and Cromer below the forest bed (Nathorst).
E^3. Glacial clay of Schwerzenbach—between Zurich and Constance—(Nathorst).
E^4. Superficial diluvium of Spitzbergen (Heer).

Signs.

+ When two groups are united by the plus sign it means that at least one-fourth of the flora is made up of the second group indicated.
? The note of interrogation is used to imply that the geological age of the bed is doubtful.

Setting out with the belief that at a most remote period there was all over the globe a high and nearly uniform temperature, followed by a gradual cooling and the development of diversities in climates M. de Candolle proceeds to show that the earliest plants must have been Megistotherm. With the exception of the carboniferous, we are too imperfectly acquainted with the floras of Primary and Secondary periods to trace their distribution. At the commencement of the Tertiary period Megatherms occupied all the then land surfaces up to 58°. The other groups became gradually separated, and migrated as increase of cold drove them from their former areas. The means by which this was effected is a matter of hypothesis, but it is not hypothesis to say that the various groups never sprung from a single group. It cannot be proved that there formerly existed a single form of vegetation, while M. de Candolle urges that the surface of the globe certainly had formerly one uniform climate. The distribution of physiological groups indicates two sorts of floras, one migratory, the other fixed. Intertropical floras have had but few vicissitudes, arctic and antarctic have experienced many.

We submit this *résumé* of M. de Candolle's proposal and illustration without at present offering any remarks.

NOTES

The usual programme of the forthcoming (the 44th) meeting of the British Association at Belfast has been issued. The First General Meeting will be held on Wednesday, Aug. 19, at 8 A.M. precisely, when Prof. Williamson, F.R.S., will resign the chair, and Prof. Tyndall, F.R.S., President-elect, will assume

the presidency, and deliver an address. On Thursday evening, Aug. 20, at 8 P.M., there will be a Soirée; on Friday evening, Aug. 21, at 8 P.M., a Discourse by Prof. Huxley, F.R.S.; on Monday evening, Aug. 24, at 8.30 P.M., a Discourse by Sir John Lubbock, Bart., M.P., F.R.S.; on Tuesday evening, Aug. 25, at 8 P.M., a Soirée; on Wednesday, Aug. 26, the concluding General Meeting will be held at 2.30 P.M. The following are the officials of the various sections:—A, Mathematical and Physical Science.—President: Rev. Prof. J. H. Jellett, M.R.I.A. Vice-Presidents: Prof. Everett, F.R.S.E.; Prof. Purser, M.R.I.A. Secretaries: Prof. W. K. Clifford, F.R.S.; J. W. L. Glaisher, F.R.A.S.; Prof. Herschel, F.R.A.S.; Randal Nixon; G. F. Rodwell, F.R.A.S. B, Chemical Science.—President: Prof. A. Crum Brown, F.R.S.E. Vice-Presidents: Prof. Maxwell Simpson, F.R.S.; Dr. Debus, F.R.S. Secretaries: Dr. J. F. Hodges, F.C.S.; W. Chandler Roberts, F.C.S.; Prof. Thorpe, F.R.S.E. C, Geology.—President: Prof. Hull, F.R.S. Vice-Presidents: Prof. Harkness, F.R.S.; Prof. Geikie, F.R.S. Secretaries: Louis C. Miall; R. G. Symes. D, Biology.—President: Prof. Redfern, M.D. Vice-Presidents: Dr. Hooker, C.B., Pres. R.S.; Sir W. R. Wilde; J. Gwyn Jeffreys, F.R.S. Department of Anatomy and Physiology.—Prof. Redfern (president) will preside. Secretaries: Dr. J. J. Charles; Dr. P. H. Pye-Smith. Department of Zoology and Botany.—Dr. Hooker, C.B., Pres. R.S. (vice-president), will preside. Secretaries: Prof. W.T. Thiselton-Dyer, Prof. R. O. Cunningham, F.L.S. Department of Anthropology.—Sir W. R. Wilde (vice-president) will preside. Secretary: F. W. Rudler, F.G.S. E, Geography,—President: Major Wilson, F.R.S., Director of the Topographical Department of the Army. Vice-presidents: Sir Bartle Frere, G.C.S.I., K.C.B., F.R.G.S.; Admiral Ommanney, C.B., F.R.S.; Major-General Strachey, F.R.S.; Secretaries: E. G. Ravenstein, F.R.G.S.; E. C. Rye; J. H. Thomas, F.R.G.S. F, Economic Science and Statistics.—President:——. Vice-presidents: W. Donnelly, C.B.; Prof. T. E. Cliffe Leslie. Secretaries: F. P. Fellowes, F.S.A.; E. Macrory. G, Mechanical Science.—President: Prof. James Thomson, F.R.S.E. Vice-presidents: Sir John Hawkshaw, F.R.S.; Sir Charles Lanyon. Secretaries: James Barton; E. H. Carbutt; J. N. Shoolbred, F.G.S.

THE announcements for holding the twenty-third meeting of the American Association for the Advancement of Science at Hartford, Connecticut, on Aug. 12, have been issued by the secretary, in which we are informed that the head-quarters will be at the State House. Dr. John L. Leconte, of Philadelphia, is president of the coming meeting; Prof. C. S. Lyman, vice-president; F. W. Putnam, of Salem, permanent secretary; Dr. A. C. Hamlin, general secretary; and William S. Vaux, treasurer. The Hon. H. C. Robinson is chairman of the local committee.

A MARBLE *replica* of Woolner's remarkably fine bust of the late Prof. Sedgwick has just been placed in the hall of the Geological Museum in Jermyn Street, the gift of a lady who wishes to be anonymous. The School of British Geology is now well represented in this museum by the busts of the following geologists:—Hutton, Playfair, Sir James Hall, William Smith, Greenough, Buckland, De la Beche, Forbes, Murchison, and Sedgwick.

IT will be heard with regret that Dr. J. Hughes Bennett has been obliged, on account of his health, to intimate his resignation of the Chair of Physiology in the University of Edinburgh. It is understood that Dr. McKendrick, Dr. Bell Pettigrew, and Prof. Rutherford will offer themselves for the vacant chair.

PROF. SCHROEDER of Erlangen (*Deutsche Archiv für klinische Medicin*) confirms, by a remarkable case occurring in his own practice, the previous observations of Winkel and C. Braun, of the occasional occurrence of small cysts in the mucous membrane of the vagina of pregnant females containing some kind of air. These cysts he proposes to call air-cysts. When they are opened the air escapes with a report or crack. These observations, if verified by subsequent inquirers, will form a remarkable addition to the pathology of gaseous secretion or production.

THE Observatory at Kiel, of which Dr. C. A. F. Peters is director, is to be removed to Altona, in order to be in closer connection with the University.

THE death is announced of Mr. Henry Grinnell, of New York, whom the English public will remember in connection with the Grinnell Arctic Expedition.

AT the distribution last week of prizes at King's College, Mr. W. E. Forster, M.P., gave an address in which, among other subjects, he contrasted the expense of educating a boy from the age of nine to twenty-two at the older schools and universities with the cost of education during the same period at King's College; in the former case it is between 1,600*l.* and 1,800*l.*, in the latter only 400*l.* Mr. Forster also referred to the superior advantages, in some respects, of German over English schools; he might at the same time have pointed out that a German boy can obtain the best education which his country can give at a cost of something like 5*l.* a year, which for the thirteen years between nine and twenty-two amounts to the ridiculously small sum of 65*l.*

AT St. John's College, Cambridge, in April 1875, there will be offered for competition an Exhibition of 50*l.* per annum for proficiency in Natural Science, the Exhibition to be tenable for three years in case the Exhibitioner have passed within two years the Previous Examination as required for candidates for honours: otherwise the Exhibition to cease at the end of two years. The candidates for the Exhibition will have a special examination (commencing on Saturday, April 3, at 1 P.M.) in (1) Chemistry, including practical work in the laboratory; (2) Physics, viz. Electricity, Heat, Light; (3) Physiology. They will also have the opportunity of being examined in one or more of the following subjects—(4) Geology; (5) Anatomy; (6) Botany, provided that they give notice of the subjects in which they wish to be examined four weeks prior to the examination. No candidate will be examined in more than three of these six subjects, wherof one at least must be chosen from the former group. It is the wish of the master and seniors that excellence in some single department should be specially regarded by the candidates. They may also, if they think fit, offer themselves for examination in any of the Classical or Mathematical subjects. Candidates must send their names to one of the tutors fourteen days before the commencement of the examination. The Exhibition is not limited in respect to the age of candidates, and is not vacated by election to Foundation Scholarships.

THERE will be an examination at Queen's College, Cambridge, on Thursday, Oct. 8, 1874, for an Exhibition for proficiency in Natural Science, open to all persons under twenty years of age who shall not have commenced residence in the University. The Exhibition will be of the value of 40*l.* per annum. Candidates will be required to pass an examination in elementary classics and mathematics. No Exhibition will be given unless the examiners report that a candidate merits such a distinction. Each candidate must forward to the President of the College before the day of examination a certificate of birth or baptism, and a certificate of good conduct from a graduate of Cambridge, Oxford, or Dublin. The successful candidates will be required to enter their names on the boards of the College and to commence residence at once. Further particulars will be furnished

by the Rev. Dr. Campion, or the Rev. G. Pirie, Tutors of the College.

THE first number of a new journal, which promises to be an important organ on an important subject, appeared on Saturday last. The *Sanitary Record*, a weekly journal of public health, proposes for its object, to collect and digest information relating to the health of the people, now much scattered, and therefore in a condition much less available for reference and study than it might be. It is also to contain original papers in which sanitary points are discussed in their scientific, social, and legislative aspects; together with reviews of the British and foreign literature of the subject. The staff of contributors includes names of many who hold the highest scientific position, and who are well known as authorities on hygienic matters. Miss Octavia Hill and several other ladies are also included; a paper by Miss Beale, Principal of the Cheltenham College for Ladies, appearing in the first number, while others are promised shortly by Miss Stanley, Miss Hill, and Mrs. E. Maurice. We are convinced that this new journal will fill a gap which has existed for some time; and, from the introductory number before us, we think that no one will have reason to complain of the manner in which it has been organised and started.

PROF. O. C. MARSH, of Yale College, has directed attention, at a recent meeting of the Connecticut Academy of Arts and Sciences, to the peculiarly diminished capacity of the brain-case in some of the Tertiary mammalia of North America. This is most marked in the Eocene genus Dinoceras, an animal which must have been nearly as bulky as a full-sized elephant, and yet its brain could not have been more than one-eighth the average bulk of that in the Indian rhinoceros. In the Miocene Brontotherium the brain-case was considerably large proportionately; and in the Pliocene Mastodon bigger still. These facts have an important bearing on the evolution of mammals, and open an interesting field for further investigation.

AN important addition to ornithological literature has just appeared in the form of Mr. Sharpe's "Catalogue of the Birds in the British Museum," of which the first volume, comprising the Accipitres, or Raptorial birds, is before us.

WE believe that at a recent meeting of the Council of the Zoological Society it was determined that a new building, on a large and much improved scale, should be commenced next spring and completed during the summer, to contain the lions, tigers, and other large feline animals.

THE Senate of the University of London, at a meeting on July 1, adopted the following amendment by 17 votes to 10 on a proposal to obtain a new charter enabling the University to confer degrees on women:—"That the Senate is desirous to extend the scope of the educational advantages now offered to women, but it is not prepared to apply for a new charter to admit women to its degrees."

THE well-known German ethnologist, Dr. A. Bastian, is about to publish a work with maps and illustrations, giving the results of the German expedition to the coast of Loango.

M. LEVERRIER has asked for an authorisation to attend or to send a representative to the Maritime Congress, the programme of which we gave in a recent number.

THE comet is beginning to attract the notice of the general public. Telescopes are let on hire in several parts of Paris to get a view of it.

THE balloon of the Observatory of Paris is undergoing repairs under the superintendence of M. W. de Fonvielle. It will be used by him in making ascents in order to verify the law of barometric pressure calculated by Laplace. Trigonometrical measures will be taken of the balloon by the astronomer of the Paris Observatory. The balloon is a silk one worth 1,600*l*., which was built during the war and was used for making captive ascents by the *armée de la Loire*. It is to be called the *Neptune*.

SCIENTIFIC ascents are becoming numerous in Paris. Last Friday a balloon was sent up from La Villette gasworks to try an apparatus invented by M. Jules Godard to ascertain whether the balloon is descending or ascending. The motor of the apparatus is a large horizontal disc, which is pushed by air pressure and puts in motion an electrical signal. The contrivance is rather heavy and bulky, and the rate of motion gives no idea of the numerical value of the movement.

WE take the following from the *Academy*:—"Some of the American papers state that Prof. Huxley is likely to be the successor of Prof. Agassiz, at Harvard. We hope there is no truth in this. Are the English Universities so rich in really eminent professors, and so poor in money, that they can or must allow Prof. Huxley to go to America in order to find leisure for work? It would require nothing but the will for either Oxford or Cambridge to offer Huxley two or three thousand a year, without anybody suffering for it. There are hundreds of non-resident Fellows, doing no good to the University, doing harm to themselves in resting on their oars, when they ought to be pulling with all their might. Why not give five or ten such Fellowships to men like Huxley, and make the Universities again what they were in the middle ages, the very centres of intellectual force and light in the country? The Universities are so rich that they could beggar the whole world. Will they allow themselves to be beggared by Harvard?"

THE first number of the *Linguist and Educational Review*, a monthly journal devoted to language, antiquities, science, and education, has appeared; its object is the popular treatment of the various branches of ethnology, folk-lore, and kindred subjects. This first number contains an interesting article on practical education, in which the wider use of the natural sciences in schools is advocated and the disproportionate amount of time spent on the study of the classics deprecated. It also contains several other interesting articles in ethnology, &c. We gladly note that the editor intends to give a portion of space monthly to the proceedings and papers of local scientific societies.

AT the General Monthly Meeting of the Royal Institution, on Monday, the Secretary reported that Lady Fellows, the widow of Sir Charles Fellows, who was long a member and frequently a manager of the Royal Institution, had bequeathed to the Institution her drawings of Sir Charles's celebrated collection of watches, bequeathed to the British Museum.

ARRANGEMENTS have been concluded between the proprietors of the *Daily Telegraph* and Mr. Bennett, proprietor of the *New York Herald*, under which an expedition will at once be despatched to Africa, with the objects of investigating and reporting upon the haunts of the slave-traders, of pursuing the discoveries of Dr. Livingstone, and of completing if possible the remaining problems of Central African geography. This expedition has been undertaken by and will be under the sole command of Mr. Henry M. Stanley.

AT the fortieth Annual Meeting of the Statistical Society, held on June 30, the report showed an increase of seventy-six Fellows in the year ending December 31, 1873. By consequence, the financial state of the Society is satisfactory, the surplus of assets over liabilities being 2,508*l*. Dr. Guy was re-elected president.

IT was reported last week that the cable steamer *Faraday* (see NATURE, vol. x. p. 64) had struck on an iceberg off Halifax and became a total wreck. Happily this rumour has been proved to be without foundation.

ON Saturday last, July 4, a meeting of the Council of the Royal School of Mines was held at the Jermyn Street Museum, at which the reports of the examinations of the students connected with that institution were received and considered, and the prizes awarded. The following gentlemen received the diploma of Associate of the Royal School of Mines:—Mining, Metallurgical, and Geological Divisions, S. A. Hill and W. Saise; Mining and Metallurgical Divisions, R. Cowper, A. R. Guerard, C. Lloyd Morgan; Metallurgical Division, W. Pearce; Geological Division, A. R. Willis and W. Frecheville. The two Royal Scholarships of 15*l.* each for first year's students were awarded to Henry Louis and E. Fisher Pittman; H.R.H. the Duke of Cornwall's Scholarship was awarded to A. R. Willis, and the Royal Scholarship of 25*l.* to W. S. Lowe; the Edward Forbes Medal and prize of books were awarded to A. R. Willis; the De la Beche medal and prize of books to C. Lloyd Morgan; the Murchison Medal and prize of books to A. R. Willis.

THE Quarterly Weather Report of the Meteorological Office has been issued, containing the observations of the seven observatories from April to June 1873.

THE additions to the Zoological Society's Gardens during the last week include a Himalayan Bear (*Ursus tibetanus*), presented by Mr. George Lockie; two Red Kangaroos (*Macropus robustus*) from Australia, presented by the Acclimatisation Society of Melbourne; two Audouin's Gulls (*Larus audouini*) from Sardinia, presented by Lord Lilford; a Kappler's Armadillo (*Tatusia kappleri*) from Surinam, deposited; two Musquashes (*Fiber zibeticus*) from North America, received in exchange; a Harpy Eagle (*Thrasaëtus harpyia*) from Paraguay; seven Ariel Toucans (*Ramphastos ariel*) from Brazil, purchased; a Collared Fruit Bat (*Cynonycteris collaris*), born in the Gardens.

SCIENTIFIC SERIALS

THE current number of the *Journal of Anatomy and Physiology* contains several papers of interest. Dr. Binz commence with an article On some effects of alcohol on warm-blooded animals, in which he supports the non-heating action of alcohol, considering the subjective impression as partly the consequence of the irritation of the nerves of the stomach, and of the enlargement of the cutaneous vessels. The cooling effect of alcohol on febrile conditions is demonstrated and shown to depend on its direct diminution of the activity of the cellular elements of the body, on the increase of the cutaneous circulation which arises frem strengthening of the heart's action, and in the diminution of muscular activity which follows its exhibition. —Dr. J. Blake continues his observations On the action of inorganic substances when introduced directly into the blood, endeavouring to show that in the same isomorphous group of elements, the intensity of physiological action increases as the atomic weight of the elements, but the relative atomicity of groups which are not closely related shows no corresponding gradation. The salts described on the present occasion are those of the alkaline earths.—Prof. Cleland discusses double-bodied monsters (kittens), and the development of the tongue in them, that organ being frequently found situated in the nasal passages, the palate at the same time being cleft.—Dr. C. Reyher described points connected with the cartilages and synovial membranes of joints, showing that the "synovial process," or portion of the synovial membrane which lies over the borders of the cartilages, is not to be looked upon as an ingrowth of the synovial membrane but as being formed *in situ* as the development of the joint proceeds.—Mr. Reoch endeavours to account for the presence of free hydrochloric acid in the gastric juice, the constant presence of which he gives experiments in proof of, on the far-fetched assumption that the oxidation of the sulphur which is contained in albumen takes place in the walls of the stomach; that the sulphuric acid thus formed decomposes the sodium chloride, liberating free hydrochloric acid to form part of the gastric juice. —Prof. Turner having had a second specimen of the Greenland shark (*Laemargus borealis*), is enabled to give an account of parts omitted in the original description, to be found in the same journal of the year previous. He gives a drawing of the animal, which was six feet long. It was male, and the sexual organs are described. The testes possess no vasa-deferentia, their products must therefore be shed into the peritoneal cavity, whence they reach the exterior water through the abdominal pores. The ureters were found to combine before they entered the cloaca by the single duct.—Prof. Savory has a paper On the use of the ligamentum teres of the hip-joint, in which he endeavours to prove the idea, which, as he remarks, had been previously suggested by the late Prof. Partridge and by Prof. Turner, that the body is slung on the two ligaments as a carriage is on C-springs. Prof. Humphry criticises Mr. Savory's results, restating his former remarks that the ligamentum teres is not tense in the erect posture.—Prof. Turner, in description of variations in the arrangement of the nerves of the human body, mentions a branch from the fourth cranial nerve to the orbicularis palpebrarum. In another instance the same nerve sent a branch to the infra-trochlear of the nasal. Peculiarities in the various plexuses are also noted.—A loquacious paper follows by Dr. Radcliffe on the syntheses of motion, vital and physical, in which it is attempted to be shown, that in muscle the state of rest is that of contraction, the state of action relaxation. —Mr. Ogilvie and Mr. Cathcart give the dissection of a malformed lamb.—Prof. Crum-Brown gives an ingenious explanation of the sense of rotation and its connection with the semicircular canals, connecting it with the inertia of their contents affecting the peripheral ends of the auditory nerves.—Dr. Brunton proves the value of external warmth in preventing death from an over-dose of chloral.—Mr. F. Champneys gives a detailed description of the septum of the auricles of the frog and the rabbit.—Mr. J. C. Ewart describes the epithelium in front of the retina and the external surface of the lens.—Dr. J. Ogle describes and figures a man born without legs.—Prof. Turner gives a drawing of the surface of the brain in its relation to the skull, which is followed by part of his paper on the placentation of the sloths, which we have noticed on a former occasion.—Notes on some muscular irregularities, follow, by Prof. Curnow; and the papers of the number end with three short notes by Mr. G. J. M. Smith, Mr. J. A. Russell, and Mr. Bellamy, on the dissection of an excised elbow, on unusually large renal calculus, three inches long, and a fusion of some of the carpal bones, repectively.

Bulletin Mensuel de la Société d'Acclimatation de Paris.—In his anniversary speech, reported in the Bulletin for April, M. Drouyn de Lhuys, the president, gives an interesting account of the victories of acclimatisation in the case of the coffee plant, the product of which, now universally esteemed, would never have been general but for its transplantation from its native home, Abyssinia, into other parts of Africa, into Europe, Asia, America, and those East and West Indian Islands which are now its best producers.—M. H. Bouley follows with an exhaustive paper on the subjection of animals by man to his own purposes. He analyses the various effects of food, of climate, of locality, of selection, and other influences on the natures of animals, and shows how our principal useful animals, such as the horse and the dog, have gradually, by dint of the constant exertion of various powers, been brought to their present state of subjection.—The annual report of the Society gives a retrospective glance at the year's work. Among birds the principal acquisitions have been varieties of pheasants, black swans, and Chilian geese. Among fishes, the telescope fish, the rainbow fish of China, and the *gourami*, are the most remarkable. Among plants, numerous Australian trees, acacias, and others; various kinds of bamboos; the *Eucalyptus*, fairly acclimatised in Algeria; and China grass, which promises to form a useful textile fabric, have been introduced.

Zeitschrift für Ethnologie.—Recent numbers of the *Zeitschrift für Ethnologie* have been continuing and concluding the series of papers in which its readers have been put in possession of a very minute summary of Col. Dalton's official report on the ethnology of Bengal, translated by Herr Oscar Flex, missionary in Ranshi. These valuable reports proclaim the remarkable dissimilarity which prevails in the domestic habits and national customs of tribes presenting strong linguistic and psychical affinity with one another. Thus amongst the Manipuris, who may possibly, however, be of Aryan descent, although they have long been followers of the religion of Brahma, and claimed him for their proto-genitor, the women enjoy perfect freedom, both in regard to their control of the household and their participation in games in which men take part; and although the husband may divorce his wife on good grounds, if he ventures to do so with-

out valid reason the woman may leave him and appropriate to herself all his possessions, with the exception of a cup and his loin-cloth. These people also celebrate feasts at which meat is partaken of, contrary to the proscriptions of their present form of religion. Among the neighbouring Kukis no such practices prevail, the men drinking and smoking apart in their festive gatherings, and celebrating solemn festivals by visiting the graves of their forefathers to consult oracles and seek for omens. In the country of the Kasias, where Lieut. Bedingfield was murdered two years after its annexation to our Indian empire, monoliths and other stone memorials are common, and for the most part present great similarity to the menhirs and cromlechs of Cornwall and Brittany. The Garos, whose country lies west of Kasia and extends in the south and east as far as the Brahmaputra, are but little known beyond their own frontiers, while the mountainous districts of their settlements continue to be almost wholly unexplored. These tribes claim to be a primitive people, while, like the Brits, they pretend to have affinity with the English races.—Dr. J. G. Wetzstein gives an interesting account of the ancient Hebrew threshing board, still in use in Syria, where every village has its communal threshing ground to which the neighbouring landowners—both great proprietors and the small peasants—bring their grain, mostly on camels, to be prepared on these curious tables or boards. Dr. Wetzstein has laid before the Anthropological Society of Berlin a sample of the stones in use for this simple mechanical contrivance, which appears to be almost unchanged in its structure and mode of use from Biblical times to the present day, and may be seen amongst the Berbers, the Cypriots, and in other parts of Asia Minor, besides Syria.

SOCIETIES AND ACADEMIES

London

Royal Society, June 18.—On the Employment of a Planimeter to obtain Mean Values from the traces of continuous Self-recording Meteorological Instruments, by Robert H. Scott, F.R.S.

The usual method of dealing with barograms and thermograms is to measure them at certain intervals by appropriate scales, and to treat the numerical values so obtained by arithmetical processes so as to arrive at mean results.

At the suggestion of Mr. Francis Galton, the Meteorological Committee gave instructions that measurements should be made of the curves by means of Amsler's Planimeter, in order to test the accuracy of unpublished means.

It is perfectly obvious that the measurement of the area of the curve, if it can be executed with sufficient accuracy, must give a far more satisfactory mode of ascertaining the value of the mean ordinate of the curve, than the calculation of the average of any number of measured individual ordinates, while the economy of time insured by the use of the planimeter forms a most important recommendation for its use.

The mode of employing the instrument is as follows:—The entire perimeter of the curve, down to the base line, is measured, and the value noted. Then *using the same base line*, a rectangle of known height, in units of the scale of the curve, is next measured in the same way, and the value noted again.

The ratio of these two values is the mean value of the ordinate of the curve, or the mean pressure or temperature for the interval embraced by the curve.

The table subjoined to the paper shows for a period of eight months the means of temperature for Kew Observatory obtained by the planimeter, as well as those yielded by the old method, both for daily and for five-day means. It will be seen that the difference in 242 determinations of daily means only amounted to 0°·5 on six occasions, and to 0°·6 in one instance, while out of 49 cases of five-day means the greatest difference was only 0°·4, and this was only once attained.

At the end of the table a column headed "Wr. Rep. Plates" gives the values obtained by measurement of the plates published in the "Quarterly Weather Report" for the period embraced by the measurements to which I have just alluded. It will be seen from it that the five-day means so obtained hardly differ from those which are yielded by the direct measurement of the photographic curve by means of the planimeter.

The plates in question are obtained by the use of Mr. Francis Galton's Pantagraph, which transfers the seconds at a reduced time-scale to zinc plates, which plates are subsequently further reduced and transferred to copper by Wagner's Pantagraph, as explained in the report of the Committee for 1870.

Such a test as this affords a satisfactory proof of the accuracy of the reproduction of our automatic records which are executed in the Meteorological Office.

The result of these preliminary experiments is that the planimeter means are practically identical with those obtained by treatment of the values of the hourly ordinates.

On the diuretic action of *Digitalis*, by T. Lauder Brunton, M.D., and Henry Power, M.B.

The object of this communication is to show that the diuretic effects which follow the exhibition of digitalis depend on the reactionary relaxation which follows the spasm of the smaller renal arteries consequent on the influence of the digitalis, instead of on the direct increase in the arterial blood-pressure, the direct effect of the drug.

An account of certain Organisms occurring in the Blood, by W. Osler, M.D.

In many diseased conditions, and sometimes in health, careful investigation of the blood proves that, in addition to the usual elements, there exist pale granular masses, which on closer inspection present a corpuscular appearance, varying in size from a quarter that of a white blood-corpuscle to enormous masses, with an oval or rounded form, sometimes elongate or irregular. The author watches these bodies at a temperature of 37° C. and finds that they undergo remarkable changes. At first uniform and still, Brownian movements soon commence; fine projections from the mass develop; its edges become less dense, more loosely arranged; semi-free minor corpuscles form, which quickly break away, moving independently in the fluid. Other filaments undergo the same change, fresh detachments becoming so numerous as to fill the field of the object glass. Granules present themselves in abundance. The original mass has now become perceptibly smaller and more granular. The variety of the forms increases as the development goes on; and whereas at first spermatozoa-like or spindle-shaped forms were almost exclusively to be seen, more irregular forms appear later, possessing two, three, or more tail-like processes. It is to be noted that in blood without the addition of saline solution or serum, no change takes place in the corpuscles under consideration, even after prolonged warning. It must still be confessed that we know nothing of the origin or destiny of these corpuscles; they evidently cannot arise from the disintegration of white corpuscles, for they form individual elements circulating through the blood.

On Coniferine and its Conversion into the Aromatic Principle of Vanilla, by Ferd. Tiemann and Wilh. Haarmann. Communicated by A. W. Hoffmann, F.R.S.

Given the number of figures (not exceeding 100) in the reciprocal of a prime number, to determine the prime itself, by William Shanks. Communicated by the Rev. G. Salmon, F.R.S.

Description of the living and extinct races of gigantic Land Tortoises. Part I. and II. Introduction, and the Tortoises of the Galapagos Islands, by Albert Günther, F.R.S.

The author having the opportunity of examining remains of tortoises from the Mascarene Islands concludes that the several extinct gigantic species are different from the more recent ones, and that there is the greatest resemblance between the tortoises of the Mascarene and Galapagos Islands. An historical account is given, which shows that the presence of these tortoises at two so distant stations cannot be accounted for by the agency of man, at least not in historic times, and therefore that these animals must be regarded as indigenous. The second part contains a description of the Galapagos tortoises.

Edinburgh.

Scottish Meteorological Society, July 2.—This was the Half-yearly General Meeting of the Society; the Marquis of Tweeddale, president of the Society, in the chair. The report was read by Mr. Milne Home, chairman of the Council, from which it appeared that the Society's stations number at present 104, of which 92 are in Scotland, and that the Society consists of 558 ordinary, 15 corresponding, and 8 honorary members. Observations are made at fourteen stations in Scotland at 12.43 P.M., in connection with the International scheme of Meteorology. The Hon. B. Primrose, secretary of the Fishery Board, who had entered with much zeal into the inquiry into the relations of meteorology to the herring fishery, having intimated that if the Society would furnish the necessary instruments he would endeavour that twenty sets of observa-

tions of sea temperature should be carried on during the fishing season, the Marquis of Tweeddale has liberally provided the instruments required. Dr. Arthur Mitchell stated that the Ozone Committee had resolved publicly to invite investigators to submit to them any scheme which in their opinion would increase our knowledge of ozone, and which they were desirous to prosecute if asserted. It is hoped that some line of inquiry likely to lead to satisfactory results will soon be suggested, and whenever this is done the Committee will be prepared to give assistance out of the fund of 100*l.* placed at their disposal by the munificence of the noble President. Dr. Arthur Mitchell and Mr. Buchan read a paper on the influence of seasons on human mortality, which we hope to give next week. Mr. Ballingall, Islay, exhibited and described a new pressure aneometer, invented by him. The instrument consists of a measured surface, which, exposed to the wind, registers its force by means of an index, acted upon by a wooden plunger in a bath of mercury. Mr. Thomas Stevenson, C.E., described a portable barometer made of malleable iron, which he suggested for portable purposes. The instrument also contained an ingenious arrangement suggested to him by Mr. E. Sang. Iron will also be very suitable for water or oil barometers in which a very large scale is desirable for showing sudden changes in the atmospheric pressure, the accurate observations of which are likely to grow in importance from year to year.

Berlin

German Chemical Society, June 8.—C. Rammelsberg, president, in the chair.—G. Langbein described the manufacture of iodide of potassium from iodide of copper, containing 60—66 per cent. of iodine, which is now largely imported from Peru. It is transformed into HI by treating it with SH_2 and then saturated with carbonate of potassium.—J. Thomsen maintains his view against that expressed by Berthelot, who believes the existence of definite hydrates of acids and alkalis to be proved by the heat of combination.—M. Nencky, by heating acetate of guanidine, has obtained a new monoatomic base, guanamine, of the formula $C_4N_5H_7$.—The same author has obtained a direct combination of oxalate of ethyl with sulpho-urea.—K. Heuman communicates observations on cinnabar. Light transforms it into the black modification, particularly when obtained by precipitation. Metallic copper at 100° separates mercury from it in the metallic state.—C. Liebermann, by treating benzoyl-benzoic acid $C_{14}H_{10}O_3$ with sulphuric acid, has transformed it into anthracen-sulphuric acid.—A. W. Hofmann has investigated residues of the aniline manufactory of M. Weiler in Cologne, consisting of pure phenylene-diamine.—K. Wippermann publishes new investigations on the condensed hydrocyanic acid $C_3N_3H_3$ lately obtained by Langé. It is always formed when hydrocyanic acid is kept with a small quantity of alkali, and then distilled. It is extracted from the residue by ether. Hydrate of baryta transforms it into glycocol. Its formula appears to be $N\equiv C-C(NH_2)H-C\equiv N$, the nitrile of amido-malonic acid.—H. Schiff assigns the formula of a dilaureate of glycerine to the fat of laurel, which has hitherto been considered as a derivative of allylic glycol.—L. Henry proves the formula of lactide to be doubly as large as has been admitted until now = $(C_3H_4O_3)_2$.—The same chemist described derivatives of propargyl C_3H_3 with Br, Br_3 and Br_5, of chloride of allyl with HBrO and of chloral with monochlorhydrin of glycol.—C. Kaiser showed a set of very exact weights cut in rock crystal and obtained from the manufactory of Hermann Stern in Oberstein, near Kreuznach.

Paris

Academy of Sciences, June 29.—M. Bertrand in the chair.—Gen. Morin communicated to the Academy a telegraphic despatch from the Emperor of Brazil, sent from Rio de Janeiro on June 23, and received in Paris on the 24th.—The following communications were read:—On a new property of metallic rhodium, by MM. H. Sainte-Claire Deville and H. Debray. When iridium and rhodium are precipitated from their solutions by formic acid or alcohol, the finely divided metallic powders possess remarkable properties. The rhodium thus obtained decomposes alcohol (in presence of alkali) hydrogen being liberated and an acetate produced. Formic acid is decomposed by the same substance into carbon dioxide and water. Platinum and palladium in the same condition do not attack formic acid, while iridium and ruthenium act like rhodium.—M. A. Ledieu presented the concluding portion of his researches on the theory of the collision of bodies with consideration of atomic vibrations.—On the spectra of vapours at high temperatures, by Mr. J. N. Lockyer. This paper contains the results of experiments already communicated to the Royal Society and published in Nature.—Report on the state of the preparations for the expeditions sent by the Academy to observe the transit of Venus on Dec. 9, by M. Dumas.—Report on the administrative measures to be taken for the preservation of territories threatened by *Phylloxera*, by the Commissioners. It is suggested to the Academy that a special law should be made compelling proprietors to declare the first appearance of the scourge, that experts should then be appointed to examine into the state of the infested vines, and that these should be destroyed when thought necessary by ministerial decision, the proprietor receiving adequate compensation. It is further suggested to destroy the vines surrounding the districts actually invaded, to disinfect the soil by chemical methods, and to burn the cuttings, leaves, and roots of the diseased plants as well as the plants themselves in the same district where the uprooting has taken place, and finally to prohibit with the utmost rigour the exportation from infested territories of anything that might serve as a vehicle for the insect.—M. Heis communicated a letter sent by him to M. Faye concerning the studies recommended to the observers of the forthcoming transit of Venus. The author suggests the observation of meteors and the zodiacal light with respect to colour, intensity, form, &c.; also of the milky way and of polar auroras.—On the temperature of the sun, by M. J. Violle. The author gave a description of the apparatus employed by him in this inquiry. A determination made at Grenoble on June 20 at 3.30 gave the temperature 1,354°, but to get at the true temperature of the sun this number must be corrected for atmospheric absorption and other causes. To eliminate these errors the author has made several ascents of the Alps, but the results are not yet made known.—Some remarks were made on the foregoing paper by M. H. Sainte-Claire Deville, and M. Berthelot communicated a paper *à propos* of these remarks entitled "On high temperatures."—On the application of carbon disulphide mixed with tar and with alkalies for the destruction of *Phylloxera*, by M. C. Monestier.—M. Lecoq de Boisbaudran communicated a note on the use of carbon disulphide for the same purpose.—On a point in the theory of functions, by M. Halphen.—Geometrical integration of the equation $L(xdy - ydx) - Mdy + Ndx = O$, in which L, M, and N designate linear functions of x and y, by M. Fouret.—New method for determining the index of refraction of liquids, by MM. Terguem and Trannin. The authors gave a description of their apparatus and some of the results obtained by it.—On electro-static phenomena in voltaic batteries, by M. A. Angot.—On the evaporation of liquids at temperatures above their boiling points, by M. de Gernez.—On new apparatus called *accelerometers*, for the study of the phenomena of the combustion of gunpowders, by MM. Deprez and H. Sebert.—Note on an intestinal calculus of the sturgeon, by MM. Delachanal and Mermet.—Results of the employment of phenol in burials, by M. Prat.—On the publication of the observations of meteors made by M. Coulvier-Gravier, a letter from M. Schiaparelli.—On the structure of the caudal appendage of certain ascidian larvæ, by M. J. Giard.—On the presence of lead in the brain, by M. Daremberg. This was found after cases of lead-poisoning.—M. Chatin was elected during the meeting to supply the vacancy in the botanical section caused by the death of M. C. Gay.

CONTENTS

THURSDAY, JULY 16, 1874

SCIENCE IN THE SHOWYARD

IT is difficult to over-estimate the benefits which practical agriculture has derived from the great country meetings of our Agricultural Societies. Shifting from year to year to different parts of England these annual exhibitions have brought the general progress of agriculture to bear in a direct manner upon local practice, and made the country farmer acquainted with the improvements that have originated in distant centres of activity; while at the same time the peculiar excellences of the district visited are prominently brought to light, and give their own distinctive character and teaching to the exhibition. The beneficial influence of such Agricultural Shows is much increased when, as in the case of the show now being held at Bedford, they are conducted by a first-class Society. Not only are the exhibitions in this case of greater number, and superior quality, but the character of the judging is superior also, and science is really brought to bear in awarding the prizes in the various classes. To refer to the present show of the Royal Agricultural Society at Bedford, the official lists tell us of the vast number of agricultural implements entered for competition, the class of drills alone including 135 entries. Every one of these implements, before this article is in type, will have been carefully tested by actual work in the field; the quantity of power required to produce a certain amount of work will have been ascertained by a dynamometer contrived expressly for the purpose; the construction of each implement will have been thoroughly criticised; and finally, its merits in each department of its work will have been expressed by an elaborate system of marking. The reports of these trials will in due course appear in the Society's Journal, and the farmer will obtain a valuable mass of information on the subject of implements such as no private individual could have given him. Anyone who desires to see how thoroughly the work of judging is done, and what wonderful skill is now brought to bear on the construction of agricultural machines, should read the two reports on Portable Steam-engines and on Ploughs and Harrows in the last volume of the Royal Agricultural Society's Journal. There can be no question of the immense benefit resulting to practical agriculture from such exhibitions, and from the publication of such reports.

Another chief item in Agricultural Shows, and perhaps the most attractive, is the live stock. The non-agricultural public has seldom any notion of the points aimed at by an intelligent breeder of stock, and those who have never attended one of the country meetings of our great Agricultural Societies may very likely expect to see a mere collection of fat beasts. Our agricultural readers well know that this is far from being the case. Bulk is by no means the object which the breeder has in view; his aim is the production of an animal perfect both in form and quality, and fitted in the highest degree for the various purposes which it is intended to serve. The same principle is also steadily kept in view by the judges, who are instructed by the Society to form their decisions entirely on the animal's character for breeding purposes, and not on its present fitness for the butcher. We need hardly say that our Agricultural Shows have had a large share in that wonderful improvement of our various breeds of stock which has taken place to such a marked extent in recent years.

The subject of the varieties and breeds of cattle is full of interest; indeed we hardly know a more instructive field for the naturalist's study than that presented by the showyards of our Agricultural Societies. Here he will meet with abundant and striking instances of what may be effected by artificial selection persistently carried on with a definite purpose in view; and here also he will meet with equal evidence of the great influence of climate and other ill-understood conditions, which put a limit to the possible work of the breeder, and confine certain varieties to certain districts. That so small a country as Britain should have so many distinct breeds of sheep and cattle localised in different parts of the island is certainly remarkable, and the subject becomes more interesting when we find that in many cases these local breeds cannot be maintained true to their character if transported to other parts of the island. Thus we have in Lincolnshire a breed of sheep remarkable for their long glossy wool. Many attempts have been made to establish flocks of these sheep in other parts of England, but as far as we are aware the peculiar gloss of the wool has always disappeared after a few years.

The effect of external conditions on the character of an animal becomes still more apparent if, after making acquaintance with British sheep and cattle, the naturalist crosses the sea and pays a visit to a continental agricultural show. The British farmer who visited the Vienna Exhibition last year must have stared with wonder at the collection of animals there displayed. He would probably regard with contempt the long-legged, woolly pig, with large and powerful snout, quite unlike the inhabitants of his own styes; but when he learnt that the Transylvanian pig spends its life in the forest, and in winter time has to grub for its food through a foot or more of snow, the British visitor would begin to perceive that the animal is really far better fitted for such a life than his own favourite "Berkshire;" and he would be prepared to hear that English pigs in such districts have proved a failure. Equally remarkable to an Englishman would appear the curious Merino sheep, bred entirely with a view to wool, but worthless considered as mutton, and the fine Hungarian draught oxen, admirably fitted for hard work and hard living, but which no amount of cake would turn into beef at two years old. These would be striking examples of the effect of artificial selection and natural conditions in producing different kinds of excellence from those aimed at in our own country.

In our autumnal shows the naturalist's attention might be directed with equal advantage to the influence of cultivation on the characters of the various seeds and roots exhibited. It is not so very long ago that the first Swede and the first mangold were introduced into this country; the varieties are now endless, and there is probably now quite as much difference between the roots originally imported and their modern representatives as between the greyhound-like swine one sees in old engravings and the present English examples of the race. Artificial selection has, in the case of roots and seeds, taken a wide scope, endeavouring to supply the very various wants of

the farmer. Varieties suitable for early and late growth, and for various descriptions of soil and climate, are aimed at, and in many instances produced. The advantage of having a continual supply of *new* varieties appears in some cases to be considerable; thus in the case of the potato disease it seems generally acknowledged that a recently introduced kind resists disease far better than an old sort. Varieties cannot, however, as is well known, be trusted to maintain their character; fresh seed must constantly be employed, and the process of selection must continually be maintained. The trade of the seedsman is thus one of never-ending use and importance. Perhaps one of the most striking recent instances of what may be effected by cultivation with a definite object is afforded by the case of sugar-beet. Beetroot contains somewhere about 8 per cent. of sugar; cultivation, however, and suitable manuring have so increased this percentage that sugar-beet now yields 12-14 per cent. of sugar in the average of seasons, and in favourable seasons 17 per cent. is sometimes reached. We need hardly point out that the practical influence of Agricultural Shows is again most useful in bringing under the farmer's notice both the new varieties raised in this country and the new species introduced from time to time abroad.

The Royal Agricultural Society has lately gone a step beyond the usual limits of the showyard, and has taken advantage of its country meetings to offer prizes for the best-managed farm in the surrounding district. This is undoubtedly a step in the right direction. Hitherto the teaching of the Agricultural Show has been pretty much confined to the subjects of live stock and implements. Certain portions of the farmer's work have been exhaustively illustrated; but farming as a whole has scarcely been dealt with. Might we suggest that the Royal Agricultural Society should go still further in carrying out its admirable motto, "Practice with Science," and endeavour to make its country meetings yet more effective in diffusing true knowledge. Why should not the Society arrange for two or three public lectures in the show-week, to be given by persons eminent in science or in practical agriculture? How much valuable teaching might thus be imparted. The Royal Agricultural Society has already exerted itself in the cause of scientific education for the sons of farmers, and has continued this work in the face of considerable opposition; let it enlarge its good work still further, and aim at teaching the farmers who are annually gathered at its Agricultural Shows.

COLONIAL GEOLOGICAL SURVEYS

II.—Victoria

Geological Survey of Victoria—Report of Progress. By R. Brough Smyth. (Melbourne, 1874.)

MR. SMYTH must be a shrewd and clever person. He has one of the most difficult tasks to perform—to persuade or cajole a Colonial Government or Assembly which knows nothing and cares still less about anything scientific, to vote money for a scientific object and to take some interest in having that object carried out. Not many years ago Victoria had a regular Geological Survey, equipped at the colony's expense and directed by Mr. Selwyn, who now so ably conducts the great Survey of Canada. For some reason which we have heard variously described, but which seems to have lain to some extent at least in official jealousies and in differences of opinion as to the degree in which geological research as opposed to mere mineral prospecting should guide the progress of work, the Victorian Survey came to an end and its officers were left to seek employment elsewhere. At the same time the Department of Mines in the colony showed great activity in collecting mining and geological information, the prime mover in this being the secretary, Mr. Brough Smyth. When the Geological Survey ceased to exist he seems to have thrown himself more into a geological line. With no little sagacity and tact he gradually organised a less ambitious scheme for having the country geologically surveyed. He obtained the services of one or two members of the previous Geological Survey, and, with a small grant from the legislature, began to make a geological examination of some of the mining districts, and to prepare maps and sections to show their structure. Under the wing of the Mining Department he evidently could do a good deal without placing a formal vote for a Geological Survey service on the colonial estimates.

How much soever a man may have science at heart, in such a population as that of Victoria he can hardly hope to find much encouragement for science pure and simple. It is needful for him to show some practical utility in his work before he can expect to receive aid, especially of a pecuniary kind. Fortunately in Victoria one great element in the national wealth lies in mining. Anything therefore which tends to increase the value of mines, or to lead to the discovery of fresh mineral fields, appeals at once to the feelings of the colonial legislators.

Mr. Smyth indeed in the present Report grows very bold, going even so far as to assert that the main object of the survey should be scientific discovery, any practical benefit arising from the work being a sort of secondary and accidental circumstance. He takes good care, however, to bring the practical benefits well into the foreground, so that we imagine his superiors are not likely to quarrel with his theory so long as he adheres to his present practice. It would, indeed, be very short-sighted policy to interfere with him. He is unquestionably right in endeavouring to place the knowledge of the mineral structure of the colony on a sound basis of scientific exploration. There may perhaps be no apparent pecuniary return for the outlay at first, but the money expended as he is expending it will assuredly in the end be repaid tenfold. It will save a vast amount of expense in enabling colonists to decide where to begin their mineral ventures and in pointing out where no possible outlay could be profitable. It will stimulate the development of the mineral wealth of the country, and thus add directly and largely to the national prosperity.

We do not notice much of geological novelty in this Report of Progress, though some of the details are interesting, particularly in regard to fresh illustrations of the wonderful volcanic history of some of the goldfields, and to certain of the fossils which have been obtained in recent explorations. A list of all the fossil species hitherto obtained in the colony is inserted in the Report, and forms, so far as we know, the first list of the kind which Victoria has furnished. A considerable proportion of the species is from Upper or Lower Silurian rocks. A few are Devonian and Upper Palæozoic. With regard to Secondary and Tertiary rocks, Mr. Smyth very properly

avoids identifying his formations with those of Europe, and contents himself with indicating such indefinite horizons as Lower and Upper Mesozoic. The list of publications on the mines and geological structure of Victoria is already a tolerably long one, and indicates no small amount of activity. It includes Mr. Smyth's work on the "Goldfields of Victoria," which we favourably noticed at the time of its appearance.

Easy-going geologists in this country, who spend their winters comfortably in town, and can at any moment transport themselves by train or steamer to even the farthest parts of the kingdom, have little notion what geologising is in an unexplored region like that of so vast a portion of Australia. Mr. Smyth, for instance, in the most matter-of-fact way refers to one part of geological work in Victoria as "cutting tracks," that is, levelling the trees and scrub in a densely-timbered region so as to make a roadway into the wilds. He truly adds that every mile of such road-cutting is a gain of so much territory to the colony. We find that during three months of last year the survey spent 172*l.* 16*s.* 6*d.* in cutting tracks, each of which was of course a geological section.

But while all this work is going on in his own colony, Mr. Smyth's energies extend over the whole of his continent. At his suggestion, representations have been made to the authorities of the other Australian colonies, to aid in the preparation of a general geological map embracing the whole of Australia and Tasmania. This proposal having been favourably received, considerable progress has been made in the preparation of the map. Mr. Smyth remarks however, that no response has been received from New South Wales, which still remains a blank on his map. No explanation is given of this not very intelligible statement. Certainly there is abundance of information to be had regarding the geological structure of that colony, where, among others, the veteran W. B. Clarke has laboured so long and so well.

As an illustration of the thoroughness with which the Department of Mines endeavours to do its work, it may be mentioned that specimens of rocks or minerals which may be sent up from any part of the country are examined, and if need be analysed, a boon which appears to be taken advantage of to a considerable extent. Appended to Mr. Smyth's Report of Progress is an excellent Report on the Mineral Resources of Ballarat, by R. A. F. Murray, who we believe was one of Mr. Selwyn's staff. The appendix contains also reports on some of the colonial coalfields. In conclusion, it should be added, that this Report is admirably, indeed almost luxuriously, printed and illustrated, presenting a very striking contrast to the blue-books we are accustomed to at home. Mr. Smyth deserves great credit for the way in which he has organised his work, and we trust that a long series of excellent reports may be obtained from him. ARCH. GEIKIE

THE FISHERIES OF NEW ENGLAND

Report on the Condition of the Sea Fisheries of the South Coast of New England in 1871 *and* 1872. By Spencer F. Baird, Commissioner. (Washington: Government Printing Office, 1873.)

WHILE the question of the supply of fish to the English markets is being year by year more anxiously discussed, and measures taken for the restoration of those fisheries which have been decimated, and for the protection of those whose productiveness is threatened by overfishing, our Transatlantic brethren are engaged in the investigation of a similar question in connection with the produce of their own waters. The wonderful fertility of fish, and the apparently inexhaustible supplies to be found in the waters of all parts of the world, have given rise to the idea that there is no limit to their abundance, and that no appreciable diminution in their numbers can be effected by the most unrestricted fishing. The experience afforded by the example of the salmon fisheries of this country has shown the fallacy of this idea. The most productive rivers have been reduced to absolute unproductiveness, and the most stringent measures have been adopted for encouraging the growth and restricting the destruction of fish. Overfishing, it is found, is not only possible, but has a very speedy effect on the natural supplies; and already the people on the other side of the Atlantic are experiencing the truth of this fact. Notwithstanding the enormous seaboard possessed by the United States, it is found that the supplies of fish are no longer equal to the demand, and the most important fish-producing States have consequently instituted inquiries with the view of adopting remedial measures. Opinions on no subject are more varied and contradictory than on the question of fish supplies. This is inevitable, as comparatively little is known of the habits of fish, and persons are too apt to generalise upon the result of their own limited experience. Finding the testimony of various authorities too conflicting to be of any use, the State of New England appointed Prof. Baird, of the Smithsonian Institution, to make a detailed inquiry into the condition of the fisheries on the coast and lakes of the country generally. The present report is the result of his first year's operations.

Anyone conversant with the fisheries of this country cannot fail to be struck with the similarity that exists between their condition and that of the American fisheries. The river fisheries of England had long been falling into decay, and were almost annihilated, when measures were adopted for their restoration. The river fisheries of America have also fallen off in productiveness, the only astonishing feature being the suddenness of this decay. There are many causes, such as the existence of pollutions, of obstructions, and of navigation, that have militated against the fisheries of this country which have not had equal force in America; but the principal cause of decay has acted more speedily there, and it is apparent that overfishing, and the destruction of spawning fish, have been on both sides of the Atlantic the chief enemy to the continued prosperity of river fisheries. Here salmon, there bass, have been trapped both in their upward and downward progress in the rivers, and no "close season" has been allowed in which they might, unmolested, perform their natural functions of reproduction. In England "fixed engines," *i.e.* devices fixed in the run of the fish, and intercepting almost every individual that would attempt to pass them, have been abolished. In America these instruments are more largely used than ever they were here; and a glance at the diagrams presented by Mr. Baird shows their terribly destructive nature. In some rivers, and on some parts of the coast, they are placed so thickly that no fish can pass

them; and, as they are *in situ* all the year round without intermission, it is no wonder that the fisheries are decreasing in value. The total abolition of these engines is suggested as the only real remedy. But the Commissioner is afraid that such a regulation would entail great loss on the owners of such instruments, and would also suddenly interfere with the supply of fish to the public. These traps can fish without human help, while the more legitimate fishermen's nets and gear can only be employed in suitable weather. He recommends that an interval of sixty hours every week should be enforced, during which the use of traps and pounds should be absolutely interdicted; that an annual close time of fifty-six days, viz. from April 20 to June 15, should be established, during which the use of such engines should be prohibited; and that the licensing system adopted in England should be introduced.

This is certainly a step in the right direction, but we venture to think that a diminution in the number of fixed engines would be advisable, and that such diminution should be partially enforced at once, and be gradually continued till the whole of these instruments are abolished. This need entail very little hardship on individuals, and would certainly not interfere with the regular supply of fish to the markets, while the eventual increase would more than justify the enactment.

In regard to the more purely sea fisheries, the similarity between the British and American fisheries is equally striking, while at the same time the rapidity with which the produce of American waters has fallen off is still more marked. On the English coasts the fisheries are continually fluctuating, but in no part does the diminution in the capture appear to have been so great and so permanent as it is recorded to be in America. The curious extracts from works of two hundred years ago testify to the great natural abundance of fish in the seas adjoining to the American shores; and, to come to more recent years, the printed evidence of living fishermen clearly shows that, for some reason or another, the sea fisheries, like the river fisheries, are much less valuable than they were thirty years ago.

The principal fishes of the coast to which the volume more particularly refers are the "blue fish" (*Pomatomus saltatrix*), also called "horse-mackerel;" the "scup" (*Pagrus* or *Stenotomus argyrops*), "squeteague" (*Cynoscion regalis*), a species of bream; "menhaden" (*Brevoortia menhaden*), a species of herring; sea bass and striped bass (*Roccus* or *Labrax lineatus*); mackerel (*Scomber scombrus*), similar to the common European mackerel; "tautog" or black fish (*Tautoga americana*), of the *Labridæ*, or wrasse family; herring (*Clupea harengus*), and cod, both of the well-known species. Of these, the principal diminution has been found to have occurred among the blue fish, the bass, the scup, and the tautog. The former of these is a very voracious fish, rivalling the shark in its powers of destruction, so much so that to its agency has been ascribed the diminution of other kinds of fish in localities where it is generally caught. But since it has itself greatly diminished, it is hardly possible that the decrease of other fish is attributable in any degree to the depredations of one predaceous kind.

Besides the above there are many other kinds of fish, more or less valuable as food, and sought after also on account of the oil they yield, and for the purposes of utilising them as manure, a complete list of which is given by Prof. Baird. This list is most valuable as condensing and correcting the various imperfect catalogues that have from time to time been made, and as exemplifying the natural richness and fertility of the seas on the seaboard of the Eastern States. As an instance of the extreme difficulty of accounting accurately for the increase and diminution in the capture of fish, we may quote the unexpected appearance of a species of Tunny, a kind of small horse-mackerel (*Orcynus thunnina*), which, though never previously recorded as having been caught on the American coast, was found in great abundance in Menemsha Bight by the Commissioner. The movements of fish are far more difficult to watch and to account for than those of land-animals, and great difficulty is experienced in following them. On some occasions a certain kind of fish has been very abundant in one locality, while a short distance away it has been very scarce; and one fishing-ground has been deserted one year, to be visited by large numbers the next year. One fallacy concerning the movements of the American migratory fish seems quite exploded. To quote Prof. Baird:—

"It was formerly supposed that certain fish, as the herring, the shad, and the alewives, with others of like habits, prosecuted an extensive migration along the shores of the ocean, covering, sometimes, thousands of miles in the sweep of their travels; and much eloquent writing has been expended by such authors as Pennant and others in defining the starting-point and terminus, as well as the intermediate stages of the voyage. The shad, too, which, as is well known, occupies all the rivers of the Atlantic coast from Florida to the Gulf of St. Lawrence, was thought to begin its course in the West Indies, and in an immense body, which, going northward, sent a detachment to occupy each fresh-water stream as it was reached, the last remnant of the band finally passing up the St. Lawrence, and there closing the course. We now, however, have much reason to think that in the case of the herring, the shad, the alewife, and the salmon, the journey is simply from the mouths of the rivers by the nearest deep gully or trough to the outer sea, and that the appearance of the fish in the mouths of the rivers along the coast at successive intervals, from early spring in the south to near midsummer in the north, is simply due to their taking up their line of march, at successive epochs, from the open sea to the river they had left during a previous season, induced by the stimulus of a definite temperature, which, of course, would be successively attained at later and later dates as the distance northward increased."

It seems pretty well established that, with the American migratory fish, which enter fresh water to spawn, as with the English salmon, the same individuals pass as nearly as possible to the same river, or at least to the same locality, and the same rule applies to their progeny—the young fry appearing to return to the river in which they were hatched.

Of these migratory fish the salmon has been well nigh exterminated, and the shad alone appears to keep up its numbers. Whether or not this is altogether owing to the exertions of the fish culturists, who have hatched artificially many millions of these fish and turned them into the various rivers, it would be rash to say positively; but no doubt this means, and the erection of suitable fish-passes to enable the fish to surmount the weirs, have had a large part in effecting this result.

As regards the practical protection of fisheries, whether in sea or river, the case of the Americans is almost identical with our own ; and the remedies to be adopted must be the same in both countries. As regards the scientific side of the question, relative to the habits and distribution of fish, there is much that is new and valuable in the Commissioner's report. Indeed, the greater share of the volume is devoted to such questions, and to the scientific classification, not only of fish proper, but of the various other forms of life found in the waters, and important as either providing food for the useful fishes or as preying upon them.

The various invertebrate animals which form the principal diet of fishes appear to exist in profusion, so that the scarcity of food-fishes cannot be attributed to the want of natural sustenance. Some of these animals which serve as a prey to fish when young, in their turn become aggressors when full grown. An interesting account is given of the destruction caused by various kinds of *Cephalopoda*, which commit great havoc amongst the schools of mackerel and herring. In attacking the mackerel "they would suddenly dart backward among the fish with the velocity of an arrow, and as suddenly turn obliquely to the right or left and seize a fish, which was almost instantly killed by a bite in the back of the neck with the sharp beaks;" and yet these same "squids," when young, themselves afford abundant and favourite food to fish.

The subject of sea-bottom is nowhere of such importance as where oysters exist, and Prof. Baird's researches on this point are most valuable. His remarks, which we have not space to quote in full, might be studied with advantage by those who are interested in oyster culture in England and in France.

Nearly 300 carefully executed engravings of the rare and more valuable forms of invertebrata conclude a volume of which but a faint outline has been given.

BALDWIN'S "IRISH FARMING"

Introduction to Irish Farming. By Thomas Baldwin, M.R.I.A., Superintendent of the Agricultural Department of National Education in Ireland, &c. (London : Macmillan & Co., 1874.)

IT is only by the spread of thorough technical education among our farmers that the most will ever be made of the comparatively small area which in these islands can be devoted to agricultural purposes ; only by a scientific knowledge of the material with which he deals will the farmer be enabled to improve to the utmost the quantity and quality both of his crops and live stock. By careful selection and suitable feeding vast improvements have within recent years been made in the quality of the latter commodity, and by a scientific study of the various kinds of crops, of soils, and of manures, natural and artificial, rapid progress is being made in forcing "the earth to yield her increase" in greater and greater quantity and of richer and richer quality. No doubt as the reign of science becomes more and more universal, farming, like all other human pursuits, will be followed with more and more of skill founded on accurate scientific knowledge; and will become gradually less a matter of blind rule-of-thumb. In many instances this is the case in Great Britain and in Ireland even now, many of our farmers bringing to bear upon their pursuit a knowledge of the results of the most extensive and exact scientific investigation. It will be long before such an intelligent knowledge becomes universal, we fear; and meantime such manuals as Mr. Baldwin's are of use in spreading among farmers, large and small, who have had no technical training in their occupation, a knowledge, conveyed in popular language, of what can be attained by scientific or skilled farming.

The work comprehends much in comparatively small compass. It treats first of manures, and the necessity of their application to supply the waste in the land caused by cropping. Without going deeply into the chemical properties of soils and manures, it affords plain directions which the unscientific man can clearly understand and appreciate ; and considering the general character of the large class which the author essays to enlighten, he has taken the most efficient method for attaining his purpose. His remarks on farmyard manure are just, but he might have expressed his preference for covered yards more strongly, as, besides other advantages, these preserve the manure from rain-water ; and, where fodder is in plenty, the liquid is absorbed and utilised in a way which it cannot be to equal advantage when applied by itself. It is well ascertained that dung made in such yards is much richer than in ordinary yards, as from being gradually compressed by the treading of the cattle the ammonia cannot escape, nor any appreciable waste occur. The author's estimate of the quantity of the manure made from one cow in the year at twelve tons is certainly too great if quality as well as quantity is desired.

The second chapter is devoted to the culture and management of green crops and cereals, including potatoes, carrots, turnips, mangold, &c., and the ordinary corn crops. Specific directions are given as to what kinds to sow on particular soils, and how to manage them in the fields and in storing them, each variety being specially referred to in its comparative productiveness and utility. The author's remarks on hay-making are well worthy of perusal. There is no crop so mismanaged as this, especially in Scotland, and considering its extent and value, no censure can be too strong on the negligence and want of skill so generally manifested in securing it.

The third chapter is devoted to live stock, and here the author seems to have studied the various phases of breeding and fattening with a practical eye. Ireland is peculiarly well fitted for rearing stock, and the yearly supply it affords to Great Britain is marvellous. With a moist climate and an alluvial soil, the Irish farmers possess facilities in their fresh swards and luxuriant green crops which we do not possess on this side of the Channel ; until at all events we go across the Tweed, and not even there in sufficient breadth and measure, for permanent grass meadows are seldom to be seen. The quality of the various breeds of cattle and sheep is discussed ; but it must be remarked that a great complaint on this side of the Channel is made as to the want of quality and growth in much of the supply afforded us ; this is no doubt owing principally to the careless selection of breeders, and to too much indiscriminate crossing. The author's remarks on poultry deserve special attention, not

that he says anything peculiarly novel, but he treats the subject so plainly and in so much detail, that practical use can be made of his directions on a hitherto too much neglected point in rural economy.

In Chap. IV. examples are given of successful farming, both in large and small holdings, which all interested would do well to peruse. With industry and skill based on scientific knowledge, the productive power of the soil is astonishing. We see this more especially in the arid and sandy ground in Belgium, where two or three acres, produce is sufficient for the support of a family. Steam ploughing, no doubt, is an equivalent for spade husbandry in stirring and pulverising the soil, but the personal exertions and superintendence of the cottager in thorough tilling, in careful seeding, successive cropping, manuring, weeding, and harvesting. cannot be excelled or equalled in substantial production. There is, moreover, in Scotland at all events, a degree of comfort and healthy sturdy appearance among that class, now perhaps too limited in number, which bears a striking contrast to the beer-drinking artisan and his wan shrivelled children in towns.

The author concludes with a chapter on cottage-gardening, which may be profitably studied by those of more pretension than the mere cottager. In England the taste for decoration and utility in small gardening is much more manifest than in Scotland, where little else than Scotch kail and weeds are, as a rule, to be seen. Mr. Baldwin has, on the whole, done ample justice to the various subjects he has treated, while the scope of his work is sufficiently comprehensive for the guidance of those who need instruction; and most farmers do, be their rural occupation of small or large compass.

We hope that the spread of works of this class will pave the way for the general circulation among farmers of works of a much more technical and scientific kind, and that ere very long, through the exertions of the Agricultural Societies, both of England and Scotland, Agricultural Schools will be established in convenient centres both in England, Scotland, and Ireland, by means of which the British farmer will be at least on as good a footing as the farmer on the Continent of Europe and in America.

OUR BOOK SHELF

Elementary Dynamics, with numerous Examples. By W. G. Willson, M.A. (Calcutta: Thacker, Spink, and Co.)

Principles of Mechanics. By T. M. Goodeve, M.A. (Longmans' Text-books of Science.)

THE first work on our list does not aim at a novel exposition of principles, though it differs from the ordinary text-books in use amongst junior students. Notes originally put together by the author for the use of pass students of the Calcutta University have, after some considerable trial of their merits, been put together in the present form so as to embrace all the parts of the subjects which are generally treated of in text-books.

Mr. Willson is an ardent admirer of the works by Professors Thomson and Tait ("the magnificent treatise on Natural Philosophy," "the reader who wishes for further information on this subject (and on all such subjects) is recommended to consult," &c.), and his principal aim has been, we expect, to render the views of these distinguished writers more accessible to junior students. Knowing how liable authors are to go to pieces on the kinematic rocks, we have gone as carefully as we could through the text, and it appears to us that the author not only understands his subject, but has manifested ability in presenting his material in a clear form to his readers. Dynamics he subdivides into statics and kinetics. In both these branches he adopts for unit of force the kinetic unit for which the pound avordupois is the unit of mass. We may remark in passing, that this is the only elementary book we know which goes fully and carefully into the subjects of the several units. Under the head of statics, the writer treats of force at a point, of parallel forces, of moments, of centre of gravity, resisting forces, machines, and of work and energy; under the head of kinematics, we have velocity, accelerated velocity, and kinematical principles and methods; under kinetics, we have dynamical laws and principles, the force of gravity (falling bodies, motion on an inclined plane, Attwood's machine, &c.), collision of bodies, and energy. On p. 130, the term *Roman* steelyard is derived from Rumán, an Arabic word for a pomegranate, "and the shape of the counterpoise seems to have given rise to the name." There are a great many examples, many very familiar to us, given at the end of the various chapters. The author apologises for imperfections in type and diagrams, but he need hardly have done so; we have seen worse diagrams in text-books got out nearer home. Some typographical blunders we have detected, but the context will enable a reader to correct them. The work has no index, is of a handy size, and gives one a favourable impression of the sort of training provided for the Calcutta students.

Mr. Goodeve's name is sufficient warrant for the accuracy and thoroughness of any work on mechanics that bears it on its title-page. His style is very lucid, and the accuracy and fulness of his knowledge of his subject enable him to give just sufficient explanation and yet not be too concise. He aims at a different class of students than that we have had to consider in the former part of our notice. These Text-books are designed for the "self-instruction of working men," and the two works by our present author in this series seem to us just fitted for them. In the work before us we are taken over a wide field. In an Introduction of sixty pages we have a miniature treatise, the representation of force, the gravitation measure of force, the laws of motion, and the meaning of the term energy, *inter alia*, are discussed. In the remaining twelve chapters most of the ground gone over in the first-noticed work is gone over rapidly here, and copious application of the principles is furnished by the description of a number of machines, the bare enumeration of the names of which would furnish an ordinary "Bookshelf" notice; in addition we have an account of the equilibrium and pressure of fluids and of gases, of the hydraulic press and hydraulic cranes, a chapter on girder beams and bridges, the strength of tubes and the catenary, all treated without reference (except in one or two places) to the calculus. We have much pleasure in commending this recent addition to the series, with its clear type and numerous and excellent diagrams, to all who take an interest in mechanical applications. There are many excellent exercises scattered throughout the work.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

The Degeneracy of Man

IN NATURE, vol. x. p. 147, Mr. Edward B. Tylor writes:—

"It would be well worth while if Dr. Peschel, from personal or published sources available to him, would settle once for all the question whether the great Bavarian ethnologist (Martius) continued through life the degenerationist that we in England suppose him to have been."

Now I can assure Mr. Tylor, from having often conversed with Dr. Martius on Brazilian topics, that his degeneration theory belonged to his earlier life, that afterwards he altered his opinions, and that the passage quoted by Mr. Tylor from Martius contained his latest conviction. Soon after the publication of his Ethnography he died at Munich.

OSCAR PESCHEL

DR. MARTIUS found the rude natives of Brazil treating the hunting-ground of each tribe as common to all the tribesmen, but allowing each family to hold as its own freehold the ground which it had built huts on, or brought under tillage. It is not surprising that this ethnologist, comparing such a rudimentary form of the "village community" with its more artificial arrangements in ancient Europe, should have considered the Brazilian tribes to have arrived at an intermediate stage of the development of land-laws, above that of the lowest savages, and on the way to that of more civilised nations. Mr. Edkins, however, in his letter to NATURE, vol. x. p. 163, thinks that Dr. Martius should not have explained the origin of the Brazilian land-law in this obvious way. The suggestion which he offers in its place is, that inasmuch as the Chinese had in old times a highly artificial system of partitioning their village-lands among the heads of families, some of these Chinese are to be supposed to have emigrated to the Brazilian forests and introduced this system, which in course of ages decayed till nothing was left but the simple rule found by Dr. Martius. But is not the word "far-fetched" applicable to this argument? Sooner than allow the rude people of Brazil to have been human beings capable of adopting the simplest social regulation for their own evident benefit, Mr. Edkins sends half-way round the world for imaginary Chinese emigrants, to introduce, not the savage law itself, but a civilised law which, if broken down to its last remnant, might be reduced to the Brazilian level. And, one may go on to ask, where is it likely that the Chinese themselves got their law of village-lands, if it was not developed out of lower stages of the law of property, belonging to lower stages of civilisation? If Mr. Edkins would turn his great knowledge of Chinese matters to investigating the origin of Chinese institutions, I think he would contribute new evidence to the development-theory of culture. Mr. Edkins next brings forward the evidence of numerals in Polynesia as proof of degeneracy in civilisation. The fact that the word *mano* means 10,000 in the Tonga Islands, 4,000 in the Sandwich Islands, and 1,000 in New Zealand, he accounts for on the supposition that the highest number was the original meaning, but that it was lowered with a fall in civilisation. But he will, I think, on further examination be satisfied that the real reason has nothing to do with degeneration, but with the curious Polynesian habit of counting by twos, fours, and even tens. Thus *rau* and *mano*, which in New Zealand mean 100 and 1,000, come to mean in Hawaii so many fours, viz. 400 and 4,000; Mr. Edkins' own example from Ponape shows the same done with tens (see Hale's "Ethnography of Wilkes' Expedition"). Mr. Edkins also remarks that "the Polynesians formerly had a decimal arithmetic; now it has sunk in Australia to quaternary or quinary arithmetic." But the Australians are not of the same race as the Polynesians, nor is there the least reason to suppose that they were ever at a Polynesian level of culture. As the evidence of numerals has been introduced, it may be mentioned that both Australians and Polynesians use numerals derived from counting on the fingers. Thus the Polynesian *lima*, *i.e.* "hand," is the ordinary numeral for five, while the West Australian will say "the hand on either side and half the feet," meaning by this long expression the number 15 (see my "Primitive Culture," chap. 7). I may add that I have been trying for years to get any degenerationist to answer the argument from numerals of this very common class, which can only have arisen by development from the lower stage of counting on the fingers, and which therefore prove savage tribes to be capable of independent intellectual development.

The *Quarterly Review* argument from the recent discoveries of Dr. Schliemann in the ruins he considers to be of Troy, merely shows that low barbarians may build on the ruins of towns previously inhabited by more civilised nations. This often happens, and can hardly be held to prove that the higher civilisation existed in the world before the lower.

As to the observations (vol. x. p. 163) of Mr. Hyde Clarke on affinities which he believes to exist between languages of Brazil and of the Old World, I cannot make any answer, not having seen any comparative vocabularies on which such an opinion could be founded.

EDWARD B. TYLOR

Photographic Irradiation

FOR the purpose of determining whether any sensible amount of the photographic irradiation surrounding the image of a bright object could be traced to an action taking place within the thickness of the collodion film, I some time ago tried an experiment in many respects similar to that detailed by Mr. Aitken in your last number (vol. x. p. 185). A piece of cardboard with four parallel narrow openings, each some 12 in. long, was hung against the glass roof of a photographic studio so as to be projected against the background of a bright sky. One of the slits or openings was covered with a piece of red glass, another was glazed with blue glass, the third was left entirely uncovered, and the fourth was covered by a piece of thin tracing paper. The slits in the cardboard screen were carefully focused, and over-exposed photographs were taken with a camera in which no stops were used. Upon the collodion film and immediately in contact with it was laid a piece of platinum foil quite thick enough to be perfectly opaque. The camera was so placed that the images of the slits fell partly upon the platinum foil and partly upon the collodion film. I have now before me two of the plates, each taken with an exposure of five minutes. The first was coated in the ordinary manner with a single collodion film, but the other was coated three times successively with collodion, so that the film was rendered very thick; but the eating in or encroachment of the photographic images of the slits under the platinum foil is hardly perceptible in either plate; indeed, I feel that I cannot say with certainty whether there is any encroachment of the image proper, though there are very marked brush-like extensions from the ends of the images, as well as a cloudy semicircular field symmetrical with the end of each image, evidently arising from reflections from the back of the plate. At first sight the brush-like semi-opaque extensions might be taken for the ordinary photographic irradiation eating under the platinum foil; but on more closely examining the ends of the images, the hazy opacity is seen to extend farther in some directions than in others, and to be broken up in some cases into five or six little streams or brushes. The decrease in the opacity of the brushes is also less uniform than the decrease in the opacity of the ordinary irradiation border. The brushes extend to a distance of about ·02 in. under the edge of the platinum foil.

I do not at present see my way to devise an experiment which would determine what is the cause of these little brushes, nor have I at present had an opportunity of repeating a similar experiment with the dry-plate process; but the brushes have the appearance to me of having been produced by streams in the delicate film of liquid which must extend under the platinum, streams which probably carry with them little masses of light-altered silver, that are soon deposited or strained out in the spongy tissue of the collodion.

If the spreading action under the platinum foil were caused by light dispersed within the thickness of the collodion, one would expect such action to take place symmetrically around the place where the bright image is cut off instead of being broken up, as I have described, into bundles or brushes. On the other hand, slight differences in the texture of the collodion, or minute inequalities on the edge of the platinum foil, might cause the streams in the liquid film to move more easily at one point than at another.

I should be glad to be informed what was the distance of the opaque bar from the collodion plate in Mr. Aitken's experiments, and whether there is not any photographic trace of defraction bands, owing to the bar not having been in focus; possibly the presence of these may account for the apparent difference in our results. It will be seen that the experiment which I have described points to the same conclusion as that formerly announced by Lord Lindsay and myself, viz. that the inner photographic diffraction edge is chiefly due to the imperfection of the instrument producing the image, chief among which is to be counted the aberration of oblique pencils.

A. COWPER RANYARD

MR. AITKEN'S observations on photographic irradiation in NATURE, vol. x. p. 185, are confirmed by many experiments I have made. I spent a long time in efforts to get rid of irradiation in bromide of silver films, one of the results of which I stated in a former note to NATURE (vol. x. p. 63). There is the most striking difference in the behaviour of films containing iodide of silver only to those containing the bromide alone, the latter, especially when dry, giving much greater irradiation; and the difference is again complicated by the addition of certain substances (notably albumen) to the film in the course of preparation. As my experi-

ments were mainly with dry plates, I will leave out of question the forms which the phenomenon may assume in wet-plate photography, and summarise the results of hundreds of experiments with dry plates iodised, bromo-iodised, and bromised.

With a simply bromised film the amount of irradiation is extreme. The film is very translucent and the irradiation is of two kinds, that caused by reflection from the back of the plate being by far the most extensive, but remediable by the usual expedient of coating the back of the plate with red or black colour, while the form noticed by Mr. Aitken is perhaps partially inherent in bromised films, but to a much greater degree dependent on the nature of the pyroxyline. Two samples of pyroxyline made at different temperatures, and treated in precisely the same manner, differ so much, that while one will, with the coloured backing, give scarcely a perceptible degree of irradiation, the other will develop it to an extent which no backing, nor even tinting the film with the aniline reds, will obviate. The former is generally a compact, lustrous film, scarcely to be distinguished from the glass itself, while the other (both being used without preservative solution) will give a dull and dusty-looking surface, only capable of reflecting at very small angles. If with the latter a strip of blackened wood be laid on the film so as to cut across the lightest portions of the image thrown on it by the lens, the effect of the light will be found to spread behind the strip of wood, sometimes to the extent of a centimetre; but I have never noticed the sharp limitation of this form of irradiation which Mr. Aitken observes, and which probably depends on the wet state of the film. It is clearly, as he supposes, an agitation which is set up in the film, and which depends for its propagation amongst the surrounding molecules upon a kind of chemical transparency in the film holding the bromide of silver. That this is to a great extent true is shown by two experiments: (1) a film which, in its simple state, gives considerable halation, will, when coated with albumen, especially if coagulated with nitrate of silver, give none at all, or very little, though the ocular transparency is rather increased than diminished by the albumen; (2) an emulsion prepared by exposing it to the action of nitrate of silver until it becomes structurally decomposed, and highly charged with bromide of silver, shows absolutely no irradiation under any circumstances even if the glass be not backed, and no kind of preservative used. The film in this case resembles unbaked porcelain in its whiteness, entire want of lustre, and in opacity, and the molecules of bromide of silver are more than usually free from any restraining influence which a preservative might be expected, reasoning from the usual action of the albumen, to exert. In these two cases of extreme translucency and opacity of the film there is almost an equal freedom from the phenomenon in question.

In the old albumen process with translucent films the irradiation is imperceptible, and in the collodio-albumen, where the film of albumen is allowed to remain on the collodion, it is almost so; but in this case, as in all cases where the film is charged only with iodide of silver, there is another element which complicates the action. The bromide of silver is reduced *in situ* while the iodide requires a supply of silver from the developer from which to build up the image, in the one case the deposition being by reduction, in the other by accumulation. This alone would account for a wide difference in respect to irradiation, but will not account for all, as is proven by the diverse results obtained from different bromide films, due to the varying structure of the material which holds the bromide in place.

What Mr. Aitken calls "molecular irradiation" (and which is not by any means the harmless thing he considers it in regard to artistic photography any more than to scientific) is unquestionably the great enemy of all photographic precision. It seems, however, to be complicated with what I have been obliged to call structural irradiation, alluded to above, and depending, as I have said, on the mechanical rather than the chemical condition of the pyroxyline of which the bulk of the film consists. The subject yet demands much investigation, of a purely empirical character, in order to determine the quality of vehicle for carrying the sensitive salts, neither chemical analysis nor chemical analogy affording any indication of the true cause of the difference between the two qualities of pyroxylene I have noted, nor do they, so far as I am aware, account for the difference between the action of collodion and albumen.

W. J. STILLMAN

Altenburgh Gardens,
Clapham Common, S.W., July 13

OBSERVATORIES IN THE UNITED STATES*

II.

LIEUT. M. F. MAURY was placed in charge of the new U.S. Naval Observatory, and entered on his duties with zealous purposes. He proposed in 1846 the immense astronomical work of a more extensive and precise cataloguing of the stars than Bessel's "Zone Observations" or Struve's "Dorpat Catalogue." Valuable results of the scheme, so far as it could be entered on, by the observations of Profs. Coffin, Walker, Yarnall, Hubbard, Keith, Major, and Ferguson, and Lieutenants Almy, Maynard, Muse, and others, have been lately reduced and published.

Two events marked this early part of the history with still more importance. Walker, in 1846, proved that the new planet Neptune, just then discovered by Leverrier, had been catalogued as a star by Lalande in his "Histoire celeste" in 1793; and Walker, with Lieutenants Almy and Gilliss, was the very first to use, in 1846, the new discovery of the telegraph to determine differences of longitude. The identification of Neptune with Lalande's star gave astronomers, in determining the new planet's orbit, the use of observations made fifty-two years before. It gave the *American Nautical Almanac* two years earlier ephemerides for the mariner. It brought the observatory into prominence. The superintendency of Maury extended from 1845 to April 26, 1861, when he suddenly left the city to join the cause of the South.

In 1861 Lieut. J. M. Gilliss was at length placed in charge. He re-established and vigorously pressed forward astronomical work as well as the duties of the "Hydrographical Office," a title which had been added to that of the Naval Observatory. After his very sudden death, his successor, Rear-Admiral C. H. Davis, carried forward the astronomical work with that eminent success which had been guaranteed by his previous astronomical tastes and occupancy on the Coast Survey and as superintendent of the *Nautical Almanac*. Rear-Admiral B. F. Sands, succeeding him in the year 1867, has most efficiently improved the opportunities of a longer superintendency to inaugurate and carry forward some of the most important astronomical operations of the day. The phenomena of the total eclipses of 1869 in the United States and of 1870 in the Mediterranean countries were closely observed.

Beyond the regular and severely exacting astronomical routine of observations, two centres of interest have been recently occupying the utmost activities of the institution; the reception, mounting, and use of the new great equatorial, and preparations for the transit of Venus.

The great equatorial has but one near approach to itself in the diameter of its object-glass—that of the private establishment of Mr. R. S. Newall, at Gateshead-on-Tyne, whose telescope has an object-glass of 25 in. in diameter. The Naval Observatory glass has 26 in. clear aperture. It is not easy to realise what this power is, and what it promises. The reader must imagine himself within a dome, itself 41 ft. in diameter and 40 ft. in height, looking through a tube made of three sections of steel stretching away for 32 ft.; the whole telescope and its metallic base weighing about 6 tons.

In the dome, on a pier of mason-work, supported by a pedestal, which is one block weighing $7\frac{1}{2}$ tons, stands the fine equatorial made by Merz and Mahler, Munich, at a cost of 6,000 dols., its object-glass being valued at more than half that sum. The work of this instrument under, successively, Profs. Ferguson, Walker, Hubbard, and Hall, has been chiefly upon the smaller planets, the asteroids, and comets. Mr. James Ferguson was the first American to discover an asteroid, Euphrosyne, in 1854, the thirty-first on a list which has been recently enlarged beyond even a hundred by Peters of Clinton and Watson of Ann

* Continued from p. 187.

Arbor. The object-glass of the equatorial has an aperture of 9·62 in. and a focal length of 14 ft. 4·5 in. Its powers of positive eye-pieces for use with its filar micrometer vary from 90 to 899.

Descending from the dome, and passing the superintendent's office, in which are a most excellent mean-time clock, with others, in the electric circuit with the clocks at the departments, ticking each, beat for beat, the visitor finds himself in the library, now embracing nearly 6,000 volumes. These are mostly works of the highest standard value, astronomical and meteorological observations and discussions, some being as old as the year 1482, others representing the full work of the European observatories and learned Societies to the present date.

From the library we pass into the transit-circle room, built in 1869, to admire the beautiful instrument, with its collimators and its chronograph. The focal length of the object-glass is 12 ft. 1 in.; its clear aperture 8·52 in.; and the power of its eye-pieces 135 to 396. The diameter of its circles at the outer edge is 45·30 in., and at the graduation 43·40 in., both circles being divided to every two minutes. The power of the reading microscopes is 45·3 diameters. Its collimators have a focal length of 2 ft. 11 in. This instrument, under Profs. Newcomb, Harkness, and Eastman, and their assistants, has had for its chief work the more accurate determination of the stars whose places are computed in the *Nautical Almanac*, and of those needed by the Coast Survey. The chronograph, made by Alvan Clark, is of the form known as the

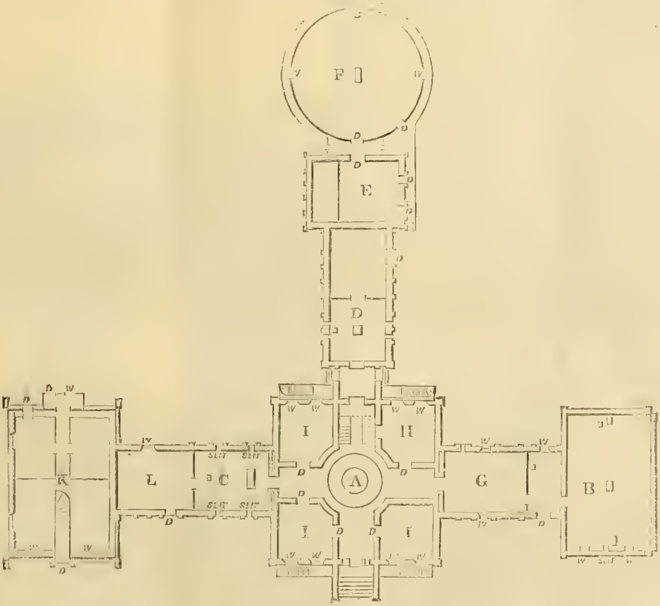


FIG. 6.—The United States Naval Observatory—Ground Plan. A, Pier of Equatorial. B, Transit Circle. C, Mural Circle and Transit. D, Prime Vertical. E, Computer's Room for Great Equatorial. F, Great Equatorial. G, Library. H, Superintendent's Office. I, I, I, Offices. K, Superintendent's Dwelling. L, Chronometer-Room. D, Door. W, Window.

Hipp chronograph, with modifications by Prof. Harkness.

Passing to the eastern wing there are seen, side by side, the mural circle and the smaller transit instrument, with their clock and chronograph. The mural circle has an object-glass of 4·10 in., and a focal length of 5 ft. 3·8 in., the highest power of the eye-pieces being 240. The diameter of the circle at its outer edge, where the graduation is placed, is 60·35 in. It is divided to every five minutes; the power of its reading microscope is 17·1 diameters. The transit has a focal length of 7 ft. 0·4 in., and its object-glass an aperture of 5·33 in.

The chronometer-room shows another and a distinct but important office of the observatory. The relation of all its work to the interests of practical navigation is sufficiently clear. More than 200 time-keepers have been at one time under care in this room. As many as eighty in 1867 were condemned and withdrawn from use. It is as gratifying as it is creditable to American skill to find that the chronometers of Messrs. Negus and Co., of New York, equal, if they do not excel, any of foreign workmanship.

From this room of the observatory the exact time is furnished daily at 12 M. to the Western Union Telegraph Office in Washington for dispatch throughout the United States. The naval officer, standing by the standard mean clock, and having the astronomical correction of that clock also before him, at three minutes before 12 M. calls the telegraph operator at his office, and, at the instant of noon, taps the electric key, giving the time to the company's office. He also drops the dome ball. The chronometer-room is under the very efficient direction of Commander A. W. Johnson, U.S.N.

The seventeen annual volumes of astronomical and meteorological observations now published best set forth in themselves the work of the observatory. The latest of

these volumes vie in extent and in value with the publications of Greenwich and Paris. The star catalogue, issued as Appendix No. 1 to the volume for 1871, embraces more than 100,000 observations, giving the places of 10,000 stars. It is the twenty years' work of Prof. M. Yarnall, embracing the reduction of his own observations and those of others from the year 1845 to 1871. The astronomer knows how to appreciate such a work.

Congress, in whose hands is the destiny of the institution, has promptly appreciated its claims, and does not withhold the liberal appropriations asked for it as due to astronomy and to this branch of naval efficiency.

West Point Observatory.—This observatory was erected in 1839 for astronomical purposes and the accommodation of the library of the Academy and its philosophical apparatus. The institution of an observatory is to be credited to Prof. W. H. C. Bartlett, LL.D., so well known for more than thirty years as its director. In 1840 Prof. Bartlett visited Europe for the United States Government, inspected and reported upon its chief observatories, submitting also a plan for an observatory at Washington, and purchasing for West Point whilst abroad its three large instruments, the equatorial, the transit, and the mural circle.

The transit instrument in the east tower was made yb Ertel and Son, and its object-glass by Merz and Mähler, at Munich, the whole cost being about 1,130 dols. It was mounted in 1843, the memorable year for observatories in the United States. Its object-glass has a clear aperture of 4·62 in., and a focal length of 76·75 in. It is provided with four eye-pieces and one dark glass, and has an illuminating apparatus, giving either a bright field with dark lines, or a dark field with bright lines, which can be modified at will by means of a coloured wedge. The

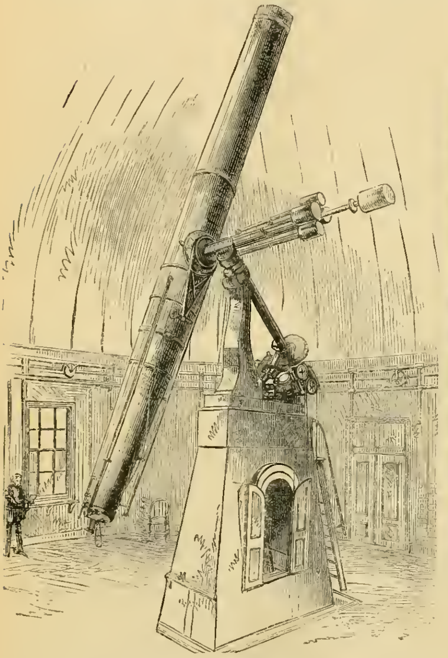


FIG 7.—The Great Equatorial—United States Naval Observatory.

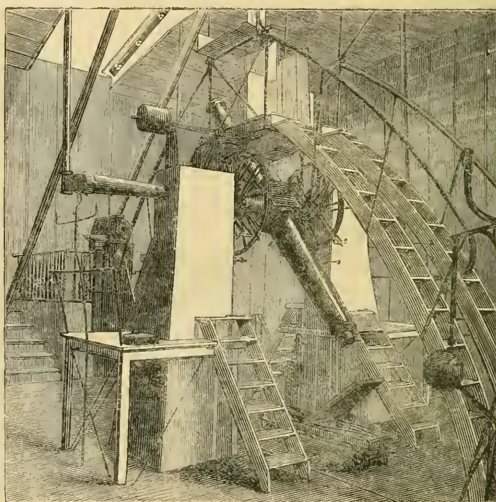


FIG. 8.—Transit Circle—United States Naval Observatory.

reticule has seven vertical and two horizontal lines. An extra vertical wire is driven in a horizontal direction by means of a micrometer screw, each division of which corresponds to $0''\cdot334$. It has a striding level, each small division being $1''\cdot23 = 0\cdot082s$. The steel pivots have not sensibly changed their equality of dimensions since the instrument was mounted.

The west tower has the mural circle, by Troughton and Simms, of London. This was cast in one entire piece of brass. Its diameter is 5 ft., and its graduations are on two bands, one of gold, the other of palladium. The telescope has a clear aperture of 4 in., with a focal length of 60 in.

The central main tower has a revolving dome of 27 ft. in diameter, which rests on six 24-pound cannon-balls, turning between cast-iron annular grooves. The equatorial, made by Mr. Henry Fitz, of New York, has a focal length of 14 ft., and a clear aperture of $9\frac{3}{4}$ in. It has thirteen eye-pieces. The hour circle reads to two seconds of time, and the declination circle to twenty seconds of an arc, each circle being 20 in. in diameter. This instrument cost 5,000 dols.

The sidereal clock, by Hardy, has a Bond break-circuit attachment, and is connected with the several instruments by wires and break-circuit keys. Besides these there are valuable portable instruments in the observatory, which lends them from time to time to topographical and surveying parties in the west and north-west, or to stations of the Engineer Corps, like the one at Willett's Point, New York. Several valuable additions, including a Bond chronograph, the odolites, and sextants, have been made within the last two years.

The purposes of the observatory of the Academy are most effectively secured by confining its workings to the end of educating the cadets in the knowledge and practical use of the instruments. During the spring months they are taken in parties of two, three, or four to receive such instruction, and are required themselves to make observations with each instrument, and reduce them. During the summer encampment a month is devoted to further instruction in connection with a field observatory at Fort Clinton, where they use a field transit, zenith telescope, and other instruments. Each makes his own records, and works out his results for the ordinary problems of time, latitude, longitude. Würdeman of Washington is constructing for this field observatory a new transit and zenith telescope.

Although the chief design of the observatory has been from the first to secure such proficiency in the cadets as would prove of most value to them in the field work to which so many army officers are called, and although neither the professors nor their assistants, who are daily instructors in several other branches, can find time available for lengthened series of observations, still at different times valuable observations have been secured in the midst of pressing duties. Among these are those of Prof. Bartlett on the great comet of 1843, published in the Transactions of the American Philosophical Society, and recent observations under Prof. Michie and his assistants, Lieut. Bass and others, for determining the longitude of the observatory.

Annapolis Observatory.—We cannot complete this sketch of the United States Government observatories without a just, though necessarily very brief, notice of the observatory used in the instruction of midshipmen at Annapolis.

The Department of Astronomy was created in 1853, and until 1865 was in charge successively of Profs. Chauvenet and Coffin. Since that time a graduate of the Academy has from time to time been in charge. The course in astronomy is of necessity limited, most of the midshipman's time in this department being required for the study of practical navigation. We learn from the report of Lieutenant-Commander R. L. Phythian to Admiral Porter in 1869 the following facts:—"The instruments used in this department are the chronometer, the sextant, the artificial horizon, the azimuth compass, the surveyor's chain and compass, the theodolite, and the plane-table. The observatory is supplied with a sidereal clock, an equatorially-mounted telescope, and a superior meridian clock. These instruments are used in instruction only to show the midshipmen the principles of them. There is not sufficient time for them to acquire a practical knowledge of their use by observing with them."

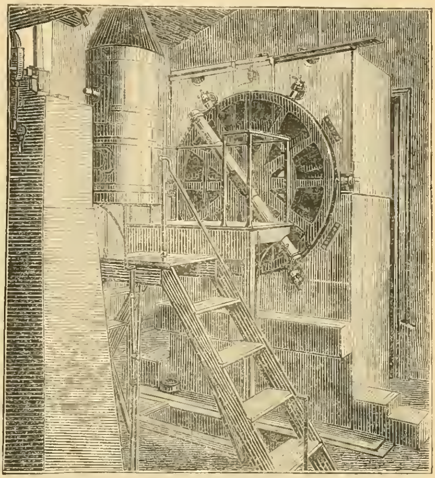


Fig. 9.—Mural Circle and Smaller Transit Instrument—United States Naval Observatory.

Fig. 10.—West Point Observatory—North Front.

Altogether the United States has reason to be proud of her observatories, and of the work already done by her astronomers.

THE RELATIONS BETWEEN HUMAN MORTALITY AND THE SEASONS OF THE YEAR

At the anniversary meeting of the Scottish Meteorological Society, a very valuable paper was read by Dr. Arthur Mitchell, and the Secretary, Mr. Alex. Buchan, giving an account of their investigations on the subject of the influence of the seasons on human mortality at different ages as caused by different diseases. The authors have calculated the weekly average death-rate of London for the past thirty years for thirty-one diseases, together with the averages of temperature, moisture, rain, &c. Considering the weather experienced in the course of the year as made up of several distinct climates differing from each other according to the prevailing temperature and moisture and their relations to each other, the influence of these climates. characterised respectively by cold, cold and dryness, dryness and heat, heat, heat and moisture, and cold and moisture, on the mortality was pointed out. The weekly mortality from all causes and at all ages shows a large excess above the average from the middle of November to the middle of April, from which it falls to the minimum in the end of May; it then slowly rises, and on the third week of July shoots suddenly up almost to the maximum of the year, at which it remains till the second week of August, and thence falls as rapidly as it rose to a secondary minimum in October. Regarding the summer excess in the death-rate, which is so abrupt in its rise and fall, it was shown that it is wholly due to one section of the population, viz. infants under five years of age, none of the curves for the other ages showing an excess in the death-rate from all causes during the summer months; and it was further shown that the summer excess is due not only to the deaths at one age, but to the deaths from one class of diseases, viz. bowel complaints. The importance of weekly averages in discussing these sudden fluctuations of the death-rate to the changes of the weather was pointedly referred to. Deducting the deaths from bowel complaints from the deaths from all causes, the curve assumes a simple form, viz. an excess in the cold months and a deficiency in the warm months. In other words, the curve of mortality is dictated by the large number of deaths from diseases of the respiratory organs. The curve of mortality in London has thus an inverse relation to the temperature, rising as the temperature falls, and falling as the temperature rises. On the other hand, in Victoria, Australia, the curves of mortality and temperature are directly related to each other—mortality and temperature rising and falling together. The character of the curve of mortality in Victoria is impressed on it by the deaths of persons below the age of five; and among such young persons the special diseases which determine this influence are diarrhœa and dysentery. This peculiarity arises from its higher mean temperature, 57°·6, as compared with that of London, 50°·0. In London also during the hottest months of the year the curves of mortality and temperature rise and fall together, whereas in Victoria the curves are throughout the whole year directly related; for though doubtless the deaths from diseases of the respiratory organs fall as the temperature rises, and rise as the temperature falls, yet the number of deaths from these diseases is, owing to the comparatively high winter temperature, never sufficiently large to influence the curve of the whole death-rate. The curves of mortality for bronchitis and pneumonia at different ages prove that the fluctuation is much less for pneumonia than for bronchitis, and that the excess in both cases of infant mortality is great, but not nearly so great as the infant mortality for diarrhœa. The curves show that the maximum mortality from the different diseases group around certain specific conditions of temperature and moisture combined, the general result of which, as regards the principal diseases, may be thus roughly stated :—

Character of Weather	Maximum Mortality
Cold	Bronchitis, pneumonia, asthma, &c.
Cold and dry	Brain-disease, convulsions, whooping-cough
Warm and dry	Suicides, small-pox
Warm and moist	Diarrhœa, dysentery, cholera
Cold and moist	Rheumatism, heart-disease, diphtheria, scarlatina, measles, croup

The deaths from cancer and liver disease show no distinct relation to weather. The period of the year least marked by the occurrence of maximum mortality from any disease is the warm dry weather which prevails from the middle of May to the end of June. At this season the only maximum is a well-pronounced secondary maximum for measles; and the maxima for suicides and small-pox, which are, however, extended from the middle of April into these months. Convulsions, teething, and atrophy and debility have a secondary maximum in the warm moist weather of July and August. In the United States, where the heat is greater in summer, the secondary maximum for convulsions is more distinctly marked than that of London; and in Victoria the summer maximum is the only one that appears. The contrast offered by certain curves to each other in all points is very striking. Thus the curve for whooping-cough begins to rise above its average in the middle of December, attains its maximum in March and April, and falls to the minimum in September and October, whilst the curve for scarlatina is exactly the reverse of all this, having its minimum in spring and its maximum in autumn. It was inferred from the general teaching of the curves, that if a curve representing the progress of the death-rate from a particular disease were given for a place whose climate was known, though it might be impossible to name the exact disease, it would be possible to say with a considerable degree of certainty whether, for instance, the nervous system, or the respiratory organs, or the abdominal organs were involved in the disorder which caused the deaths.

CONFERENCE ON THE REGISTRATION OF PERIODICAL NATURAL PHENOMENA

The Council of the Meteorological Society recently resolved to organise a system of Observations of Natural Phenomena, connected with the return of the seasons, as well as of such branches of physical inquiry as tend to establish a connection between meteorological agencies and the development of vegetable life.

As a preliminary to carrying out this intention they invited the various Societies before which such subjects most naturally come to nominate delegates to join a committee by whom the whole question as bearing upon agriculture, horticulture, &c., should be considered, and to whom also any written communications should be submitted.

The first meeting of this joint committee was held at the Office of the Meteorological Society, 30, Great George Street, on Thursday, July 2, when delegates were present and promises of co-operation read from the Royal Horticultural, Royal Agricultural, Royal Botanical, and other Societies. After the subject had been fully discussed the Rev. T. A. Preston, of Marlborough College, was requested to prepare a list of plants to be observed, and also to draw up a report on the same. Other gentlemen were requested to prepare lists of insects, birds, and animals.

THE SPECTRUM OF THE AURORA BOREALIS *

The author's object in this paper is to make a small contribution towards the solution of the question, how the composition of the spectrum may be most correctly explained?

* By the late Prof. A. J. Angström.

It may be assumed that the spectrum of the aurora is composed of *two* different spectra, which, even although appearing sometimes simultaneously, have in all probability different origins.

The one spectrum consists of the homogeneous yellow light which is so characteristic of the aurora, and which is found even in its weakest manifestations. The other spectrum consists of extremely feeble bands of light, which only in the stronger auroræ attain such an intensity as enables one to fix their position, though only approximatively.

As to the yellow lines in the aurora or the one-coloured spectrum, we are as little able now as when it was first observed to point out a corresponding line in any known spectrum. True Piazzi Smyth (*Comptes Rendus*, lxxiv. 597) has asserted that it corresponds to one of the bands in the spectrum of hydrocarbons; but a more exact observation shows that the line falls into a group of shaded bands which belong to the spectrum, but almost midway between the second and third Herr Vogel has observed that this line corresponds to a band in the spectrum of rarefied air (Pogg. Ann. cxlvi, 582). This is quite right, but in Angström's opinion is found on a pure misconception. The spectrum of rarefied air has in the green-yellow part seven bands of nearly equal strength; and that the auroral line corresponds with the margin of one of these bands, which is not even the strongest, cannot be anything else than merely accidental.

Observations on the spectrum have not hitherto agreed with each other; partly, perhaps, because of the weak light of the object, but partly also, it may be, on account of the variability of the aurora. The red does not always appear, and when it does is often so weak that it cannot be observed in the spectroscope. If now it be assumed that the aurora has its final cause in electrical discharges in the upper strata of the atmosphere, and that these discharges, whether disruptional or continuous, take place sometimes on the outer boundary of the atmosphere, and sometimes near to the surface of the earth, this variability will easily show in the appearance of the spectrum what the observations appear to confirm.

If we consider the conditions under which the electric light appears on the boundary of the atmosphere, moisture in that region must be set down as nil, and consequently the oxygen and hydrogen there must alone act as conductors of electricity. Angström has tried to reproduce these conditions on a small scale. Into a flask, the bottom of which is covered with a layer of phosphate, the platinum wires are introduced and the air is pumped out to the extent of several millimetres. If the inductive current of a Ruhmkorff coil be sent through the flask, the whole flask will be filled, as it were, with that violet light which otherwise only proceeds from the negative pole, and from both electrodes a spectrum is obtained consisting chiefly of shaded violet bands.

If this spectrum be compared with that of the aurora, Angström thinks that the agreement between the former and some of the best established bands of the latter is satisfactory.

Lines		Wave-lengths		
Of the aurora spectrum	According to Barker	431	470·5	
	,, ,, Vogel	—	469·4	523·3
	,, ,, Angström	—	472	521
	,, ,, Lemström	426·2	469·4	523·5
	Mean	428·6	470·3	522·6
Of the spectrum of the violet light		427·2	470·7	522·7

In the neighbourhood of the line 469·4 Herr Vogel has moreover observed two weak light bands, 466·3 and 462·9. The spectrum of the violet light has also two corresponding shaded bands, 465·4 and 460·1.

Should the aurora be flamy and shoot out like rays, there is good reason for assuming a disruptive discharge of electricity, and then there ought to appear the strongest line in the line-spectrum of the air, the green, whose wave-length is 500·3. Precisely this has been actually observed by Vogel, and has moreover been seen by Angström and others.

Finally, should the aurora be observed as it appears at a less height in the atmosphere, then are recognised both the hydrogen lines and also the strongest of the bands of the dark-banded air-spectrum, as *e.g.* 497·3. There are found also again nearly all the lines and light bands of the weak aurora spectrum, whose position has with any certainty been observed.

There still remains the line in the red field, the wave-length of which, according to Vogel, may be valued at 630. Angström has chanced to see it only a single time, while on various occasions, when the aurora has shown red lights, he has found it impossible to distinguish any lines whatever in this part of the spectrum. The cause of this may be that while the red bands in the spectrum of the negative pole are broad and very feeble in light, the corresponding light in the aurora may be imperceptible in the spectroscope on account of the dispersion of the prism, although it is strong enough to give to the aurora a reddish appearance. Angström does not venture to decide whether the red line observed by Vogel coincides with the strongest of these bands, but so much is at least certain, that it may coincide with more than one of the bands to the red field of Plucker's air-spectrum.

In general it may be thus assumed that the feeble bands in the aurora spectrum belong to the spectrum of the negative pole, and that the appearance of this spectrum may be changed more or less by additions from the banded air-spectrum or the line-spectrum of the air.

But by this is not yet explained the one-coloured spectrum or the origin of the yellow line. The only explanation of the origin of this line which in Angström's opinion is in any way probable, is that it owes its origin to *fluorescence* or phosphorescence. Since fluorescence is produced by the ultra-violet rays, *an electric discharge may easily be imagined, which, though in itself of feeble light, may be rich in ultra-violet light, and therefore in a condition to cause a sufficiently strong fluorescence.* It is also known that oxygen is phosphorescent, as also several of its compounds.

There is therefore no need, in order to account for the spectrum of the aurora, to have recourse to the "very great variability of gas spectra according to the varying circumstances of pressure and temperature," a variability which according to Angström's twenty years' observations does not exist. Just as little can Angström admit that the way in which a gas may be brought to glow or burn, can alter the nature of the spectrum; since it is an established fact in physics that the state of light and of heat which puts a body into a glowing condition is unconnected in character with that which preduces glowing.

Angström does not entirely deny the possibility that a simple body by glowing in a gaseous condition will offer several spectra. Just as one simple body can form a chemical combination with another, and this body by glowing in a gaseous condition, so long as it is not decomposed, gives its own spectrum, so must it also be able to form combinations with itself—thus to form isomeric combinations—it being always supposed that it exists in the gaseous form and can maintain itself in a glowing condition without decomposition. In this way it is indeed possible to conceive an absorption for oxygen which belongs to ozone; but since ozone, as is well known, cannot maintain itself in a glowing condition, it is in vain to look for more than one spectrum of oxygen. There is, however, at least a possibility of obtaining several spectra from sulphur, while again with respect to carbon, which cannot even be exhibited in a gaseous condition, a like assumption in the author's opinion wants the support of experience.

THE COMET

WE have received from Mr. Lockyer, who has been observing the comet with Mr. Newall's 25-inch refractor, the accompanying rough sketch of its general appearance in that instrument. The drawing he states is only intended to show the features in their most general aspect, in order that the striking differences between the present comet and former ones may be apprehended.

His observations, to which we hope to refer at some length, extended over several hours on Sunday and Tuesday nights, and great changes were observed.

One of the new observations made was that a photographic plate exposed for ten minutes gave no results on the comet, while the dimmest of the seven stars in the Great Bear, inferior to the comet in brightness, recorded itself in two minutes' exposure.

R[illegible] Nucleus and Envelopes of Coggia's Comet as seen in Mr. Newall's 25-inch Refractor on the night of July 12.

It is hoped that the observations, made under first-rate atmospheric conditions, with the magnificent instrument with which Mr. Newall has endowed British Astronomy, will throw light upon cometary structure, and help to clear up many anomalies.

JASPER'S "BIRDS OF NORTH AMERICA"*

A SHORT time ago we gave our readers some account of the important work of the "Birds of North America," lately issued by Prof. Baird with the co-operation of some of the principal naturalists of the United States. It has just come to our knowledge that a rival work has been started with nearly the same title, concerning which it may be useful to such of our readers as turn their studies in an ornithological direction that we should say a few words.

Jasper's "Birds of North America" appears to have been started by an enterprising publisher at Columbus, Ohio, "to meet a common want and gratify a universal taste." It is issued in numbers, the first of which bears date Nov. 1, 1873. It is to contain coloured figures and descriptions of over 600 species, and a popular account of their habits and manners—likewise a general outline of the science of ornithology—all from the pen and pencil of Dr. Theodore Jasper, "who has made the study of ornithology the business of his life."

Now we have no desire at all to interfere with Mr. Jacob H. Studer's undertaking. We quite agree with Mr. Studer's notions that a knowledge of American birds is or should be a "common want," and we are also of opinion that a "universal taste" should be gratified if possible. At the same time we must be allowed to say, after examining what has yet appeared of Mr. Jasper's work, that, in our judgment, those who wish to become well acquainted with American ornithology had better consult Prof. Baird's volumes. Mr. Jasper, it is true, furnishes coloured figures of every species or proposes to do so. But these, prepared by chromolithography or some similar process, are not sufficiently carefully coloured for the discrimination of specific differences—at any rate as regards the smaller birds. And in every other particular Baird's "American Birds" is far superior. Mr. Jasper's work can indeed be hardly placed in the same category, the author being obviously acquainted with little more than the results of his own experience, whilst Prof. Baird and his coadjutors are fully up to the level of modern science.

* "The Birds of North America, drawn from life and uniformly reduced to one-quarter their natural size," by Dr. Theodore Jasper. In 4to. parts. Columbus, Ohio, 1873-74.)

NOTES

THE statue of Dr. Priestley will be unveiled at Birmingham on Saturday, Aug. 1 (the centenary of his discovery of oxygen). Prof. Huxley will make the presentation to the town, on behalf of the subscribers, and will deliver an address in the Town Hall.

WE understand that the recently established Stricklandian Curatorship in the Cambridge University Natural History Museum has been offered to and is likely to be accepted by Mr. Osbert Salvin, F.R.S., one of our most distinguished ornithologists.

LORD LILFORD has just returned from a natural history cruise in the Mediterranean, and amongst the most interesting specimens he has brought home with him is a pair of Audouin's Gulls (*Larus audouini*) from the small island of Toro on the coast of Sardinia, which he has deposited in the gardens of the Zoological Society. The rareness of these birds makes them of peculiar interest.

A LARGE collection of giraffes, antelopes, and other African mammals has lately been imported into Hamburg by Mr. C. Hagenbeck, the well-known dealer in animals of that city, from the Atbara district of Upper Nubia. Three of the finest giraffes have been secured by the Zoological Society, and are daily expected to arrive in London.

A REPORT is said to be current at St. Petersburg that the Austrian Polar Expedition, of which nothing has been heard for a considerable time, and respecting the safety of which apprehension is accordingly entertained, is lying off the coast of Novaya Zemlya.

THE Caen Academy of Science and Art proposes as the subject of the Le Sauvage prize, of the value of 4,000 francs, to be awarded in 1876, the question of the Function of Leaves in the Vegetation of Plants. The Academy does not want simply an exposition of the present state of Science on this important question; it requires, besides, from competitors, exact experiments performed by themselves, and new facts tending to throw light upon, invalidate, confirm, or modify doubtful points in the theories at present accepted. The memoirs ought to be sent to the Academy before Jan. 1, 1876.

A FIFTH "sub-edition" of Dana's "Mineralogy" has been issued, with an appendix, by Prof. Brush.

JOSHUA HOOPES, the last survivor of the old school of the botanists of Chester County, Penn., of which Darlington was the chief, and the "Flora Cestrica" the memorial, died on May 11 at the age of 86.

MR. HERBERT SPENCER has published in a separate form, with some additional correspondence and comments, the correspondence which was carried on in NATURE between himself, the "Quarterly Reviewer," Mr. R. B. Hayward, and others.

M. LEVERRIER has presented to the Council of the Observatory a new set of regulations for the better working of the establishment. In drawing out these regulations the illustrious astronomer took advantage of the visit he recently made to Greenwich Observatory.

MAGNETIC instruments are to be erected on a piece of ground situated between the Boulevard Arago and the Observatory Gardens, Paris. This land belongs to the French Government, which has given it up for the purpose mentioned.

M. FAYE has been nominated President of the Bureau des Longitudes. M. Janssen, who was a member of the Section of Geography, has been appointed by the Minister a member of the Section of Astronomy. There will be an election to fill up the place thus vacated. This is the first time that a member has been transferred from one section to another.

DR. GARRIGOU, of Bagnères de Luchon, has established, at his own expense, a laboratory for analysing the mineral waters of the Pyrenees. The laboratory is open to men of science for their own researches.

THE Worshipful Company of Clothworkers has founded a "Professorship of Textile Industries" in connection with the Yorkshire College of Science, with a stipend of 300*l.* a year and two-thirds of the students' fees. The stipulated qualifications for the post have been just announced. The selected candidate will be required to have a practical knowledge of all materials used in the woollen and worsted manufactures, and the selection of materials for special kinds of goods; to be able to give instruction in every department of weaving, including the practical handling of the loom; plain drawing, and analysis of patterns; to apply the laws of colour to the production of coloured designs, and to finish coloured designs on paper, prefiguring the woven fabric; to make all the calculations required in the manufacture of woollen or worsted goods; to explain and illustrate the processes of carding, combing, and spinning; and to give practical illustrations of scouring, fulling, and finishing. The chemistry of dyeing will be taught by the Professor of Chemistry. It will be a condition of appointment (*inter alia*) that the Professor is to give lectures at stated times upon improved modes of manufacture at other of the chief towns connected with the cloth-working industry both in Yorkshire and the west of England.

THE result of the Sandwell Park trial sinking for coal being that a seam 20 ft. 6 in. has been found at a depth of 418 yards, it is proposed to furnish an account of the fossils met with and the general character of the red rocks passed through. Prof. Ramsay and others have promised their assistance for this work.

URIAH A. BOYDON, of Boston, has deposited with the Franklin Institute the sum of 1,000 dols. to be awarded as a premium to "any resident of North America who shall determine by experiment whether all rays of light, and other physical rays, are or are not transmitted with the same velocity." The memoirs, which are to describe in detail the apparatus, mode of experimenting and results, are to be sent in to the secretary of the Institute by Jan. 1, 1875. The Institute is to appoint three judges, and has reserved to it the power to decide whether or not the recommendation of the judges shall be carried out. Should the judges think proper, they may require the experiments described in any of the memoirs to be repeated in their presence.

THE report of the State Board of Health of Massachusetts, 1874, says that a large part of the 450 analyses there given were performed by a lady in the laboratory of the Massachusetts Institute of Technology.

THE Geological Society of France intends to hold its annual session this year at Mons, immediately on the conclusion of the session of the French Association for the Advancement of Science. The meetings commence on August 30, and will last about a week, during which some interesting excursions have been arranged for.

IN the Engineering Department of King's College the following Physical Science Exhibitions will be given in October next. The Treake Entrance Exhibition of 20*l.*, also two Exhibitions of 30*l.* and 21*l.* will be given by competitive examination among the students matriculating in this department at that time, provided a satisfactory degree of proficiency is shown by the candidates. The examination will consist of four papers, two in mathematics, one in elementary mechanics and physics, and one in chemistry, and will take place on Thursday, October 1, and two following days.

THE Provost and Fellows of Worcester College, Oxford, have voted the appropriation of 2 per cent. of their revenues to non-collegiate University uses, and have resolved that this sum for the next five years shall be paid in equal proportions to the Bodleian Library and University Museum.

MR. F. BUTLER, B.A., of Worcester College, who obtained a first class in Natural Science at the recent examination at Oxford, has been appointed Natural Science Master of Reading School, and during the vacation a laboratory will be fitted up at the school under his supervision.

THE large and lucrative industry which has sprung up on the American coasts in the preservation of lobsters in tins, has induced some energetic persons to start a lobster farm near Boston, where an area of about 32 acres has been laid out and protected for the purpose of cultivating the lobster. On the seaward side it is closed by banks, having hatches or sluices so as to admit of the flow and ebb of the tide. Last summer about 40,000 lobsters, of all sizes, were deposited in this ground. The maimed and the halt and the lame and probably the blind are accommodated with quarters where they can recover their lost claws; and a *crèche* for the infantine population is provided, where they can increase without the ordinary dangers attendant on lobsterial infancy. Food, in the shape of refuse fish, &c., is liberally supplied to this interesting community. In the winter the managers evinced the natural deceitfulness of human nature by catching and scalding the lobsters on which so much attention had been lavished, and a fine harvest rewarded them; 15,000 fine lobsters were sold, and the success of the experiment seems complete. Besides lobsters, it is intended that the farm shall be turned to account by being made a nursery for fish of various kinds. As a matter of fact many eels and other fishes were caught in the spring. The venture seems a very successful one; and in view of the enormous drain on the natural lobster grounds of America, it is very necessary that some such steps should be taken, as a supplement to the regulations proposed to prevent overfishing, and fishing in the breeding season.

THE suggestion has been made that kangaroos might be generally cultivated in parks and other enclosures in this country; and it is probable that they would prove quite as useful as deer. A French naturalist, M. Cornély, has recently published some novel information on the subject, which seems to show that the proposal is perfectly feasible in every way. The experience of the various zoological societies in Europe shows that this marsupial will thrive and breed in our climate, damp being the only condition which is fatal to it. It will bear great extremes of heat and cold without injury. M. Cornély says that they are not destructive to trees and shrubs, and that if any individuals contract the habit of barking trees, they can be broken of it by shutting them up for two or three days without food. On being released they are so eager in search of grass that they do not touch the trees. As an ornamental adjunct to an English park, the presence of kangaroos would prove very valuable; their skins are highly prized on account of the quality of the leather, and most probably the principal obstruction to the more general cultivation of the animal is the prejudice that exists against the introduction of novelties.

A SEVERE earthquake is reported to have occurred in Utah at midnight on June 18.

WE learn with great pleasure that during the last three years there has been a very successful class for botany in connection with the Royal Veterinary College. From some notices of excursions made during the present summer which have been sent us, we see the field-class is one of the largest in London, or anywhere else we should think, and that the excursions are made the means of valuable training as well as of conveying solid information.

THE Council of the Institution of Civil Engineers has just awarded the following, among other premiums and prizes:—A Telford Medal and a Telford Premium to Joseph Prestwich, F.R.S., Assoc. Inst. C.E., for his paper On the geological conditions affecting the construction of a tunnel between England and France. A Watt Medal, and a Telford Premium, to Alexander Carnegie Kirk, Assoc. Inst. C.E., for his paper On the mechanical production of Cold. A Telford Premium to Major James Browne, R.E., Assoc. Inst. C.E., for his paper On the tracing and construction of roads in mountainous tropical districts.

THE following is a translation of the telegraphic despatch received in Paris by Gen. Morin from H.M. the Emperor of Brazil:—"Service from Rio de Janeiro to Paris *vià* Falmouth, June 23, 6 o'clock. Electric telegraph established from Europe to Brazil. In addressing you my congratulations on this victory of science, I beg you to communicate my satisfaction to all your colleagues of the Academy of Sciences, to whom I owe so many marks of good-will. Don Pedro." The Academy immediately replied:—"The Academy, moved by his Majesty's remembrance, offers him its thanks, its respects, and its vows."

WE would strongly urge on our readers' attention the appeal made through the daily papers by Mr. C. R. Markham, F.R.S., on behalf of the Cameron-Livingstone expedition. A letter from Lieut. Cameron, dated Ujiji, Feb. 28, tells of his having secured Dr. Livingstone's map and journal from Mikandany, which he was to send home in a few days. "The fish of Tanganyika," he states, "are more like sea than fresh-water fish. The Tanganyika is a veritable sea. I will send home a bottle of lake-water to be analysed. I cannot understand, receiving as it does rivers that flow through a salt soil, why the waters of the lake should not be salt. I believe that it is gradually being filled up."

THE Report of the Commissioners of Fisheries for the State of New York states that in 1872 upwards of seven and a half millions of young shad were hatched and turned into the river Hudson at the cost of the State; and five millions were added in 1873. In the spring of the latter year, several hundred thousand shad were transported into California and into the great American lakes, where it is hoped they will become fairly acclimatised. The Sacramento River Salmon, and the Whitefish (*Coregonus albus*) have, in return, been introduced from the lakes and rivers of the West to the Eastern States. The enactment of a close time, during which the shad may be allowed to proceed unmolested up stream to spawn, is urgently desired, otherwise the natural increase of the fish can never occur, and the results of the artificial culture and propagation are nullified. The efforts of the Commissioners, who have erected extensive hatching premises at the cost of the State, have resulted in much more light being thrown on the subject of pisciculture. So thoroughly is the process of artificial spawning and fecundation carried out, and so carefully are the after stages of development assisted, that nearly cent. per cent. of the eggs taken are actually hatched. Under ordinary circumstances hardly twenty per cent. of the eggs are hatched. The importance of this system in re-stocking barren or depopulated waters cannot be over-estimated; but its results can never be fully successful until all impediments to the ascent of fish in the spawning season are removed; and when this is the case, artificial propagation will be no longer necessary.

MR. SETH GREEN, the well-known American pisciculturist, proposes that some enterprising persons should turn their attention to frog culture; and he gives careful directions for procuring and treating the spawn and frogs. The spawn will hatch in about fifteen days, and if the tadpoles and young frogs are placed in a suitable position it is calculated that they may be easily reared, and a large profit made. The mode of feeding the frogs is to place

pieces of meat, or other substance, to attract the flies, upon which the frogs feed; they will also eat the maggots of decayed meat, and even the meat itself. It appears that the demand for frogs in America is increasing, and in that case a frog-farm might be made a good investment.

Of the 120,000 salmon eggs which were sent from England to New Zealand in the winter of 1872, only about 60 are now alive. Although the ship *Oberon* by which they were sent was only 93 days on the passage, she was delayed on her arrival at Dunedin in consequence of a quantity of gunpowder being on board, which was obliged to be discharged before she could get into port. Probably the eggs were not properly fertilised; though several boxes of ova which were kept packed in ice in England for 108 days under exactly similar conditions, produced a good percentage of fish. The Government of New Zealand intend to repeat the experiment this year, when Glasgow will be the port of despatch.

On July 1 severe thunderstorms were felt in several parts of southern France, principally in and around Montpellier, which seems to have been a centre of electric manifestations. But the harm done was principally owing to the hailstones, which have been numerous and of considerable size, many of them reaching the bulk of a marble. Many crops were damaged, and even in some instances completely destroyed. These hail clouds travelled at a rapid rate from the eastern Pyrenees, near the Rhone, in a north-eastern direction for more than a hundred miles with a breadth of not more than eight or nine miles. A map will be published in the *Atlas Météorologique* of France, which was founded by M. Leverrier in 1864, and was published in 1864-68. The volume for 1869 will be issued shortly, and will contain the most notable facts for 1870-71. The publication, which has been stopped since M. Leverrier left the Observatory, will be resumed yearly henceforth, the Versailles National Assembly having granted the necessary funds. It has been remarked already by M. Charles Martin and the two Becquerels that hailstorms are always connected with thunderstorms, and follow mostly a strongly zigzag line, almost always recurring in a number of chosen spots, for which they seem to feel an irresistible attraction. Woods are very seldom touched by them, a fact which has induced MM. Becquerel to advise farmers to grow trees in order to be protected against hailstones. M. Arago encouraged some years ago a scheme for erecting captive balloons with an iron rod, connected with the earth by an iron chain, in order to provoke electrical discharges and suppress the cause of hail-production. The proposal seems to be rather daring, but the above statements render it desirable that it should at least be tried. Aiming at certain spots in preference to others, the efficiency of protection is sure to be easily tried. M. Colladon, a Genevan physicist, has published many experiments on the fall of lightning on trees. He supposes that poplars are really very attractive, and that they may effectually render the same service as true lightning conductors, if plates of iron are connected with the trunk and earth. These suggestions are very likely to be tried on a grand scale.

Icebergs seem to be unusually plentiful this season; a despatch from New York states that several ships have encountered them in uncommonly large numbers and of very unusual size.

Messrs. Trübner & Co. have in the press "Tea, Coffee, and Cocoa," a practical treatise on the examination of tea, coffee, and cocoa, by Mr. J. A. Wanklyn, M.R.C.S.

Another supplement, No. 37, to Petermann's *Mittheilungen* has just been issued, containing a long account of Carl Mauch's travels in the interior of South Africa in the years 1865-72. The accompanying map illustrates a journey made by Mauch in 1871-72, from Simbabye in 20° 10′ S., and 31° 40′ E. in a north and east direction, to Senna on the Zambesi, in 17° 20′ S., 35° 8′ E.

If anyone wants to see how lamentable is the absence of practical work in the examination system of the University of London, let him get "Questions in Chemistry and Natural Philosophy given at the Matriculation Examination of the University of London from the year 1864 to June 1873, classified according to the syllabus of subjects," by C. J. Woodward, B.Sc. (Simpkin, Marshall, & Co.) We say nothing against the book itself, which is a creditable compilation of its kind, but the system capable of giving birth to such a text-book must be an unmitigated encouragement to "Cram."

A telegram dated Singapore, July 2, states that H.M.S. *Basilisk* had arrived there, having successfully completed a survey of the previously unknown north-eastern shores of New Guinea. Capt. Moresby reports that the existence of a new and shorter route between Australia and China is an established fact.

The additions to the Zoological Society's Gardens during the past week include a Branded Ichneumon (*Herpestes fasciatus*) from West Africa, presented by Lady Sheffield; a Rose-ringed Parrakeet (*Palæornis docilis*) from the Zambesi River, presented by Mrs. Loveday; a Chimpanzee (*Troglodytes niger*) from West Africa; a Spectacled Bear (*Ursus ornatus*) from the Upper Amazon; an Eyra Cat (*Felis eyra*)) from South America; a Nisnas Monkey (*Cercopithecus nisnas*), an Eleonora Falcon (*Falco eleonoræ*) deposited; two Pumas (*Felis concolor*), and nine Rosy-billed Ducks (*Metopiana peposaca*) born in the gardens.

SCIENTIFIC SERIALS

The *Journal of the Chemical Society* for June contains the following papers communicated to the Society:—On the cobalt bromides and iodides, by Walter Noel Hartley. The bromide is prepared by allowing metallic cobalt to stand in a dish with bromine and water for a week or so, when a purple solution is obtained which becomes blue after dilution and filtration. When evaporated over sulphuric acid, purple-red prismatic crystals separate, having the formula $CoBr_2 . 6H_2O$. When heated to 100° the salt loses 4 molecules of water. The iodide obtained in the same manner forms a mass of highly deliquescent green crystals. Heated to 100° in the air a basic salt is produced; on adding water and filtering a red oxyiodide is obtained, having possibly the formula Co_2I_3O. The green crystals have the formula $CoI_2 . 2H_2O$; an iodide, $CoI_2 . 6H_2O$, of a dusky red colour also exists, and likewise the anhydrous salt CoI_2, which is described as a black amorphous substance.—Note on the solubility of plumbic chloride in glycerin, by Charles H. Piesse. The author has made quantitative determinations of the amount of $PbCl_2$ dissolved by pure glycerin and by mixtures of glycerin and water. The mean of two experiments gives 1·995 as the amount of $PbCl_2$ dissolved by 100 parts of glycerin. The solubility is not perceptibly increased by the temperature. Experiments were also made with mixtures containing respectively 50, 75, and 87·5 per cent. of water, and the amount of $PbCl_2$ dissolved agrees very closely in each case with the number obtained by adding the amount of the salt dissolved in the water to the amount dissolved by the glycerin, the solubility in water being taken at 0·733 per cent.—On the products of the decomposition of castor oil. No. 2. The distillation of sodium ricinoleate, by E. Neison. The author's experiments confirm the statements of Bouis, that the sodium salt named yields methyl-hexyl ketone on destructive distillation. The results obtained by Städeler, who got by this reaction only heptylic aldehyde, are explained by a difference in the nature of the soap used.—Note on a reaction of gallic acid, by Henry R. Procter. When a solution of potassic or sodic arsenate is added to one containing gallic acid and the mixture exposed to the air, oxygen is absorbed, and an intense green colour produced. Dilute acids change the colour to purplish red—strong H_2SO_4

and HNO_3, and boiling HCl change it to a pale yellow. The colour is also destroyed by reducing agents.—On ozone as a concomitant of the oxidation of the essential oils. Part I. by Charles T. Kingzett. The author first determined the amount of oxygen absorbed by ether, oil of turpentine, and various essential oils. Various reactions of the so-called ozonised oil of turpentine have been studied. The oxidised substance resembles both ozone and hydrogen peroxide in certain properties, but its aqueous solution retains its properties after long-continued boiling. The substance is destroyed also by MnO_2 and by heating with $ZnCl_2$. The author concludes from his experiment that the supposed ozone is an oxidised compound of the turpentine oil, $C_{10}H_{16}O.H_2O$.—It is much to be regretted that the Society still finds it necessary to advertise on the wrapper of the present number (as also of the last) a list of books missing from the library.

American Journal of Science and Arts, June.—The first article is by W. Hilyard, Univ. of Michigan, On some points in Mallet's theory of vulcanicity. He gives a *résumé* of the state of the question. Among other points considered Mr. Hilyard says:—"While Mr. Mallet's theory accounts satisfactorily for earthquake phenomena and volcanic activity as manifested since the cessation of fissure eruption; and also for the gradual or sudden depression of both large and small areas, even subsequent to that time; it makes no provision for their elevation, and therefore leaves unexplained the numerous oscillations of level of which we find the record down to our own time. In assuming the movements as taking place exclusively within the solid shell, he (unnecessarily, it seems to me) leaves a point open to objection." . . . "At the first blush the 'squeezing out of sub-mountain liquid matter' assumed by Leconte as the consequence of the folding and fissuring of strata by tangential thrust, appears natural enough. Yet it seems hardly possible that the same force which makes and elevates mountain-folds (being the result of interior shrinkage) should at the same time serve to compress the interior liquid, unless either such folding occurs beneath the general level of the liquid; or the latter is locally confined; or the movement is so brusque or cataclysmal that viscosity would prevent the lateral or downward escape of the liquid rock." While the assumption of locally limited fire seas, as proposed by Dana, would remove the difficulty, calculation shows the required size of the seas to be such that they would approach to nearly a general undercrust fluidity.—In the second article Mr. L. Lesquereux replies to Dr. Newberry's objections to the Colorado Lower lignite formation being referred to the period of the Lower Eocene. He shows that many of the species it contains are common to Alum Bay and Mount Bolca, and he objects to Heer's statement that the floras of these two localities have "a distinctly tropical and Indo-Australian character." The next article is a continuation of Mr. C. H. Hitchcock's paper On the Helderberg rocks of New Hampshire. The beds in question border on the line of the Ammonoosuc River in three areas, the Littleton, North Lisbon, and Lyman. Of the fossils Mr. Billings says: "I do not consider the fossils sufficient to decide the age of the rock very closely, but only that it is Upper Silurian or Lower Devonian.' The communication, which occupies twenty pages, is illustrated with map and sections.—A description of a new fossil resin, by O. Loew, named by him Wheelerite. Its formula is C_5H_6O, and it melts at 154° C.—The next article is a completion of Mr. W. M. Fontaine's paper On the great conglomerate on New River, West Virginia. This series, while in some features resembling the lower coal rocks, is distinguished by an almost entire absence of shales. The study of it has led to the consideration, "Does not the successive formation of coal on an extended scale along the south-west border of the Appalachian coal-field, commencing in the Devonian period, point to the existence at this time of a continental mass nearer than the azoic of Canada?"—On a felspar from Bamle in Norway, by G. W. Hawes.—Notes on some fossils in Illinois State Geological Reports, vol. v., by F. B. Meek.—Chemical composition of the wood of Acrogens, by C. W. Hawes. The analyses show that the wood of Acrogens does not differ in ultimate composition from forest trees.—Under the head "Scientific Intelligence," there is a note that a skeleton of a whale (*Beluga vermontana*) has been found at a depth of 12 ft. 6 in. in clay of the Champlain period, at Jacquet River, Dalhousie, New Brunswick.—The flora of the Dakota group of the Cretaceous is, according to Mr. Lesquereux, remarkable for the absence of any European species of the same age.

THE *Geographical Magazine*, July.—This number opens with an interesting sketch of the history of Indian Marine Surveys.—Col. H. Yule, C.B., contributes an abstract from the *Bulletin* of the St. Petersburg Geographical Society of Mr. F. Paderin's account of his visit to the site of Karakaroum in 1873, which is illustrated by a sketch-map.—Another paper by Col. Yule contains some valuable information concerning the wonderfully accurate *Atlas Sinensis* (1655) of the Jesuit Martin Martini.—A number of valuable notes on the Kashgar Mission are given in the form of letters from Lieut.-Col. Gordon and Capt. Biddulph.—Baron von Richthofen sheds considerable light on the question of land communication between Asia and Europe. No one is entitled to speak with more authority than this great explorer of China, and he distinctly states that "the trade-route from Si-ngan-fu, past Hami, to Kuldja, is the best natural line for a railway from China to Europe." He is confident of the practicability of the undertaking.

THE *Journal of Botany*, May, June, July.—The number for May commences with a short sketch of the life of a little-known botanist, William Sherard, a contemporary of Ray, who died in 1728, and bequeathed his library and herbarium to the University of Oxford, together with an endowment of 3,000*l*., for the Professor of Botany.—Mr. F. A. Lees has a useful paper On the flora of the Yorkshire coal-field.—Prof. Thiselton Dyer appends some remarks to a translation of M. Vesque's paper On new species of Dipterocarpus, from the *Comptes Rendus*, some of M. Vesque's names having a claim of priority over those published by Prof. Dyer in the preceding number of the *Journal*, while others appear identical with previously described species, and to have been published on insufficient grounds.—In the number for June the papers are mostly of a character to interest species-botanists only.—Mr. J. G. Baker describes some new species of Dracæna from Tropical Africa.—The same remark may be applied to the number for July, with the exception of an account of the Botanical Congress at Florence, continued from the preceding number, and reprints of the Official Reports of the Keeper of the Botanical Department of the British Museum, and the Curator of the Herbarium and Library at Kew for 1873.—One or more plates in every number now add to the permanent value of this admirably conducted magazine.

IN the *Scottish Naturalist* for July, we find papers on Scotch zoology, phytology, and geology. We would call special attention to one by Mr. G. Sim, On the food and use of our rapacious birds, an eloquent appeal for the protection of our "Raptores," which are now becoming scarcer every year. From an examination of the stomachs of 305 birds which have passed through his hands during the last ten years, eagles, buzzards, ospreys, falcons, merlins, kestrels, sparrow-hawks, owls, &c., the author has come to the conclusion that the injury done by these birds to the farmer and game-preserver is very small compared to the benefit, by far the most abundant articles of their food being mice, shrews, and various insects. Even when hawks do kill game, he maintains that it is the weakly and sickly birds that fall victims.—Mr. F. Smith concludes his paper On the geology of the Earn Valley, and Dr. Buchanan White and Dr. Sharp give further instalments of the Lepidoptera and Coleoptera of Scotland.

THE *Transactions of the Linnean Society* has now entered on its thirtieth volume. The first part, just published, contains Mr. J. Scott's paper On the tree-ferns of British Sikkim, illustrated with eighteen plates; a paper On some recent forms of *Lagenæ* from deep-sea soundings in the Java seas, by F. W. O. Rymer Jones, with one plate; an enumeration of the Orchids collected by the Rev. E. C. Parish near Moulmein, by Prof. H. G. Reichenbach, f., with six plates; and a most elaborate and laborious monograph of the habits, structure, and relations of the three-banded armadillo, *Tolypeutes conurus*, by Dr. James Murie, with seven plates.

Memorie della Societa degli Spectroscopisti Italiani, May.—Secchi and Tacchini contribute a table showing the solar prominences for November and December 1872, in which there is a marked aggregation of prominences on either side of the solar equator and a total absence at the poles.—There is also a coloured plate of some prominences and faculæ, by Gautier.—Schiaparelli gives an account of Capt. Tupman's observations on shooting stars, accompanied by a table showing the length of the trajectory in degrees and duration of numbers of meteorites.—Lorenzoni gives a discussion of the results of the researches at the Vienna University on the orbits of meteorites, with a table showing the elements of sixteen meteor streams.—Prof. Bre-

dichin gives his solar observations for last autumn, together with a discussion on the formation of prominences.—Tacchini gives his observations on solar spots for May 1874.

Astronomische Nachrichten, No. 1,997.—This number contains an account of the observations of the minor planet Virginia since its discovery in 1857, and the following elements are calculated:—

1874, June 19, Berlin.

$$\begin{aligned} M &= 322^\circ\ 19'\ 49''\cdot80 \\ \pi &= 10\ \ 0\ \ 42\cdot76 \\ \Omega &= 173\ 27\ 39\cdot0 \\ i &= 2\ 47\ 53\cdot5 \\ \phi &= 16\ 37\ \ 4\cdot3 \\ \mu &= 822''\cdot710835 \\ \text{Log. } a &= 0\cdot4231729 \end{aligned}$$

An ephemeris is also added for the opposition this summer.—Doberck contributes new elements for Comet I., 1824, deduced from Rümker and Sir J. Brisbane's observations.—Some observations of position of Henry's Comet, 1873, are given by J. J. Plummer.—No. 1,998 contains a paper on the photographic processes applicable to the transit of Venus.—C. S. Sellack contributes a paper on the direct photography of the solar protuberance.—A communication on the elements of the orbit of Alceste is made by A. Hall, corrected by observations made at Washington.—M. Flammarion gives the following periods of double stars:—

	Years.	Apparent semi-axis major.	Perihelion passage.
ξ Ursa Majoris . .	60·60	2″·45	1873·40 at 358°
ζ Horculis	34·57	1·19	1864·35 at 298
η Corona Bos . . .	40·17	0·865	1853·95 at 287
γ Virginis	175·	3·385	1836·45 at 320

No. 1,999. — This number contains an ephemeris of the five inner satellites of Saturn from June 1 to Oct. 28, by A. Marth, and a discussion of the various theories of comets, by W. Zenker.—In No. 2,000 is an account of some spectroscopic observations on certain variable and other stars, by H. C. Vogel; the author gives the wave-lengths of the lines in some cases.—G. Strasser gives a number of observations on comets (Winnecke and Coggia), together with the list of comparison stars.—C. H. F. Peters contributes observations on some of the planetoids, and A. Krüger gives some position observations of Coggia's comet.

Justus Liebig's Annalen der Chemie und Pharmacie, Band 172, Heft 1. This number contains the following papers:—A condensation product of glyoxal, by Hugo Schiff. Glyoxal is dissolved in five or six volumes of strong acetic acid and a stream of hydrochloric acid gas passed through the solution for about fifteen minutes. The solution on standing deposits a white substance, which was found to possess the composition $C_{12}H_{14}O_{13} = 6C_2H_2O_2 + H_2O$, and which the author proposes to name *hexaglyoxal hydrate*. Treated with acetic anhydride, one atom of hydrogen is replaced by acetyl, giving the compound $C_{12}H_{13}(C_2H_3O)O_{13}$; similarly with benzoyl chloride the compound $C_{12}H_{13}(C_7H_5O)O_{13}$ is produced. The author concludes from these reactions that the substance contains *one* semi-molecule of hydroxyl.—Improved air-bath for heating sealed tubes, by J. Habermann.—On the oxidation products of amylum and paramylum with bromine, water, and oxide of silver, by the same. Amylum yields dextronic or glucosic acid $C_6H_{12}O_7$, and paramylum the same. The calcium, barium, and cadmium salts of the acids were examined.—On the sodium contained in the ashes of plants, by G. Bunge. The author is of opinion that the result obtained by Peligot, who found that the ash of beans was free from sodium, is due to some error in the method of determination employed. An examination of the analytical method employed by Peligot has been undertaken, the results of the analysis of the ash of cows' milk being given as an example. This examination leads the author to the conclusion that by determining the alkalies merely in the aqueous extract of the ash, not only is a low value obtained, but the ratio between the two bases is a false one. Details of the method of analysis adopted are next given, and its application to the ash of beans, clover, meadow grass, apples, and strawberries. The author remarks that by his analyses Peligot's conclusions are not refuted, but at the same time they cannot be considered as established on the grounds of the analyses made by that chemist.—On oxysulphobenzide and a new derivative of this substance, by Dr. J. Annaheim. The following substances are described in this paper:—Oxysulphobenzide, $\left(\begin{matrix} C_6H_4HO \\ C_6H_4HO \end{matrix}\right\} SO_2\Big)$; Phenoltrisulphonic acid, $\underset{(SO_3H)_2}{\overset{HO}{C_6H_2SO_3H}}$; Tetrachloroxysulphobenzide, $\left.\begin{matrix} C_6H_2Cl_2OH \\ C_6H_2Cl_2OH \end{matrix}\right\} SO_2$, and the corresponding bromine and iodine compounds; methyloxysulphobenzide, $\left.\begin{matrix} C_6H_4OCH_3 \\ C_6H_4OCH_3 \end{matrix}\right\} SO_2$; the dinitromethyl compound, $\left.\begin{matrix} C_6H_3NO_2OCH_3 \\ C_6H_3NO_3OCH_3 \end{matrix}\right\} SO_2$; the diamido compound, $\left.\begin{matrix} C_6H_3NH_2OCH_3 \\ C_6H_3NH_2OCH_3 \end{matrix}\right\} SO_2$; the ethyl compound, $\left.\begin{matrix} C_6H_4OC_2H_5 \\ C_6H_4OC_2H_5 \end{matrix}\right\} SO_2$ the corresponding amyl compound, and their nitro-, amido-, and brominated substitution derivatives.—The concluding paper is by Otto Hecht and Julius Strauss: On normal hexylene and some of its derivatives. The authors have examined the dibromide $C_6H_{12}Br_2$, and the monobromide, $C_6H_{11}Br$.—A plate illustrating Habermann's paper On an improved air-bath accompanies the present part.

SOCIETIES AND ACADEMIES

LONDON

Anthropological Institute, July 1. Special meeting at the East London Museum, Bethnal Green.—Prof. Busk, F.R.S., president, in the chair.—Col. Lane Fox read a paper on the principles of classification adopted in the arrangement of his anthropological collection exhibited in the East London Museum. The paper contained three divisions, viz. Psychological, Ethnological, and Prehistoric. The author's object had been, during the twenty years he had been occupied in forming the collection, to select the specimens not so much for their rarity or beauty as for their utility in illustrating the succession of ideas by which the minds of men in a primitive condition of culture had progressed from the simple to the complex. Contrary to the usual system of arrangement, which was geographical, and was to be found in most ethnographical museums, the author's primary arrangement had been guided by form, *i.e.* spears, bows, clubs, &c. had been placed by themselves in distinct classes; and within each class there were sub-classes for special localities, and in each of the sub-classes the specimens were arranged according to their affinities. It was shown how far the arts of existing savages might be employed to illustrate the relics of primeval men. In studying the evidence of progress, the phenomena that might be observed were (1) a continuous succession of ideas; (2) the complexity of the ideas in an increasing ratio to the time; (3) the tendency to automatic action upon any given set of ideas in proportion to the length of time during which the ancestors of the individual have exercised their minds in those particular ideas. After a lengthened elaboration of those psychological considerations Col. Fox pointed out that the forms of implements used by savage races, instead of affording evidence of their having been derived from higher and more complex forms, showed evidence of derivation from natural forms, such as might have been employed by man before he had learned the art of modifying them to his own use; and that the persistency of the forms is in proportion to the low state of culture. That conclusion was illustrated by reference to the Australian and other savage peoples. The third and concluding part of the paper was devoted to the correlation of modern implements in use among existing savages with those of Prehistoric times.—The reading of the paper was followed by an explanation of the collection, which was arranged with a view to illustrate the principle of sequence contended for by the author.

PHILADELPHIA, U.S.

Academy of Natural Sciences, Dec. 23.—Dr. Ruschenberger, president, in the chair.—Prof. Cope made some remarks on fishes from the coal measures at Linton, Ohio. He stated that Prof. Newberry, Director of the Geological Survey of Ohio, had sent to him numerous specimens of fishes and batrachians for determination and description. Among these he had discovered batrachians which were labelled and had been described as fishes (*Pygopterus scutellatus* Newb.), and fishes (*Conchiopsis* and *Peplorhina* Cope) some of which were labelled "Amphibian or Reptilian." Having determined the latter to be fishes and described them, he called attention to a note of Prof. Newberry on the latter, in which he states (1)

that *Peplorhina anthracina* is a batrachian; (2) that it is identical with *Conchiopsis exanthematicus*; (3) that *C. filiferus* is *Coelacanthus elegans*; (4) that the dentition described by him is not that of *Coelacanthus*; and that (5) the genus is the same as that described by Agassiz forty years ago as *Coelacanthus*. To these propositions Mr. Cope replied that (1) additional evidence derived from two specimens of *Peplorhina anthracina*, recently studied, confirms the view that it is a fish, which evidence is given below; (2) that neither of the two specimens exhibits in its cranial bones the characters of *C. exanthematicus*, though both sides are exhibited. They show, however, that the latter should be referred to the genus *Peplorhina*, since among other points they present the same type of teeth, which I find labelled on one of them "ova?" (3) Mr. Newberry's identification of the species *C. filiferus* with *Coelacanthus elegans* is doubtless correct; but (4 and 5) its reference (with that of similar species) to Agassiz's genus is not warranted until it is found to possess an osseous natatory bladder, and osseous ribs and the type of dentition are discovered in *Coelacanthus granulatus*, the type of the genus. The characters relied on as indicative of the reference of *Peplorhina* to the fishes, are (1) the presence of opercula like those of *Conchiopsis*; (2) the presence of jugular bones, and (3) of oval imbricated scales; (4) the absence of ambulatory limbs. The thin scutiform cranial bones, the dense patch of vomerine teeth, and the mucous ducts of the bones and scales were all ichthyic characters. As no limbs had been discovered in three specimens preserved in the appropriate regions, their nature, if existing, could not be determined at present.—Prof. Cope brought before the Academy some results derived from study of material obtained by him during the preceding summer in the Miocene formations of Colorado. He announced the discovery of the first fossil monkey of the Miocene of America, giving it the name of *Menotherium lemurinum*. He regarded it as allied to the *Tomitherium* of the Bridger Eocene, and as the representative of the more numerous group of the lemuroids, which he had discovered in the latter formation. Size, that of a domestic cat. He stated that his recent discovery of snakes, lizards, and lemurs of forms allied to those previously discovered by Prof. Marsh and himself in the Eocene of Wyoming, constituted points of affinity to the fauna of that period not previously suspected. He also observed that he had discovered some additional species of *Ruminantia* allied to the musk, and to the *Leptomeryx evansii*, which he named *Hypisodus minimus*, and *Hypertragulus calcaratus*, and *H. tricostatus*. The first was the least of the order, not exceeding a cat-squirrel in size. *Hypertragulus* differs from *Leptomeryx* in the isolation of the first premolar, as in the camels, and in the sectorial character of the penultimate premolar.—On circulatory movement in Vaucheria. Prof. Leidy made some remarks on the intracellular circulation of plants, as exemplified in the hairs of the Mullem, the leaf-cells of Vallisneria, &c. The moving streams of protoplasm he likened to amœboid movements, and expressed the opinion that they were of the same character. In the common alga, *Vaucheria*, the filaments of which consist of very long cells, comparable to those of Nitella or Chara, he had observed an apparent motion of the cell contents, which is somewhat peculiar and, at least, is not generally mentioned by writers. The wall of the cells is invested on the interior with a layer of tenacious protoplasm, containing the thinner liquid cell contents as usual. The parietal protoplasm is closely paved with green granules, and these appear very slowly but incessantly to change their position in relation with one another. The motion is so slow that it was a question for some time whether it did actually occur, but it appears sufficiently obvious if observed in relation with the lines of a micrometer, and its existence was confirmed by several friends whose attention was directed to it.

PARIS

Academy of Sciences, July 6.—M. Bertrand in the chair. —The following papers were read:—Presentation of a specimen of the photographs of an artificial transit of Venus obtained with the "photographic revolver," by M. J. Janssen.—Researches on solution, crystallisation, precipitation, and dilution, by M. Berthelot. This is a continuation of the author's important researches in thermo-chemistry. The thermal effects accompanying coagulation, the transformation of an amorphous into a crystalline substance, and the mixture of two saline liquids are now treated of. A differential method for measuring the specific heats of dilute solutions has been introduced.—On parasitism and contagion, by M. Ch. Robin.—M. Dumas made some remarks in reply to the foregoing paper.—On the spectrum of Coggia's comet, a letter from P. Secchi to the perpetual secretary. The author has observed that of the three carbon bands the green is the brightest, while in Tempel's comet the yellow was the brightest, a fact which proves that the gaseous combinations are not rigorously the same for all comets. It was further stated that at the beginning of the month only the band spectrum was visible, but now a general line of connection exists, forming a quasi-continuous spectrum through the centres of the bands. A drawing of the spectrum accompanied the paper.—On the photographic apparatus adopted by the Transit of Venus Commission: reclamation of priority; extract from a letter from Col. Laussedat to M. Dumas.—On the method of employing carbon disulphide in the treatment of vines attacked by *Phylloxera*, by M. Fouque.—In mathematical analysis:—On osculatory surfaces, by W. Spottiswoode.—Note on orthogonal surfaces, by M. E. Catalan, and Reply to the observations of M. Combescure, by M. l'Abbé Aoust.—M. Praznowski presented (through M. Janssen) a note on the helioscope. This instrument is designed by the author for diminishing the brilliancy of the sun's image by polarisation.—On the diffusion of light and the illumination of transparent bodies, by M. J. L. Soret. By examining quartz, amethyst, diamond, and other crystals, the author has concluded that the illumination of non-fluorescent transparent crystalline substances is always due to want of homogeneity.—On the formation of solar spots, by M. Tacchini. The author sees no confirmation of the cyclone theory of sun-spots in the detailed observations of the chromosphere made in Italy, America, and England. Some solar observations for June were also communicated, from which it appears that the sun was in a state of great activity during that month. On the 11th Mg. was reversed all round the sun's limb; on the 4th two double lines (4,924-5,018) were reversed on the western limb, and on the 11th they occupied nearly all that limb and encroached upon the eastern border. A great eruption took place on the 10th, when all the lines from *b* to 1,474 were seen reversed.—Researches on electric transmission through ligneous bodies, by M. Th. du Moncel. The author's experiments show that wood owes a considerable portion, if not all, its relative conductivity to moisture contained in the pores.—On the embryology of *Rhizocephalus*, by M. A. Giard. These animals constitute a Cirrhipedian group.—On the male accessory glands of some animals and on the physiological rôle of their product, by M. P. Hallez.—On the movement of the stamens of *Sparrmannia africana* L., of *Cistes* and of *Helianthemum*, by M. E. Heckel.—On the existence of diatoms in different geological formations, by M. l'Abbé Castracane. —Carboniferous limestone of the Pyrenees. Marble of Saint-Béat and of Mont (Haute Garonne), by M. F. Garrigou.—A neolithic flute, by E. Piette.—On a scab of the horse of intermittent character caused by an acarus, presenting the singular peculiarity of being psoric during winter, and simply parasitic during summer, by M. Mégnin.—Experimental researches on the action of water injected into the veins, from the point of view of pathogeny and uremy, by M. Picot.—Analyses of beers and malts, by M. Ch. Mène.—On the extraordinary hailstorm which fell in the department of Hérault during the night of June 27–28; extract from a letter from M. J. Gay to M. Ch. Sainte-Claire Deville. The loss of vines is stated to be valued at 50,000,000 francs.

CONTENTS

THURSDAY, JULY 23, 1874

THE PUBLIC SCHOOLS COMMISSION

THE claims of science to form an integral part of a liberal education are, without doubt, making progress. Readers of the early numbers of NATURE will remember how it was, with justice, complained that scarcely a single Scholarship or Fellowship was to be obtained at the old Universities for science alone. In more recent numbers the statement has to be modified—there is not yet a sufficient proportion. Now it is acknowledged on all hands, that the teaching of a subject at school and its recognition at the Universities are inseparably connected—and especially with regard to science. The Colleges say, We cannot give more scholarships, because a sufficient number of men of good attainments do not present themselves; and the Schools reply, We cannot spend our time on subjects for which there are so few rewards. Both profess willingness, but each calls on the other to take the initiative. One might, perhaps, be inclined to wonder that this question of pecuniary rewards should be of so much consequence as consciously to override the acknowledged main object in view—that of giving the best possible education. But it must be remembered that scholarships at the Universities are the honours of a school—the only means it has of showing to the world that it is doing its work well.

The progress due to the stimulus of scholarships is from these reasons slow, though perceptible; and the friends of science have been looking therefore to the Royal Commissions on Scientific Instruction, and on the Public Schools, to supply a stimulus from another quarter.

The proposed "Regulations" of the latter Commission which have just been issued will be welcomed by those who heartily wish for the progress of Science Teaching. Ignoring, of course, the question of University scholarships, they indirectly settle it by placing science on exactly the same level as mathematics, and enforcing the necessary outlay for its efficient teaching. And there can be little doubt that this is the right end at which to begin the reform, for it is a narrow view to consider the Universities as making the demand by offering rewards, and the schools as affording the supply. It is the public that demand scientifically educated men, and the schools first, and then the Universities, are called upon to supply them.

These Regulations apply, of course, to a very limited number of schools, some of which have already done much that is now required of them; but they are the most important schools in the kingdom, and will inevitably influence all others by the standard thus set. If these Regulations be confirmed the nail will be driven home, and science will be established as a necessary part of every public school curriculum.

The following are the Regulations to which we especially draw attention, and which are common to all the schools in the view of the Commission:—

"2. In every examination determining the position of a boy (not being one of the senior boys) in the school, or in any report of a general examination, the proportion of the marks to be assigned to mathematics shall be not less than one-eighth, nor more than one-fourth, as the governing body may think fit.

"3. In every examination determining the position of a boy (not being one of the senior boys) in the school, or in any report of a general examination, the proportion of the marks to be assigned to natural science shall be not less than one-eighth, nor more than one-fourth, as the governing body may think fit.

"4. In any examination for the senior boys, the proportion of the marks to be assigned to the several subjects of study shall be determined by the head master, with the approval of the governing body.

"5. The governing body shall from time to time determine the point in the school list above which the boys shall be reckoned as senior boys for the purposes of these regulations.

"6. The head master shall give facilities so far as practicable to any senior boy, at the request of his parent or guardian, to pursue any particular subject or subjects of study as may be deemed most expedient for him, and to discontinue any other subject or subjects of study for that purpose.

"7. The governing body shall, as soon as possible, provide and maintain out of the income of the property of the school, or out of any other means at their disposal for the educational purposes of the school, laboratories, and collections of apparatus, and of specimens."

It will be observed that the wording of Nos. 2 and 3 is identically the same, except the substitution of the words Natural Science for Mathematics—thus placing these two subjects upon exactly the same level. With regard to the limits one-fourth and one-eighth, taking it as approximately correct that the proportion of marks in an examination will be that of the time devoted to the subject, these two together will require at least one-fourth of the whole time, a larger proportion than is now given to mathematics in most schools, especially with those who are not "senior boys;" and thus an encroachment on the classical time is involved, and this lower limit is not likely, therefore, to be much exceeded, in these great schools at all events. But even this will insure greater breadth than under the old system, and will secure that every boy shall know something of the elements of science before he goes on to the elegancies of classics.

The individual character, however, of particular schools is not interfered with, for this depends essentially on the work of the senior boys; and for them by Regulation 4 the head master may arrange the marks to suit the old traditions of the school. Yet, when we consider the effect of Nos. 6 and 7, we may doubt whether the individuality will continue so well marked. For with laboratories to work in, and specimens to handle, and facilities to pursue their favourite subject, it is impossible but that some fair proportion of the scholars should be attracted by the charms of physical investigation or of natural history, and mix the honours of the school.

Of all the proposed Regulations, however, the most pregnant with consequences is the last.

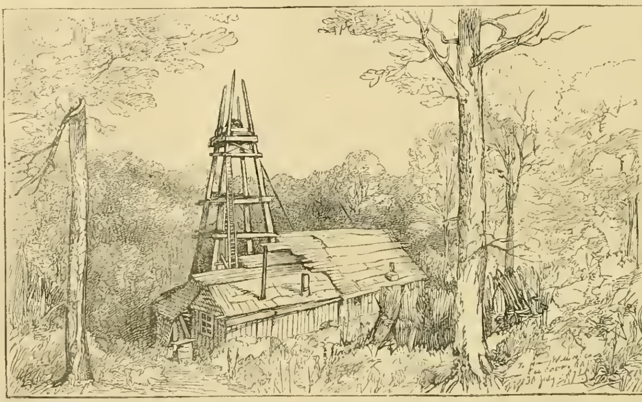
There is no need surely in these days to insist on the absolute necessity for "laboratories and collections of apparatus and of specimens," if science is to be taught at all; and we may look, therefore, on this as simply the definition of the term "Natural Science;" it is not book learning, but science learnt from Nature herself by practical work. If a governing body be called on to provide such laboratories, we may rely on it that for the credit of their school they will do it well, and a good laboratory

leaves only a good teacher to be desired, and itself helps to form and train him. The confirming of this Regulation will be a great step towards that much-to-be-desired state of things when a laboratory will be considered as necessary a part of a school as a class-room, bottles and bones as essential as books and boards. But we must not ignore what has already been done in schools like Eton and Rugby; with their laboratories and museums, such a Regulation is superfluous; but with the good work which has been accomplished before us, we have a happy omen of the result of the universal application of the principle they have voluntarily adopted. It is from these schools and others not included in the "nine," that have not fitted up their laboratories, that the Natural Science scholars are obtained, and perhaps the proportion of such scholarships to all others is as great as that of schools with laboratories to those without—probably greater. As the number of science-teaching schools increases the number of scholarships must increase too, but not at the same rate; the proper and final proportion may be left to settle itself.

On the whole we may regard these proposed Regulations with the greatest satisfaction, and it is probable that they will be looked back upon as the charter of the country's progress in scientific education. Individual efforts have been made on a grand scale, and natural science is making its way more or less efficiently into all good schools, while some are devoting themselves chiefly to its cultivation, as Taunton, Giggleswick, Burnley; but universal recognition, its acquirement of *prestige*, and consequent respect and earnest study, with the national advantages to be derived from it, can only be secured by such Regulations as these, followed or not as may be necessary, by similar ones for all the larger endowed schools.

THE SUB-WEALDEN EXPLORATION

If the word *romance* were to be imported into scientific literature there could surely be no more fitting application of it than to this recent crusade into the bowels of the earth among the woods and lanes of Sussex. Down in that southern part of the country, some hundreds of



The Sub-Wealden Exploration in Sussex—Boring at Netherfield. (Kindly lent by the Proprietors of the *Graphic*.)

miles away from the great centres of our mineral industry, with no prospect of any pecuniary reward or of any immediate economic advantage, men are found willing to subscribe money to the extent of thousands of pounds for the purpose of settling definitely some important questions in the geology of the south-east of England, viz. at what depth from the surface the secondary strata are underlain by a ridge or platform of old Palæozoic rocks, what are the nature and age of these bottom rocks of the district, and what is the arrangement of the strata lying between them and the surface. It has long been a problem of much interest to geologists to discover whether or in what manner the great series of Jurassic rocks, which stretches across our island from the coasts of Dorsetshire to those of Yorkshire, passes south-eastward underneath the chalk. That series has been found to grow thinner towards the south-east. On the French side of the Channel it reappears in the Boulonnais, coming out from under the Cretaceous strata and resting against a ridge of Palæozoic rocks which rise to the surface between Boulogne and Calais. Nearly twenty years ago Mr. Godwin Austen drew attention to the probable extension of this ridge underneath the later formations of the south-east of England and its connection with the Carboniferous tracts in our south-western counties. It was a point of great interest in any attempt to reconstruct a map of the physical geography of western Europe during Palæozoic times. Hence, at intervals since the publication of Mr. Austen's great memoir, renewed attention has been given to the subject, until at last the idea took shape that a bold attempt should be made to settle some portion at least of the problem by putting down a bore and keeping it going, if possible, until all the Secondary rocks should be pierced and definite information should be obtained as to what lies below them. Advantage was taken of the meeting of the British Association at Brighton in 1872 to organise the scheme. For so purely scientific a project it was of course natural to look for help mainly to such well-wishers

to science as attend the Association meetings, rather than to the general public. Subscription lists were opened and money came in, not in overflowing abundance indeed, but yet in quantity sufficient to enable the operations to be begun. Further donations have been given, and the work has now been carried down to a depth of more than 1,000 ft.

It would be a great misfortune to science if this undertaking, after having been successfully carried so far, were now to be brought to an abrupt close for want of funds. Already the boring has put us in possession of some new and important facts in the geology of the south-east of England. It has shown that the well-known Kimmeridge clay stretches underneath the later Secondary rocks as a deep massive formation, some 700 ft. in thickness, and that it lies upon and appears to pass down into the Oxford clay without the intervention of the sandy and calcareous beds which usually separate the two deposits. The geological position of these clays is settled by means of the fossils, of which literally thousands have been taken out of the 2-in. core of rock brought up by the diamond-boring machine. It is intended, we believe, to sort the specimens and distribute them among different public museums. How much further the bore must be sunk before the remainder of the Secondary strata is pierced, to what horizons these strata will be assignable, and what will be their basement rocks, are the parts of the problem still to be solved.

Though undertaken chiefly in the interest of pure science, the project has likewise its economic aspects. It is eminently desirable to know whether any minerals of value lie among the Secondary rocks of the south of England, such as iron-stone, rock-salt, or gypsum; whether among the Palæozoic rocks underneath there is any possibility of obtaining workable coal or any of the other minerals which have made the Carboniferous formations so valuable a source of our wealth. It is likewise greatly to be wished that as full and accurate information as possible should be obtained regarding the nature of the rocks underneath with reference to the question of water-supply—a question which, important enough now, is certain before many years to become one of the most pressing social problems of the day.

On every ground, therefore, this most heroic attempt to provide data for settling some of these questions deserves hearty encouragement. On no account must it be allowed to come to an end till its express object is accomplished. If every well-wisher to science in this country would but send his contribution, not only would the present boring be conducted to a successful issue, but a great series of similar borings might be made all over the south of England. We understand that the Government, impressed with the interest and importance of the subject, has promised to contribute a sum of 1,000*l*. conditionally upon coal being found or on the boring being continued for another 1,000 ft. This aid will be valuable, but it evidently in the meantime does not supersede private efforts; it rather makes them more needful than ever. The undertaking is in excellent hands. Mr. Topley, of the Geological Survey, looks after its geological aspects. To Mr. Henry Willett, of Arnold House, Brighton, the zealous and indefatigable honorary secretary, the enterprise is mainly indebted for its financial progress so far. He has now appealed earnestly for further help, and to him we would urge all who take interest in these matters, and who have not already contributed, to send their donations, which, whether small or large, will at the present moment be of the most essential service. A. G.

THE SCIENCE OF PAINTING

Die Farbenlehre im Hinblick auf Kunst und Kunstgewerbe. Von Prof. Wilhelm von Bezold.

THERE are two ways of popularising science. We may take up one of its great branches and treat it so simply and clearly that even the unscientific reader may with proper attention gain some insight into the principles to which the recent great advances in science have been chiefly due; or we may take up a smaller field and treat it fully and with all its applications in everyday life. He who studies a subject by the latter method will have it constantly brought under his notice, and will thus be led to observe and perhaps to experiment, and to acquire for himself that method of looking at the phenomena of nature and reasoning about them which is necessary to the understanding of every great principle in science, but which is foreign to nearly all who have not had a scientific training.

The latter method, which no doubt will prove the most successful, has been chosen by Prof. von Bezold in his work on the theory of colours. No subject is better fitted to be treated in this way, because it is in everybody's power to make observations, and perhaps even to find out some new fact. It is, however, not the only, and not even the chief, object of the author to create merely an interest in his subject outside the scientific world. He wishes his book to be of real value to the artist and to help him by theoretical speculations to such combinations of colour as shall prove most effectual. It is very doubtful whether the book will be successful in this respect. No doubt it would be a great achievement if every artist could be induced to think about the cause of the various and curious effects which are brought about by contrast and combination of colours; we therefore recommend the careful perusal of Prof. von Bezold's book to every painter. In the present state of the theory of colours, however, the attention bestowed upon it by artists will be of greater value to the subject than to themselves. It would no doubt be injurious to art if the painter were guided in his work by a theory so long as that theory is incomplete.

Painters are, however, themselves best able to bring the theory of colours into a better state; a state in which it will be beneficial to themselves and repay them for their trouble.

Two things have chiefly struck us in Prof. von Bezold's book as adding to its value and interest. The first is the care which he has taken to give his experiments in such a way that anyone without the use of large and expensive apparatus can repeat them and test for himself the truth of the author's statements. The second is the great ingenuity with which the author explains by his theory so many of the phenomena which most of us daily observe. We note one particular instance. All who have worked much at absorption spectra must have been struck by the

change of colour which light of a certain wave-length undergoes when the intensity diminishes. Prof. von Bezold uses this curious fact to explain the peculiar colours seen in a landscape when viewed by moonlight, although the light reflected by the moon is identical in composition with sunlight.

In his account of the elementary principles of optics the author abandons the old method of dividing vibrations into heat rays, light rays, and actinic rays. We note this point as it is one which must soon play an important part in physics and will doubtless provoke much discussion. The author seems to prefer the following method of viewing the facts to the old one:—A body absorbs a certain class of rays peculiar to itself; whether these rays are converted into heat or into chemically active rays depends upon the peculiar properties of the body. In order, however, to include in this statement all the facts included in the old division, we must add that, as a rule, bodies absorbing the ultra-violet rays are thereby rendered more chemically active, and, as a rule, bodies absorbing the red are thereby heated. This method of looking at the matter seems to us to be the one most closely agreeing with the facts. Prof. von Bezold gives, as a proof that the red rays may be chemically active, the fact that, as the green colouring matter of leaves absorbs the red end of the spectrum as well as the blue, the red rays alone are sufficient to sustain life in the plant. He might have referred to the recent discovery of Vogel, who photographed the red end of the spectrum by mixing a red colouring matter with bromide of silver; and, on the other hand, to the fact observed by Budde, that chlorine is heated by the ultra-violet rays. The third chapter contains a short and clear abstract of recent researches on compound and primary colours. We would call attention specially to the passage in this chapter on colour and sound, in which the author refers to the influence of dwelling too much on the analogy between sound and light. Analogies are a very dangerous help to teachers, and are used by far too often. It requires at least a partial knowledge of the subject to see where the analogy begins and where it ends. Students generally either do not see where the analogy really lies, or want to carry it too far; a good many erroneous notions are thereby acquired.

The most interesting chapter in the book, however, is the one on Contrast of Colours; the examples are well chosen, and the coloured illustrations in the accompanying plates are in all cases convincing. The author shows with great success how little we may trust our own eyes as regards colour, and how difficult and even impossible it is to form a correct judgment of the relative darkness of two shaded fields, so long as they are not on the same ground.

The last chapter, which treats of the combination of colours, is necessarily the least complete; it shows, however, that the application of the theory to the arts has fairly begun. It has already been said that this beginning does not justify us in demanding from painters obedience to rules which have not been proved to be valid without exception. It may be easy to discover the application of these rules in acknowledged masterpieces, and yet be difficult to state them in such an exhaustive way that compliance with them will in all cases lead to perfect harmony. So long as this is not done it must not be expected that the painter will derive substantial help from the theory of colours.

ARTHUR SCHUSTER

OUR BOOK SHELF

Illustrations of the Principal Natural Orders of the Vegetable Kingdom. Prepared for the Science and Art Department of the Council of Education. By Prof. Oliver, F.R.S., F.L.S. (London, Chapman and Hall, 1874.)

FEW books published of late years will be of greater practical value to the botanical teacher or student than this. The want has long been painfully felt of a work which will give in as few words as possible the salient characters of each of the more important natural orders, unencumbered by minutiæ of structure which concern only the more advanced student. This want we have here most admirably supplied, not only by 150 pages of text, but by upwards of 100 plates, which present in the most lucid form a representation (plain or coloured, as may be preferred) of a section and "diagram" of a flower belonging to many orders, together with a drawing of the fruit, seed, or other organ the structure of which is of special importance. The very comprehensive title of the work might, unless the contrary is pointed out, lead to a little disappointment, when it is found that the descriptions, and still more exclusively the plates, refer almost entirely to the more important *European* orders; very brief accounts, or in some cases none at all, being given of such remarkable extra-European groups as the Cycadeæ, Gnetaceæ, Proteaceæ, Bignoniaceæ, Piperaceæ, and others. As far as European botany is concerned, we cannot conceive that the work could have been better carried out. The plan which has been adopted of treating separately groups which are united together into a single order in our more advanced text-books—as for instance Fumariaceæ as distinct from Papaveraceæ; Oxalideæ and Tropæolaceæ from Geraniaceæ, and Droseraceæ from Saxifragaceæ—seems to us altogether commendable in a work designed especially for beginners. There has long been felt a desire that in text-books of botany the morphological and physiological portion should be divorced from the systematic and descriptive. We trust that in future this may be carried out, and that writers of text-books will confine themselves to the former branch, leaving the student to gain his elementary knowledge of the latter branch from special works like the one before us.

A. W. B.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Photographic Irradiation

IN answer to Mr. Ranyard (NATURE, vol. x. p. 205), I have to state that the opaque bar in my experiments was placed as close to the collodion as possible without touching it, not farther than ·01 in. from it, and that there were no photographic traces of diffraction bands.

Allow me now to suggest a possible explanation of the different results given by Mr. Ranyard's and my own experiments. One important difference in the arrangement of the two experiments was, that in the one case the opaque bar was in contact with the collodion, and in the other case it was placed at a very short distance from it. In the experiments with the bar in contact with the collodion, the nitrate of silver solution on the surface of the plate would not form a true plane but would be curved upwards at the edge of the bar; and further, this curve would not be regular, but would have irregularities corresponding to every irregularity in the edge of the bar. This irregular curved fluid surface would cause irregular refraction of the light

falling at the edge of the bar, and would give rise to bright and dark parts on the sensitive surface; the bright parts would be extended by molecular irradiation underneath the opaque bar, and would give rise to the irregular brushlike projections mentioned by Mr. Ranyard, instead of the uniform extension obtained when the bar is kept a short distauce from the collodion. It is also possible that the irregular curved fluid surface may at certain points, where the bar was not in actual contact with the collodion, have bent the rays of light underneath the bar and given rise to the irregular extension of the image. JOHN AITKEN

Darroch, Falkirk, July 18

I MUST confess myself at issue with Mr. Stillman as to the result of his experiment with the strip of blackened wood laid upon the collodion film. I have tried a similar experiment, and find the images of bright objects sharply cut off. Even with a film of four thicknesses of collodion and an exposure of ten minutes, I cannot detect the smallest encroachment. The minute brushes mentioned by me in my last week's letter only occasionally occur, and appear to be due to a circulation in the liquid film beneath the opaque object, probably caused by some chemical impurity, for I notice that the brushes only occur when the film beneath the opaque object is soiled.

It cannot be argued that because there is a difference in the amount of irradiation in two pictures taken by different processes (instruments, exposures, and other conditions being similar), that therefore the spreading action must take place within the film, for the plates prepared by the two processes may not be equally sensitive, and the pictures may really correspond to what, with the same process, would be different amounts of exposure. Or again, the relative rates at which faint and intense light imprint themselves in the two processes may differ. Want of sensitiveness to the action of faint light is, I imagine, the reason why irradiation is apparently decreased by the use of the red collodion. A. COWPER RANYARD

Vapourising Metals by Electricity

IN a paper in NATURE (vol. x. p. 190) Mr. H. Hopkins gave a short description of some experiments on vapourising metals by electricity between two microscopic slides, and said that the layer thus produced can be investigated by a microscope, and employed in various ways to determine the character of the metal.

But the author did not point out the *wonderful drawings* shown by the layer, chiefly when a slight gold sheet is used.

This fact, very interesting in connection with molecular vibrations, has been illustrated by Prof. Magrini in a lecture delivered at the Museum of Florence, some years ago, and translated in *La Revue Scientifique* (t. iv. p. 770), with some woodcuts prepared by Prof. Magrini himself.

A. RODIER

Earth-shrinkings and Terrestrial Magnetism

IN my previous letter (vol. ix. p. 201) I gave some reasons for believing that the earth is shrinking chiefly about its equatorial region, and is being thrust out in the direction of the Poles, and that the distribution of this force may be correlated with that of terrestrial magnetism. As this view is somewhat novel and revolutionary, and if true will lead to considerable modification of the theories generally held on cosmical forces, I wish to support it by some other considerations.

I must predicate, as to a great extent proved, that volcanoes are not found in areas of upheaval. On this point I think the evidence is conclusive, and as I have previously written about it I shall not again enlarge upon it. I must predicate also that the earth as a whole is shrinking. This I tried to show in my previous letter. It follows from these facts that the large areas we know to be rising must be compensated by larger areas that are sinking, and that we may in a measure map these latter areas out by mapping out volcanoes; for, *ex hypothesi*, they occur either in areas of depression or along the border lines of the oscillating land.

Thus occurring, and themselves with the related phenomena of earthquakes, being the most vigorous proofs we have of the mobility of the earth's crust, we may predicate further that they will be found most actively at work where movements of the earth are most vigorously active, and that where they are liberally scattered, there the earth's crust is the most yielding. Now if we examine the distribution of volcanoes from this point of view we shall find that our main position is amply supported. Within the Arctic circle there is only one volcano, so far as we know—that of Jan Mayen. Within the Antarctic there is not one. North of the 60th degree of north latitude we have the volcanoes of Iceland, and three or four in Alaska, and these only. South of the 60th degree of south latitude we have Mount Erebus and its companions in the South Shetlands, and these only. Between the parallels of 40 and 60 the number of volcanoes increases considerably. In the northern hemisphere they probably number over sixty; but the vast majority of these are contained in the semicircular line of volcanoes formed by the Kurile and Aleutian Islands, and which crown that vast area of depression, the Pacific Ocean. In the southern hemisphere we still have exceedingly few, perhaps not more than a dozen, and these along the line of the Andes. It is in the region bounded on the north and south by the 40th parallels of latitude that we find volcanoes distributed in the greatest profusion, and the focus of distribution is even more narrow than this, for it may be bounded in fact by the 20th parallel on each side of the Equator. It is here we have that region described by so many writers in graphic terms, the Eastern Archipelago, with its 109 volcanoes in active operation. "From Papua to Sumatra, every large island," says M. Reclus, "including probably the almost unknown tracts of Borneo, is pierced with one or more volcanic outlets. There are Timor, Flores, Sumbawa, Lombok, Bali, and Java, which last has no less than 45 volcanoes, 28 of which are in a state of activity, and lastly the beautiful island of Sumatra. Then to the east of Borneo, Ceram, Amboyna, Golola, the volcano of Ternata, sung by Camoens, Celebes, Mundanao, Mendora, and Luzon; these form across the sea, as it were, two great tracks of fire." (Reclus, "The Earth," 498.) Here also is that wonderful congeries of Pacific volcanoes described by the same graphic author. "The volcanoes of Abrim and Tauna, in the New Hebrides, Turahoro, in the Archipelago of Santa Cruz, and Semoya in the Salomon Islands, succeeding one after the other, connect the knot of the Feejees to the region of the Sunda Islands, where the earth is so often agitated by violent shocks. This region may be considered as the great focus of the lava-streams of our planet." It is within the same narrow limits also that we have the most active signs of movement in the Atlantic basin, namely, in the Little Antilles group of the West India Islands. In regard to the two regions last mentioned, there is a fact remarkably confirming the general position I argued in favour of in a previous letter, namely, that volcanoes are indicative of areas of depression, and which was unknown to me when I wrote it. M. Reclus says—"It is a remarkable fact that the two volcanic groups of the Antilles and the Sunda Islands are situated exactly at the Antipodes one of the other, and *also in vicinity of the two poles of flattening, the existence of which on the surface of the globe has been proved by the recent calculations of astronomers.* (Op. cit., p. 503.)

These facts seem to me to support very strongly my contention that the earth is shrinking chiefly in its equatorial region. Volcanoes are in my view the mediate and not the immediate results of the shrinking of the earth; earthquakes on the contrary are its immediate result. There is considerable difficulty in mapping out a chart of their frequency and intensity, but we may say safely that such a chart would have a deeply-coloured zone in the equatorial regions, that it is there where earthquakes and especially submarine earthquakes chiefly abound, and abound also in their more vigorous type. This can only be if that area is also the chief area of disturbance of the earth's crust. Another fact which points in the same direction is that discussed by Bischof, namely, that the soundings in the greater oceans increase as we near the equator, this increase taking place relatively to the land masses and not being merely due to the bulging out of the water in those parts by the force of attraction. So that if we accept the level of Africa or the Pampas of Brazil as a mean we shall find the greatest pits and hollows in the crust in the equatorial region.

In regard to the connection of this earth-shrinking with terrestrial magnetism, I wish to quote one or two paragraphs from Dr. Zollner's paper in the "Philosophical Magazine" on the origin of the earth's magnetism, to the conclusions of which, however, I cannot in any way assent. I quote him on the subject of the correlation of earthquakes with magnetic disturbances. He is quoting from Mr. Lamont's work.

"Kreil has given many cases," he says," where magnetic disturbances coincided with earthquakes; hence he thinks—con-

nection between the two phenomena probable. I have observed myself an extremely curious case in this respect on April 18, 1842; at 9.10 A.M., I saw by chance that the needle of the declination instrument received a sudden jerk so that the scale was pushed out of the field of view of the telescope. The oscillations continued for some time; at last the ordinary tranquillity was restored. After some days I received the news from Colla, in Parma, that he had observed violent oscillations of the needle, and comparisons showed that the movement had begun at the same moment in Parma as in Munich. A short time after, the report of a French engineer was published, on a violent earthquake which he had observed in Greece; and now it was found that the earthquake had taken place in the same minute in which the oscillations of the needle had been observed in Parma and Munich. This, together with the many cases collected by Kreil and Colla, leaves scarcely any doubt as to the presence of a close connection; but it is undecided whether one phenomenon is the consequence of the other, or whether they both come from the same source. The same connection between earthquakes and magnetic disturbances was observed by Lamont at the earthquake which took place in Greece in December 1861. He communicates his observations to *Poggendorff's Annalen* (vol. cxv. 176) in the following words: "As the connection of the magnetism of the earth with earthquakes still belongs to the insufficiently ascertained relatives, it will not appear irrelevant if I communicate a fact bearing upon this question. On December 26, 1861, at 8 o'clock A.M., when I took down the position of the magnetical instruments (some of which are put up in the magnetical observatory, viz. two for declination, two for intensity, and two for dip), I observed in all the instruments an uncommon restlessness, consisting in a quick and irregular decrease and increase in the declination, and at the same time a trembling in the vertical direction. The trembling of the needle only lasted for a short time, but the quick changes lasted until 8.30 o'clock with gradually increasing violence. Some days later the news was received of an earthquake which, exactly coincident with the above observations, had caused great destruction in many parts of Greece." (Philosophical Magazine, June 1872.) This goes far to show that terrestrial magnetism it to be correlated with the force which is shrinking the earth. HENRY H. HOWORTH

COLLIERY EXPLOSIONS

IT is astonishing that, notwithstanding the many generations during which coal-mining has been carried on in this country, so comparatively little has been done to investigate scientifically the causes of explosions in coal-mines, and thereby discover an antidote to a constantly recurring danger, one which adds considerably to the yearly bills of mortality, and still more to the number of widows and orphans. No doubt a considerable proportion of these sad accidents is owing to the carelessness of miners themselves, but very many are, without doubt, also due to ignorance, on the part of all concerned, of the conditions under which coal-mining must be carried on. Only the other day a melancholy tale of death and widespread mourning comes from Wigan—fifteen men killed, leaving behind them at least thirty-one persons destitute of the means of gaining a livelihood. We are afraid that the frequency of such accidents has made the public somewhat callous in the matter; but a little consideration must show the vast importance of acquiring a thorough knowledge of the conditions under which they may happen. To this end the paper recently read before the Royal Society by Mr. William Galloway, Inspector of Mines, is an important contribution; and we hope that the author and others who are competent will continue their investigations until, if explosions cannot be prevented, they may at least be foreseen and provided against.

The opinions promulgated by Sir Humphry Davy and the eminent Colliery Viewers who were his contemporaries, regarding the security afforded by the use of the safety-lamp, have been accepted with hesitation by many of their successors during the last twenty or thirty years; and this is not to be wondered at when we consider the large number of disastrous explosions by which thousands of lives have been lost in mines in which these lamps were in constant use. The illustrious inventor himself had discovered and pointed out, that if the lamp were exposed to the action of an explosive current, the flame might pass through the meshes of the wire-gauze and so originate an explosion; but when in good order it was considered to be safe under all other circumstances, until the experiments were made which form the subject of Mr. Galloway's paper.

At first, and for many years after the introduction of the safety-lamp, the cause of nearly every explosion was attributed to carelessness on the part of the workmen using it; then it was observed that a quantity of firedamp, sufficient to render some of the air-currents explosive, was sometimes suddenly given off by the strata, and these "outbursts of gas," as they are called, were assumed, in the absence of any other explanation, to have caused many explosions. On Dec. 12, 1866, however, the great explosion took place at the Oaks Colliery; as it was known to have happened simultaneously with the firing of a heavily-charged shot in pure air attention was drawn to the coincidence; and it appears that some search has usually been made for evidence of recent shot-firing in mines in which explosions have occurred since that date. Accordingly we find from the reports of the Inspectors of Mines that shot-firing was carried on in seventeen out of twenty-two collieries, at which important explosions have happened since Dec. 12, 1866; safety-lamps were certainly used in twelve of these collieries, and probably in the whole seventeen; in eight cases it was ascertained that a shot had blown out the tamping at or about the time of the explosion; in two an empty shot-hole was found from which it was supposed the tamping had been blown; in three a shot had been fired, bringing down the coal or rock; lastly, there were five collieries at which two or more explosions took place simultaneously, in different parts of the mine unconnected by a train of explosive gas. The Seaham explosion was a remarkable one; a heavily charged shot was fired in pure air in one of the in-take air-courses, and, according to the statement of three men who survived, the explosion of firedamp followed the shot immediately.

Two methods of accounting for the simultaneousness of the explosion of firedamp with the firing of the shot have been suggested in the reports of the Inspectors of Mines: one of them supposes that the firedamp has been ignited directly by the shot; the other that the concussion of the air caused by the explosion of gunpowder dislodges gas from cavities in the roof and from grooves, and that this gas passing along in the air-currents is ignited at the lamps of the workmen. In some instances when it has been known to be highly improbable that any gas existed nearer to the shot-hole than 10, 20, or even 40 ft., the advocates of the former hypothesis have taken it for granted that the gases issuing from the shot-hole were projected through the air as far as the accumulation of firedamp, retaining a sufficiently high temperature to ignite it on their arrival. On the other hand the advocates of the latter hypothesis have not attempted to show how the gas, which they assumed could be dislodged in quantity by a sound-wave and its reflections, could be ignited in those cases in which safety-lamps only were used. It is no doubt highly probable, however, that when once an explosion of firedamp has been initiated in one way or another, and large bodies of air are driven through the passages of a mine with great velocity, explosive accumulations will be dislodged from cavities and grooves and pressed through the safety-lamps with the velocity requisite to pass the flame.

In the beginning of the year 1872 Mr. Galloway first thought it probable that a sound-wave originated by a blown-out shot, in passing through a safety-lamp burning in an explosive mixture, would carry the flame through

the meshes of the wire-gauze in virtue of the vibration of the molecules of the explosive gas. An explosion which took place at Cethin Colliery in 1865 is a good example of one that may have been caused in this way. Several days after the explosion the safety-lamp of the overman was found securely locked and uninjured, lying at a distance of a few yards within an abandoned stall which was known to have contained firedamp. Shot-firing was carried on in this mine, and it is not improbable that a sound-wave from an overcharged or blown-out shot had passed through this lamp and ignited the explosive mixture shortly after the overman had entered it; moreover, the Inspector of Mines in his report says he has no doubt that the gas in this state was ignited and was therefore the origin of the explosion, but he is unable to state by what means it was fired.

A number of experiments were made by Mr. Galloway in connection with this subject; the cost of apparatus, &c., was provided for by the liberality of the Government Grant Committee of the Royal Society.

The first experiment was made on Jan. 16, 1872, in the physical laboratory of University College, London. A sheet of wire-gauze 1 ft. square was inclined at an angle of 70° and a slow current of gas and air from a Bunsen-burner was directed against its lower surface; part of the explosive mixture passed through the meshes, and when ignited produced a flat flame 3 in. long by 1 in. wide about the middle of the upper surface of the wire-gauze. A glass tube 3 ft. 4 in. long by about $3\frac{1}{2}$ in. diameter was placed horizontally with one end opposite to the flame on the same side of the wire-gauze and distant from it about $1\frac{1}{2}$ in. At the other end of this tube a sound-wave was produced by the explosion of a mixture of coal-gas and oxygen contained in soap-bubbles. When the sound-wave passed through the tube the flame was carried through the meshes of the wire-gauze and ignited the gas issuing from the Bunsen-burner on the other side.

Some experiments similar to the first were made in one of the laboratories of the Royal College of Chemistry in Dec. 1872. The glass tube was replaced by a tin-plate tube about 20 ft. long by 2 in. diameter: paper and other diaphragms were inserted at a distance of 10 ft. from the origin of disturbance to insure that only a sound-wave was propagated through the tube. The results were the same as before.

Two sets of apparatus, a larger and a smaller, were then constructed; in both the sound-wave of a pistol-shot is conveyed through tin-plate tubes to a distance of about 20 ft., then it passes through a safety-lamp burning in an explosive mixture. In the smaller apparatus the tube is 3 in. in diameter; one end is closed by a disc of wood with a hole in the middle large enough to receive the muzzle of a pistol; at a distance of 10 ft. from the disc there is a diaphragm of sheet india-rubber, and at the farther end is a safety-lamp with gas-flame. At the bottom of the safety-lamp there is a circular chamber with holes round about from which gas can be made to escape, and when this gas, rising up, mixes with the air it forms an explosive mixture surrounding the wire-gauze cylinder. The pistol by means of which the sound-wave is produced is charged with ·205 gramme of gunpowder, and a tamping paper is rammed down well upon the charge. When the shot is fired through the hole in the wooden disc, while the explosive mixture surrounds the lighted safety-lamp, the flame is instantly carried through the meshes by the vibration, and ignites the gas on the outside. In the larger apparatus the tube is 8 in. in diameter, and 21 ft. long; at one end there is a wooden disc as before; at 20 ft. from the disc there is a sheet india-rubber diaphragm, and the extreme end is closed by a sheet of thin paper tied over it. Part of the last 12 in. (thus isolated from the rest of the tube and from the exterior) is enlarged sufficiently to hold a safety-lamp, and it is provided with an inlet below for air or air and gas, and a chimney above for the sake of the products of combustion. A lighted Davy or Clanny lamp of ordinary construction having been placed in this space, gas is made to mix with the air which flows up through it in consequence of the draught caused by the lamp: the appearances presented by the flame are observed through a small glass window, and when they indicate that the air is explosive the shot is fired. The flame within the safety-lamp is passed through the meshes, explodes the mixture in the isolated space, blowing out the paper end, and, passing backwards through the inlet, ignites the gas where it first mixes with air. In this case the shot consists of ·41 gramme of gunpowder tamped as before.

The lamps that were tested in this apparatus are those known as the Davy, Clanny, Stephenson, Mueseler, and Eloin. The flame was easily passed through the Davy lamp, with rather more difficulty through the Clanny, and not at all through any of the others.

The first experiments with these two sets of apparatus were made in January and February 1873, at the Meteorological Office, where Mr. Scott most kindly provided accommodation: the experiment with the smaller apparatus was shown at the Royal Institution, by Mr. Spottiswoode, on the evening of Jan. 17; and afterwards at one of the Cantor Lectures of the Society of Arts, by the Rev. Arthur Rigg. The next experiments were made in No. 7 Pit, Barleith, near Glasgow, with firedamp from a blower, but the flame could not be passed through the safety-lamps on account of the impurity of the gas, which contained only 75·86 of light carburetted hydrogen. The last experiments were made in the C Pit of Hebburn Colliery, near Newcastle-on-Tyne, also with firedamp from a blower, and as the firedamp was very explosive, the flame was easily passed through the Davy-lamps of each apparatus.

After this, experiments were made on a larger scale in part of a new sewer in North Woodside Road, Glasgow. The sewer is ovoid in section; it is 6 ft. high and 4 ft. wide at its greatest dimensions; part of it is a tunnel in the solid rock, part is built in brickwork through surface-drift. The gas safety-lamp of the smaller apparatus was placed on a board fixed across the sewer at a height of 2 ft. 8 in. from the bottom, and surrounded with an explosive mixture of coal-gas and air in the same way as when it was used in connection with the tin-plate tubes. Shots were fired from a pistol at certain distances from the lamp (the details of the distances and the charges required to pass the flame in the paper and sections of the sewer are given in the plates which accompany it). One hundred and nine feet was the greatest distance available in the part built of brick, and at this point a sound-wave of sufficient intensity to pass the flame was produced by firing a charge of 3·882 grammes = 59 grains of gunpowder. At 96 ft. from the lamp a charge of 3·276 grammes was required when the sound-wave passed through the brickwork tunnel all the way, and 2·184 grammes when it passed through the tunnel in the solid rock. These experiments seem to be perfectly conclusive.

Mr. Galloway's discovery—that when the vibration of the air which constitutes a sound-wave has a certain amplitude, it can transmit flame through the wire-gauze of the Davy and Clanny lamps—furnishes an additional argument against retaining these lamps in use, at least in the hands of ordinary workmen. On Dec. 15, 1815, Davy said he was convinced that, as far as ventilation was concerned, the resources of modern science had been fully employed; he then proceeded to describe a "safety lantern," which is identical in principle with the Stephenson lamp, and is extinguished in an explosive mixture (Phil. Trans. 1816, p. 2). This "safety lantern" was afterwards discarded in favour of the Davy lamp proper, the principal advantage of which was stated to be that it would not only preserve the col-

lier from the firedamp, but enable him to apply it to use, and destroy it at the same time that it gave him a useful light (Phil. Trans. 1816, pp. 23 and 24). Fortunately the ventilation of mines is now better understood than it was in the days of Davy, and the quantities of air employed are usually very much greater. It is certain, however, that in some mines of the present day the ventilation could be doubled or trebled with advantage; and since this is merely a matter of expense it may be asked why it is not done, when it would ensure comparative immunity from danger? On the other hand it is now almost universally admitted to be highly dangerous to continue work in an explosive atmosphere, so that safety-lamps should be used only as a precaution against possible outbursts of gas or when work is carried on in the neighbourhood of gas that cannot be easily dislodged; it is evident, therefore, *primâ facie*, that lamps constructed on the principle of the "safety-lantern," such as the Stephenson, Mueseler, &c., which are extinguished in an explosive mixture, are far safer than lamps like the Davy or Clanny, which continue to burn under the same circumstances, and are then liable, at any instant, to have the flame driven through the wire gauze and communicated to the external explosive atmosphere.

THE COMET

[The following letter appeared in last Thursday's *Times*, from the columns of which journal it is reproduced, with a few verbal alterations.]

I WAS enabled on Sunday night (12th inst.), by Mr. Newall's kindness, to spend several hours in examining the beautiful comet which is now visiting us, by means of his monster telescope—a refractor of 25 in. aperture, which may safely be pronounced the finest telescope in the world, or, at all events, in the Old World.

The view of the comet which I obtained utterly exceeded my expectations, although I confess they were by no means moderate; and as some of the points suggested by the observations are, I think, new, and throw light upon many recorded facts, I beg a small portion of space in the *Times* to refer to them, as it is important that observers should have their attention called to them before the comet leaves us.

I will first deal with the telescopic view of the comet. Perhaps I can give the best idea of the appearance of the bright head in Mr. Newall's telescope, with a low power, by asking the reader to imagine a lady's fan opened out (160°) until each side is almost a prolongation of the other. An object resembling this is the first thing that strikes the eye, and the nucleus, marvellously small and definite, is situated a little to the left of the pin of the fan—not exactly, that is, at the point held in the hand. The nucleus is, of course, brighter than the fan.

Now, if this comet, outside the circular outline of the fan, offered indications of other similar concentric circular outlines, astronomers would have recognised in it a great similarity to Donati's beautiful comet of 1858 with its "concentric envelopes." But it does not do so. The envelopes are there undoubtedly, but, instead of being concentric, they are excentric, and this is the point to which I am anxious to draw attention, and, at the risk of being tedious, I must endeavour to give an idea of the appearance presented by these excentric envelopes. Still referring to the fan, imagine a circle to be struck from the left-hand corner with the right-hand corner as a centre, and make the arc a little longer than the arc of the fan. Do the same with the right-hand corner. Then with a gentle curve connect the end of each arc with a point in the arc of the fan half-way between the centre and the nearest corner. If these complicated operations have been properly performed the reader will have superadded to the fan two ear-like things, one on each side. Such "ears," as we may for convenience call them, are to be observed in the comet, and they at times are but little dimmer than the fan.

At first it looked as if these ears were the parts of the head furthest from the nucleus along the comet's axis, but careful scrutiny revealed, still in advance, a cloudy mass, the outer surface of which was regularly curved, convex side outwards, while the contour of the inner surface exactly fitted the outer outline of the ears and the intervening depression. This mass is at times so faint as to be invisible, but at other times it is brighter than all the other details of the comet which remain to be described, now that I have sketched the groundwork. These details consist of prolongations of all the curves I have referred to backwards into the tail.

Thus, behind the bright nucleus is a region of darkness (a black fan with its pin near the pin of the other pendant from it, and opened out 45° or 60° only will represent this), the left-hand boundary of which is a continuation of the lower curve of the right ear. The right-hand boundary is similarly a continuation of the lower curve of the left ear. Indeed, I may say generally—not to enter into too minute description in this place—that all the boundaries of the several different shells which show themselves, not in the head in front of the fan, but in the root of the tail behind the nucleus, are continuous in this way—the boundary of an interior shell on one side of the axis bends over in the head to form the boundary of an exterior shell on the other side of the axis.

At last, then, I have finished my poor and, I fear, tiresome description of the magnificent and truly wonderful sight presented to me as it was observed, on the whole, during some hours' close scrutiny under exceptional atmospheric conditions.

I next draw attention to the kind of change observed. To speak in the most general terms, any great change in one "ear" was counterbalanced by a change of an opposite character in the other; so that when one ear thinned or elongated, the other widened; when one was dim, the other was bright; when one was more "pricked" than usual, the other at times appeared to lie more along the curve of the fan and to form part of it. Another kind of change was in the fan itself, especially in the regularity of its curved outline and in the manner in which the straight sides of it were obliterated altogether by light, as it were, streaming down into the tail.

The only constant feature in the comet was the exquisitely soft darkness of the region extending for some little distance behind the nucleus. Further behind, where the envelopes of the tail were less marked, the delicate veil which was over even the darkest portion became less delicate, and all the features were merged into a mere luminous haze. Here all structure, if it existed, was non-recognisable, in striking contrast with the region round and immediately behind the fan.

Next it has to be borne in mind that the telescopic object is after all only a section, from which the true figure has to be built up, and it is when this is attempted that the unique character of this comet becomes apparent. There are no jets, there are no concentric envelopes; but, as I have said, in place of the latter, excentric envelopes indicated by the ears and their strange backward curvings, and possibly also by the fan itself.*

I prefer rather to lay the facts before observers than to state the conclusions to be derived from them, but I cannot help remarking that, supposing the comet to be a meteor-whirl, the greatest brilliancy is observable where the whirls cut or appear to cut each other; where we should have the greatest number of particles, of whatever nature they may be, in the line of sight; and not only so,

* By describing three parabolas on a card and spinning the card rapidly round a line not coincident with their common axis, I have been able to reproduce roughly the appearances figured last week and described above. —J. N. L.

but regions of greatest possible number of collisions associated with greatest luminosity.

It would be a comfort if the comet, to partly untie a hard knot for us, would divide itself as Biela's did. Then, I think, the whirl idea would be considerably strengthened. I could not help contemplating the possibility of this when the meaning of the "ears" first forced itself upon my attention.

The spectroscopic observations which I attempted, after the telescopic scrutiny, brought into strong relief the littleness of the planet on which we dwell, for a seven hours' rail journey from London had sufficed to bring me to a latitude in which the twilight at midnight was strong enough to show the middle part of the spectrum of the sky, while to the naked eye the tail of the comet was not so long as I saw it in London a week ago.

I had already in observations in my own observatory, with my $6\frac{1}{4}$ in. refractor (an instrument smaller than one of Mr. Newall's four finders!) obtained indications that the blue rays were singularly deficient in the continuous spectrum of the nucleus of the comet, and in a communication to NATURE I had suggested that this fact would appear to indicate a low temperature.

This conclusion has been strengthened by Sunday night's observations, and it was the chief point to which I directed my attention. The reasoning on which such a conclusion is based is very simple. If a poker be heated, the hotter it gets the more do the more refrangible—*i.e.* the blue—rays make their appearance if its spectrum be examined. The red colour of a merely red-hot poker and the yellow colour of a candle-flame are due, the former to an entire, the latter to a partial, absence of the blue rays. The colour, both of the nucleus and of the head of the comet, as observed in the telescope, was a distinct orange yellow, and this, of course, lends confirmation to the view expressed above.

The fan also gave a continuous spectrum but little inferior in brilliancy to that of the nucleus itself; while over these, and even the dark space behind the nucleus, were to be seen the spectrum of bands which indicates the presence of a rare vapour of some kind, while the continuous spectrum of the nucleus and fan, less precise in its indications, may be referred either to the presence of denser vapour, or even of solid particles.

I found that the mixture of continuous band spectrum in different parts was very unequal, and further that the continuous spectrum changed its character and position. Over some regions it was limited almost to the region between the less refrangible bands.

It is more than possible, I think, that the cometary spectrum, therefore, is not so simple as it has been supposed to be, and that the evidence in favour of mixed vapours is not to be neglected. This, fortunately, is a question on which I think much light can be thrown by laboratory experiments.

J. NORMAN LOCKYER

Mr. Newall's Observatory, Ferndene, Gateshead

P.S.—(By Telegraph.)—Wednesday night.—Sunday's observations are confirmed. The cometary nucleus is now throwing off an ear-like fan. Ten minutes' exposure of a photographic plate gave no impression of the comet, while two minutes' gave results for the faintest of seven stars in the Great Bear.

THE FORMS OF COMETS *

I.

A FEW years ago astronomers studied comets almost solely to determine their movements. So little advance had been made in the study of the figures of these bodies, that M. Arago believed himself justified in stating in his "Astronomie populaire:"—"'I don't know' will still be the reply we have to make to questions asked concerning the tails of comets." If I venture to take as the principal subject of this lecture the researches which I have undertaken during recent years in this difficult subject, I hope to disarm criticism beforehand by at once declaring that the results contrast singularly, by their imperfection, with the degree of power and of certainty we admire in the other more ancient branches of astronomy.

The reason of this contrast is very simple. While planetary astronomy received the precious heritage of the science of the Greeks and the treasury of observations bequeathed by the highest antiquity, cometary astronomy finds in the archives of history observations travestied by superstitious terror. One of the strongest prejudices of previous centuries was that which attributed to the stars a mysterious influence on our destinies. And comets, by their unforeseen appearance in the midst of the familiar constellations, their monstrous heads, their gigantic tails, were calculated to inspire a sort of apprehension which judicial astrology, that long infirmity of the human mind, did not fail to interpret as menacing presages; and as catastrophes have not been wanting in every period of our history, the singular sophism, *post hoc, ergo propter hoc*, so natural to our poor logic, helped to confirm ten or twelve times in a century this miserable superstition.

Did a comet appear in the heavens, morning or evening, the astrologer had to be consulted. He did not go to work without rules; he had a complete classification of strange forms under which these heavenly bodies already had been observed, and to each form was attached a particular signification. Pliny has preserved this nomenclature for us: Hevelius, the learned *pensionnaire* of Louis XIV., faithfully reproduced it in the middle of the 17th century, in the fantastic figures of his *Cometographia*. And, certainly, everything was taken in the most literal manner: in a comet with a crooked, or straight, or multiple tail they traced, such is the power of imagination, a gigantic sabre, a lance, or a fiery bolt, a burning torch or a dragon hurling upon an entire country the plague, rebellion or famine. Figs. 1 and 2 are indications of this idea taken from the "Theatricum cometicum" of Lubienitzki. The first comet, in the form of a blazing torch, indicates very clearly by the direction of its tail the flames which will consume the neighbouring town; the second, a veritable dragon, whose tortuous folds the artist has reproduced, threatens France and Ireland from the seven points of its tongue of fire.

These specimens will suffice; there is no use in producing similar statements and similar pictures; at the most we can barely find here and there in the theories which were then formed some traces of the truth.

Astrology thus stifled real observation until the beginning of the seventeenth century. This may now appear strange to us, but there is no doubt of it. The astronomers of those times, so near in time to ourselves, and already so bold with the universal *renaissance* of the human mind, were almost all to some extent astrologers. Kepler himself, one of the glorious fathers of modern astronomy, was obliged by the duties of his office as Imperial Astronomer both to draw the horoscope of the war of the Pope against Venice, and to give to his powerful but too-straitened patron, the Emperor Rodolph II., an opinion on the comet of 1607, which appeared to be menacing Hungary Besides, Rodolph counted much then upon his alchemist to find the gold necessary to pay his army; while his general, the Duke of Friedland, the celebrated Wallenstein, never failed to consult the heavens, always by the help of Kepler, who has preserved for us his horoscope.

But already, from the time of Tycho Brahé, astronomy had commenced to place a hesitating foot in the domain of comets, from which she was soon to drive astrology. Until then men had lived, upon the faith of

* A lecture by M. Faye delivered at the "Soirées Scientifiques de la Sorbonne." Translated from *La Revue Scientifique*.

Aristotle, in the thought that comets were not celestial bodies, but mere sublunary meteors; and now it was discovered, by substituting observation for the word of the master, that they journeyed far above the orbits of Mercury and Venus, without being in the least incommoded by the crystalline spheres of the firmament in which the old astronomy incrusted its planets and stars. From the time of Newton comets were at last embraced,

FIG. 1.

so far as the movement of the nucleus was concerned, in the theory of attraction, and consequently in planetary astronomy, with this single difference, that they described around the sun ellipses enormously elongated, almost parabolic, instead of ellipses almost circular, like the planets. Then astronomers observed carefully the successive positions of these nuclei, and calculated their orbits, but without attending to the figure of the

FIG. 2.

comets themselves, although the invention of the telescope must have already revealed a number of curious phenomena which escaped the naked eye. During this period astronomers restricted themselves to representing the comet by a small circle, the centre of which alone was of importance, for there was the centre of gravity to which the laws of Kepler applied, and the calculation of the elements of the orbit. As to the tail, which attracted

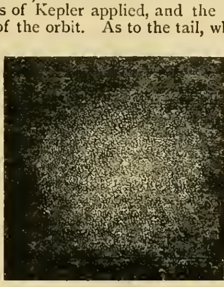


FIG. 3.

no attention, they figured it very simply by some feathery traces attached to the nucleus. In all this there is nothing to attract attention now, any more than the dragons of the astrologers. It was no longer now a superstitious prejudice which took from astronomers the desire to closely examine the facts; it was a preconceived idea, an elevated idea, no doubt, but too absolute, according to which the only force to be regarded in the celestial spaces was attraction. At bottom it was vaguely felt that the figures of comets were irreconcilable with this ruling hypothesis; and this was sufficient, for the eye was brought to bear by preference upon the subject the most attainable by the reigning theories.

Leaving aside the rude drawings of the six-tailed comet of 1744, by Chézeaux, and those which Messier made by rule and compass, we must come down to the two Herschels before we find trustworthy observations on the form of comets; the beautiful drawings of the comets of 1811 and 1835 are even now of use to science. Astronomers had at last learned, from the example of Olbers and Bessel, the high importance of these phenomena, which reveal to us more than a new world, since they tell us of a new force in the universe. At present the figure of comets has become the subject of the most earnest research, and the drawings of the beautiful comet of Donati (1858) which I am about to show you will give you an idea of the change which, in this respect, has taken place in the minds of astronomers. I can confidently vouch for their fidelity, for, while Bond was executing these drawings at the Cambridge (U.S.) Observatory, by means of a telescope of great power, I followed the same body at Paris with the first telescope which Foucault constructed on his new system, and it appears to me while looking with you on these drawings of Bond, as if I still had that wonderful comet before my eyes.

I shall endeavour first to give an exact idea of the successive metamorphoses which comets present during the course of their appearance, taking as a type a comet which has been perfectly studied—that of Donati. Let us remember that these bodies describe around the sun ellipses extremely elongated, of which the sun occupies the focus; that the point nearest the sun is called the *perihelion*, while the most distant point (in a truly parabolic orbit this would be infinite) is called the *aphelion*. Unlike the planets, which describe orbits almost circular, and remain always at nearly the same distance from the sun, comets, in general, come to us from regions much more distant than the most remote planets; but they only become visible, even to the telescope, in the part of their orbit which is nearest to the sun. After their passage at perihelion, their distance from the sun becomes greater and greater, and soon they cease to be visible. I do not believe that any comet has been seen beyond the orbit of Jupiter. It is assuredly not on account of their smallness that they thus escape our notice in regions where the most distant planets, Saturn, Uranus, and Neptune, shine so clearly with the light which they borrow from the sun; this is because the rare and nebulous matter of comets reflect much less light than the solid and compact surface of the planets of which we speak, much less even than the smallest cloud of our atmosphere.

When they are seen far from the sun through a telescope, they appear like rounded nebulosities, but vaguely defined, presenting at the centre a condensation sufficiently marked, which is called the *nucleus*; it is this nucleus, more brilliant than any other part, whose position astronomers observe. Fig. 3, representing Donati's comet at the time of its discovery, June 5, 1858, gives a sufficient idea of the aspects of all comets when they are at a great distance from the sun.

At a later period, when the comet is approaching its perihelion, it sensibly lengthens out in the direction of the radius vector, *i.e.* in the direction of an imaginary line which would join the comet and the sun; but then the bright nucleus is no longer found in the centre of the figure, but is situated excentrically on the side nearest to the sun, as is shown in Fig. 4.

Later still, the tail is formed, and is developed more and more, like an opened fan, while the nucleus shines with a more vivid brightness. The comet becomes visible to the naked eye as in Fig. 5.]

This tail is always away from the sun. At its origin, near the nucleus, it lies in the prolongation of the radius vector; at a greater distance it is curved backwards, as if it met with some resistance which hindered it from following completely the path of the nucleus. The bent axis of this tail is, however, always situated in the plane of the orbit, and this simple fact accounts for the many varieties of aspect presented to our eyes by these cometary appendages. Comets with straight tails appear such only because the eye of the observer is in the plane of the axis of the tail, *i.e.* in the plane of the orbit. When the earth, in consequence of its annual motion, is carried from this plane, the curvature of the tail becomes manifest; it becomes more and more pronounced as the comet, seen at first edgeways, so to speak, shows itself more and more on the flat, like a scimitar, to the observer.

When the comet, describing the descending branch of its orbit, reaches perihelion, these phenomena acquire their full development. But when it recedes from the sun, describing the ascending branch of its immense parabolic trajectory, the tail diminishes, disappears, and gives place to a mere elongation. Soon it again assumes the spherical form; the nucleus, which has gradually lost its brightness, is indicated only by a slight condensation of light at the centre of a globular mass entirely similar to that which was first seen. Finally this rounded nebulosity disappears.

Upon what scale do these phenomena take place, the immediate cause of which is evidently located in the sun? What may be the dimensions of these nebulosities, of these brilliant nuclei, of these curved tails? These dimensions are assuredly formidable. The comet of 1843 had a tail of 60,000,000 leagues, nearly double our distance from the sun. On the sky that tail was drawn like an immense dash of a brush of 65 degrees of angular amplitude. The tail of the famous comet of 1811 was only 40,000,000 leagues: but, on the other hand, the head alone of the comet (250,000 leagues in diameter) was nearly as large as the sun.

As to Donati's comet, its dimensions were more modest; its nucleus was 1,000 leagues in diameter, and the head only about 13,000; the tail was only about 14,000,000 leagues in length. I had the curiosity to estimate approximately the volume of this small comet, and I found, supposing that the thickness of the tail is equal to its breadth, its volume was a thousand times greater than that of the sun. As in reality the tails are flattened, it will perhaps be necessary to reduce this figure by half. There remains enough to show us that our terrestrial globe, so little beside the sun, is only a point in comparison with these gigantic bodies.

But, on the other hand, everything proves to us that these bodies contain very little matter in so enormous a volume. A characteristic which is special to them, and which assuredly belongs neither to the planets nor to their satellites, is their almost absolute transparency. The stars are seen through the tail of a comet as if the tail did not exist; they can be seen even through the head, much more dense and more brilliant than the tail. It was for long a question whether the nucleus, at least, of a comet would not be opaque and solid like a planet; but, after examination by the most powerful telescopes, it has always been found to be formed of nebulous layers, more and more dense, always permeable by rays of light. This very simple and altogether characteristic fact leads us, by itself, to think that cometary matter must be of extreme rarity, for a mist of some thousands or even of some hundreds of metres in thickness suffices to hide the stars, while a thickness of from 10,000 to 15,000 leagues of cometary matter scarcely lessens their lustre. Desiring to fix our ideas on this subject, I calculated the mass of Donati's comet, and found that it equalled at least that of a sea of 100 metres in depth, and 16,000 square leagues of superficies. This mass is only a fraction, almost imperceptible, of that of the earth. It was almost entirely concentrated in the head of the comet and around in the nucleus; even supposing it uniformly distributed over the whole volume of the tail, there will be found, for the mean density of that appendage, only a value incomparably more feeble than the density of the void approached by our pneumatic machines. But it is not to this rare gaseous residue that we must compare the matter of comets; it will resemble

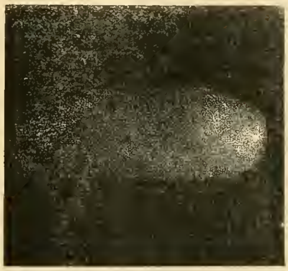


Fig. 4.

rather those impalpable grains of dust which dance in the air, and which are disclosed to us by the smallest ray of solar light penetrating a darkened chamber.

Although comets show us matter rarefied to such an extent that a celebrated physicist, M. Babinet, could with considerable justness call them "visible nothings" (*riens visibles*), do not, however, imagine that their contact with our earth would be without inconvenience. If the nucleus of our comet had directly encountered the earth, with its mass of 25,600 millions of millions of kilogrammes, and its relative speed of seventeen leagues per second (seven for the earth and ten in an opposite direction, for this retrograde comet), the actual energy of the shock would be enormous; I calculated that its transformation into heat would immediately generate fifty-one million *calories* per square metre of the hemisphere which sustained the shock. It would be enough to shatter, dissolve,

Fig. 5.

and volatilise a part of the solid crust of our globe. No living being could survive such a catastrophe. Happily the probability of such an encounter is excessively small; and, indeed, the most remote geological ages do not bear any traces of such an adventure. We cannot, however, forget that meteors and shooting stars, perhaps even the aerolites which bombard us so regularly every year and every day of the year, have probably the same origin as comets, and result from a mass of analogous materials which are decomposed in penetrating our solar world.

(*To be continued.*)

THE FLYING MAN

THE fatal experiment made by M. de Groof at Cremorne Gardens could not possibly have led to success. The possibility of directing an apparatus in the air by any mechanical contrivance, without actually using the lifting power of gas, is out of the question, and we do not wish to enter into a discussion on that point. But several interesting problems may be examined *à propos* of the inquest held by the coroner on the death of the unfortunate man.

De Groof's wings, irrespective of their motive power, may be regarded as two imperfect parachutes intended to diminish his rate of falling, and, if kept horizontal, prevent it increasing above a certain rate. It remains to see if their surface was large enough to keep that velocity within reasonable limits. The wings of De Groof were 30 ft. by 4 ft.; but being irregularly shaped, we may suppose the surface of each was 100 sq. ft., or in round numbers 200 sq. ft. for the two. The weight of the machine not being far from 4 cwt. if we include the man, we may say in gross numbers that each square foot had a kilogramme to support, which is more than ordinary; the parachute maker taking 1 kilogramme for each square metre, which is about ten times smaller.

But to ascertain if the velocity, although being larger than under ordinary circumstances, was really dangerous we must go to the formulæ established by General Didion and quoted by Poucelet—

$$R = 1{\cdot}936\ (A\ 0{\cdot}036 + 0{\cdot}084\ v^2)$$

Under the above circumstances, R the rate of falling is always inferior to the value of x given by the equation

$$10 = 1{\cdot}936\ (0{\cdot}036 + 0{\cdot}084\ x^2)$$

x being obviously enough the velocity for which $R = 10$ the weight pressing on the unit of surface. When the motion is such the velocity cannot be increased. If we make the calculation it is easy to see that the velocity is about 7 metres per second, almost = the fall from 3 metres to the ground. It is large, but not too large for a practised jumper, if he were clever enough to keep his balance, which is not very easy, it must be confessed.

Experiments on parachutes show that great oscillations always take place if the experimenters have not placed a small hole in the centre of their parachute, which increases stability at the expense of resistance. The motion of the wings, if they are working together, would very likely render the same service to the occupant of the machine, as they prevent the accumulation of the air. Unfortunately, to keep them working evenly is a difficult matter, requiring not only force of muscle but great presence and firmness of mind. The so-called *queue* or rudder was a useless encumbrance. A man working hard with his two hands, fighting for his life, cannot be expected to attend to direction with his legs attached to a rudder. The lifting power of the wings must have been very small indeed, although diminishing in some respects the rate of falling; but it is not easy to understand how a calculation may be made of the amount of mechanical power exerted in each stroke. The question must be left open for future examination.

W. DE FONVIELLE

NOTES

A CIRCULAR has been issued by the Hon. Local Secretaries of the Belfast meeting of the British Association, calling attention to the numerous objects of interest, natural and mechanical, with which the town and neighbourhood of Belfast, as well as the county of Antrim, abounds. The whole Province of Ulster is full of objects of the highest interest to the admirer of natural scenery, to the geologist, the naturalist, and the antiquarian; and many of its most interesting localities, such as the Antrim Coast, the Giant's Causeway, the Mourne Mountains, Lough Neagh, the Round Towers of Antrim and Drumbo, are within an easy distance of Belfast. The local secretaries state that a large number of the hotels will be open to members of the Association at the usual charges, and that a list of persons willing to let rooms has been prepared. We sincerely hope that this time there will be no complaint to make on the score of accommodation. Conveyance to Belfast can be obtained from any part of the country at very reasonable rates.

THE Right Hon. Lord O'Hagan will preside over the Section for Economic Science at the meeting of the British Association.

A MEETING of the General Council of the Yorkshire College of Science was held at Leeds on the 17th inst. The Council proceeded to the election of the Professor of Geology and Mining, and the Professor of Physics and Mathematics. The vote of the Council was unanimously given to Mr. A. H. Green, M.A., late Senior Fellow of Gonville and Caius College, Cambridge, as Professor of Geology; and Mr. A. W. Rücker, M.A., Fellow of Brasenose College, Oxford, as Professor of Physics and Mathematics. Prof. Green for the last five years has held the appointment of Lecturer on Geology at the School of Military Engineering at Chatham. Prof. Rücker in Oct. 1871 was appointed Demonstrator in the Physical Laboratory of Oxford University under Prof. Clifton. The appointment of the Professor of Chemistry will be made on Friday. The Council recorded a cordial vote of thanks to Sir A. Fairbairn for his liberal offer of 2,000*l.*, provided that the sum of 60,000*l.* was placed in the hands of the treasurer, and resolved to take the necessary steps for raising the required amount.

AT King's College, London, the Chair of Zoology and Comparative Anatomy, vacated by the resignation of Prof. T. Rymer Jones, F.R.S., has been filled by the election of Mr. A. H. Garrod, Fellow of St. John's College, Cambridge, and Prosector to the Zoological Society. The Chair of Materia Medica and Therapeutics, vacated by the resignation of Prof. A. B. Garrod, M.D., F.R.S., has been filled by the election of Dr. E. B. Baxter, Medical Tutor to the College.

THE prospectus has just been issued of a company to establish an aquarium for London, close to Westminster Abbey.

A BALLOON experiment to test a steering apparatus is soon to be made under the auspices of the authorities at Woolwich.

NORTHUMBERLAND, in Pennyslvania, on the Susquehannah, the place where Dr. Priestley was buried, has been selected by Americans as the spot at which all chemists are invited to gather on August 1 next, the hundredth anniversary of the discovery of oxygen by the illustrious philosopher. An address is to be delivered over his grave. This proposition of Dr. Bolton has met with a cordial response from a large number of chemists. Prof. Henry, of the Smithsonian Institution, proposes to be present with some of the original apparatus of Priestley from the Smithsonian collections. August 1 falling on Saturday, the meeting will be called for the day previous. A programme will be soon issued by the committee in charge.

THE Governing Body of Christ Church, Oxford, have voted the sum of 100*l.* per annum for five years in aid of the Biological Department of the Museum.

THE New Falcons' Aviary in the northern part of the Zoological Society's Gardens beyond the canal has just been completed, and is now tenanted by a fine series of the Diurnal Birds of Prey, principally exotic. Amongst them are examples of several rare species, such as the Red-backed Buzzard (*Buteo erythronotus*), the Laughing Eagle (*Herpetotheres cachinnans*), and the Malayan Crested Eagle (*Spizaetus caligatus*). Amongst the less-known European species are a pair of Bonelli's Eagles, a pair of Red-footed Falcons, and an Eleonora Falcon.

M. DOURNEAU DUPRÉ, a French explorer of the Sahara, has been killed by marauders on the way from Ghadames to Rhat. French colonists are making great progress in opening through the desert a road to Senegal by Timbuctoo and Niger; but Algerian refugees are their most determined opponents. The prospect of introducing water from the Mediterranean into the Chott has created a sensation in the colony and is very likely to lead to new efforts in desert exploration.

M. DE LESSEPS' scheme for making an inland sea in Algeria seems to have excited great alarm in some of the French journals. It is feared that the resulting evaporation will have a bad effect on the climate of France, one journal going so far as to suggest a return of the glacial epoch!

WE have just received the first two parts of a new monograph on the *Trochilidæ* or Humming Birds, by M. E. Mulsant, the well-known coleopterist, and the late M. E. Verreaux.

THE second series of the superb work "On the Butterflies of North America," by Mr. William H. Edwards, has just been commenced with the appearance of Part I. and with the promise of even greater beauty and excellence than the one recently closed. The illustrations, as in the preceding series, were drawn by Miss Mary Peart, who has made a specialty of this branch of art, and coloured at the establishment of Mrs. Bowen, of Philadelphia. The work bears the imprint of Hurd and Houghton, New York.

WE understand that Lieut. Cameron's journal, giving an account of his journey from Unyanyembe to Ujiji, has arrived in this country. He passed over a new route, to the south of that traversed by Capt. Burton, and north of Stanley's; and has thrown much light on the geography of the southern half of the Malagarazi drainage area. He has obtained several latitudes, and took a series of hypsometrical observations; but his most important work has been the final settling of the questions respecting the height of lake Tanganyika above the sea; and the latitude and longitude of Ujiji. Lieut. Cameron has recovered, at Ujiji, a most important map drawn by Dr. Livingstone, of the unknown country between Mikindany and Lake Nyassa, without which the record of the great explorer's discoveries would be very incomplete. Lieut. Cameron found the country between Unyanyembe and Ujiji in a more dangerous and unsettled state than ever. Mirambo and an independent body of runaway slaves were in complete possession of the route; and, though they would not molest an English officer, no Arab caravan or body of negroes could have passed. The insurgents attack and drive back all such parties, and the people would destroy all their food rather than give it to them. Lieut. Cameron's labours, first in his gallant attempts to succour Livingstone, then in furnishing aid to the explorer's servants, who brought down his body and effects, and finally in pressing onwards, in the face of great dangers and privations, to recover the journal and map at Ujiji, are deserving of the admiration of his countrymen. He is now on the verge of new discoveries, and resolved to achieve them; and we trust there will be a liberal response to the appeal for funds. Subscriptions to the Cameron Expedition Fund are received by Messrs. Ransom and Co., 1, Pall Mall East.

IN a paper in Petermann's *Mittheilungen* (Heft vii. 1874) by Dr. Joseph Chavanne, of Vienna, on "The Arctic Continent and Polar Sea," the author deduces the following conclusions from the data furnished by recent expeditions, and which he carefully discusses:—1. The long axis of the arctic land-mass (which probably consists of an island archipelago separated by narrow arms of the sea, perhaps only fjords) crosses the mathematical pole; it thus bends round Greenland, north of Shannon Island, not towards the north-west, but runs across to 82° or 83° N. lat. in a northerly direction, proceeding thence towards N.N.E. or N.E. 2. The coast of this arctic continent is consequently to be found between 25° and 170° E. long. in a mean N. lat. of 84° and 85°, the west coast between 90° and 170° W. long. in a latitude from 86° to 80°. 3. Robeson Channel, which widens suddenly north of 82° 16′ N. lat., still widening, bends sharply in 84° N. lat. to the west; Smith Sound, therefore, is freely and continuously connected with Behring Strait. Grinnell Land is an island which probably extends to 95° W. long., south of which the Parry Islands fill up the sea west of Jones's Sound. 4. The sea between the coast of the arctic polar land and the north coast of America is traversed by an arm of the warm drift-current of the Kuro Siwo, which pierces Behring Strait, and thus at certain times and in certain places is free of ice, allowing the warm current to reach Smith Sound. 5. The Gulf Stream gliding between Bear Island and Novaya Zemlya to the north-east washes the north coast of the Asiatic continent, and is united east of the New Siberia Islands with the west arm of the drift current of the Kuro Siwo. On the other hand, the arm of the Gulf Stream, which proceeds from the west coast of Spitzbergen to the North, dips, north of the Seven Islands, under the polar current, comes again to the surface in a higher latitude, and washes the coast of the arctic polar land, the climate of which, therefore, is under the influence of a temporarily open polar sea; hence both the formation of perpetual ice, as well as excessive extreme of cold, is manifestly impossible. 6. The mean elevation of the polar land above the sea diminishes towards the pole. 7. The sea between Spitzbergen and Novaya Zemlya to Behring Strait is even in winter sometimes free of ice, and may be navigated in summer and autumn. 8. The most likely routes to the pole are:—first, the sea between Spitzbergen and Novaya Zemlya; and second, the sea north of Behring Strait along the coast of the unknown polar land.

A NEW geological survey of the State of Pennsylvania has been ordered, and the bill providing for it has passed the Legislature and has received the signature of the Governor. Money for three years has been voted. Prof. J. P. Lesley, of the University of Pennsylvania, has been appointed Geologist-in-Chief.

THE programme of arrangements for the thirty-first annual meeting of the British Archæological Association is just out. The meeting will be held at Bristol in the week between Aug. 4 and 11, under the presidency of Mr. K. D. Hodgson, M.P. Excursions will be made to various places of interest in the surrounding district. Among the papers to be read at the evening meetings are the following:—On unpublished historical documents at Bristol, by W. de Gray Birch, Hon. Palæographer; and On the records of Merchant Adventurers, by Mr. J. de Haviland.

WE learn from the Report of the Radcliffe Observer that the number of transits observed from July 1, 1873, to July 1, 1874, is 3,093; and the number of zenith-distances, 4,101. The number of stars observed in the same interval is 1,585. Coggia's comet has been observed four times on the meridian and four times with the heliometer. With the heliometer, in addition to a small selected list of double stars which have been observed as usual, a series of ten measures of the equatorial and polar diameters of Jupiter has been made, and the diameter of Uranus has been measured several times. These observations have been made chiefly by Mr. Bellamy. The volume containing the results of observations for 1871 is complete and ready for distribution. This volume contains a catalogue of 1,331 stars:—97 observations of the sun, 51 observations of the moon, 25 of Mercury, 18 of Venus, and 14 of Mars; a catalogue of 21 double stars, of which several have been observed repeatedly; 11 measures of the equatorial and polar diameters of Mars, with the deduced

apparent ellipticity, and diameter at mean distance; 8 occultations of stars by the moon, with the equations deduced from the occultations; and, finally, a considerable list of shooting-stars observed chiefly by Mr. Lucas. Considerable advance has also been made in the reductions for 1872-73.

WE would draw special attention to the Catalogue of the Anthropological Collection lent by Col. Lane Fox for exhibition in the Bethnal Green Museum. Only Parts I. and II. have been yet published, and these are almost entirely occupied with Weapons, which are divided into various classes, the lists under the various classes, or rather the contents of the various screens on which the specimens are arranged in the museum, forming the subjects of dissertations by Col. Lane Fox, who endeavours to trace out the probable origin and development of the various kinds of weapons. The principles which have guided Col. Lane Fox in making and arranging his valuable collection, he pointed out in his paper read at Bethnal Green on July 1, an abstract of which will be found in our last number, p. 217. He has abandoned the mere geographical arrangement, and adopted a principle as scientific, and we hope as productive, as that which obtains in natural history. A student of anthropology going carefully over Col. Lane Fox's collection at Bethnal Green, with this catalogue in his hands, would find himself both interested and instructed to a degree that it would be difficult to attain anywhere else.

WE rejoice to see from the tone of the replies to questions in the House of Commons on Monday by Mr. Disraeli and Lord Henry Lennox, that Government is conscious of how poorly housed some of our scientific collections are, and seems really disposed to take steps to remedy the evil. Mr. Disraeli said, in reply to a question concerning the Patent Museum, that it is not the only public institution which is suffering from want of space and of suitable accommodation. "That is now a crying grievance with respect to all our public buildings, collections, and offices. In regard to the Patent Museum, however, I am aware from a communication which I have received from my noble friend the First Commissioner of Works, that the matter is at present engaging attention." Lord Henry Lennox confirmed this by subsequently stating that he intended to propose to Her Majesty's Government a scheme which, if it were agreed to, would enable him to offer the Patent Museum suitable accommodation in the southern block of the International Exhibition buildings.

MR. JOHN MURRAY has in the press a memoir of Sir Roderick I. Murchison, based upon his journals and letters, with notices of his scientific contemporaries, and a sketch of the rise and progress, for half a century, of Palæozoic geology in Britain, by Prof. Archibald Geikie, LL.D., F.R.S., &c. It will be illustrated with portraits, and will be published in two octavo volumes.

MR. KARL TRÜBNER, of Strasburg, has recently published one part of a geological map of the neighbourhood of Heidelberg, the work of Drs. Benecke and Cohen. We especially draw attention to the fact that contour lines are given faintly marked in red. The other part, and the letter-press description, will not be ready till next year.

M. CAILLETET, in studying the compressibility of gases, has been led to investigate the resistance which glass tubes oppose to pressure. In one experiment a tube 21·7 in. long, and 0·7 in. diam., was crushed by an outside pressure of 77 atmospheres, while half that pressure sufficed to break it when exerted on the interior.

THE Geologists' Association has organised a lengthened excursion to the Cotteswold Hills, May Hill, and the Severn Valley, extending from Monday last, July 20, to Saturday, July 25. The head-quarters is at Cheltenham. Judging from the programme this excursion promises to be one of great interest; the directors are Dr. Thomas Wright, F.G.S., Mr. J. Logan Lobley, F.G.S., Mr. W. C. Lacy, F.G.S., and the Rev. W. S. Symonds, F.G.S.

THE first volume of the United States Commission of Fish (8vo, 899 pp., 38 plates and 3 maps) has been recently issued from Washington. In addition to reports of proceedings there are given arguments for and against protective laws, the natural history of some of the most important food-fishes; catalogue of marine algæ of southern New England; and papers on physical characters, invertebrate animals, &c., of different districts.

FOLLOWING the report of the Inspectors of Salmon Fisheries in England and Wales, that from the Inspectors in Ireland has just been issued, containing statistics concerning not only the salmon fisheries, but the deep-sea and coast fisheries as well. It is difficult, from the form of the report, to give any general idea of the condition of the salmon fisheries, but they appear to be slightly increasing in productiveness. The same complaints are made in Ireland as in England of the dangers from pollutions, and from the want of passes over the weirs. But the inspectors do not appear to have done anything to remedy either of these evils. The oyster fisheries are in a decaying state, and the beds licensed to private persons are almost unproductive; naturally better situated than England for the production of oysters, it seems a great pity that Ireland should not yield a large number of these molluscs, if proper care were only taken, and a little energy and capital expended in improving the beds. The herring fishery for the year was less than in 1872, while the mackerel fishery was nearly double; pilchards, however, are almost unutilised, though the mass of wealth in the waters is sufficient to make an industry that would rival that of the Cornish fisheries. If the inspectors could put a little energy into the matter and the people be made to see their opportunities, the fisheries of Ireland might be the richest in the world.

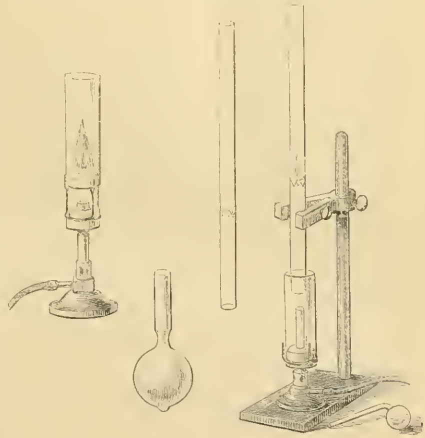
THERE appears a prospect of good coal being shortly made available for consumption in Japan. The largest of the coal-fields of Japan, that of Takosima, has come into possession of the Japanese Government, and it is hoped that an increased outlay of capital will produce satisfactory results.

THE *New Quarterly Magazine* for July contains, among other articles, an essay On birds and beasts in captivity, by Archibald Forbes, and an interesting paper by Mr. Evershed, On habit in plants and power of acclimatisation, in which, *àpropos* of the present state of the question of sewage farming, he remarks:—"It is a serious drawback to the profits of sewage cultivation that only certain plants are disposed to consume so much liquid as is offered to them under that system of management. Cereals are not drinkers to any large extent, and will not suddenly change their habits. They have enough to do to swallow the ordinary amount of wet which prevails in our climate, being naturally partial to rather drier countries like South Russia, Poland, and Spain."

THE additions to the Zoological Society's Gardens during the past week include three Giraffes (*Camelopardalis giraffa*) from Upper Nubia, purchased; two Passerine Owls (*Glaucidium passerinum*), European, presented by Mr. C. W. Tait; a Reeves' Muntjac (*Cervulus reevesi*), born in the Gardens; a Slow Loris (*Nycticebus tardigradus*), from the Malay region, deposited; a Coati (*Nasua nasica*), brown variety, and a Spotted Cavy (*Coelogenys paça*) from South America, purchased; two Bronze-winged Pigeons (*Phaps chalcoptera*) and an Olive Weaver Bird (*Hyphantornis capensis*), hatched in the Gardens.

VIBRATIONS OF AIR PRODUCED BY HEAT

DURING the past session an interesting experiment was made by some students of the College of Physical Science, Newcastle-on-Tyne, engaged in their practical course of chemistry in the laboratory, sufficiently striking and remarkable to secure it, I have little doubt, a short notice among the records of a scientific journal. While testing the inflammable properties of the explosive mixture of air and coal-gas proceeding from the mouth of an unlighted Bunsen-burner, and observing its flame kindle and flashing back along a glass tube, it occurred to one of the students and to the chemical demonstrator, Mr. Haigh, to check the flame in its descent by inserting a piece of wire-gauze in the tube. On reaching the wire-gauze the flame rested there, as they expected; not silently, however, but bursting to their surprise with remarkable clearness and loudness into the peculiar singing strain of the chemical harmonicon. Mr. Haigh made several experiments on the flame with tubes of different sizes, which, if more immediate engagements had not prevented me from pursuing them, it had been my intention to have varied, and to have examined them more completely. In the form in which it first presented itself, a convenient and easily intelligible arrangement of which is here sketched, it appears, however, to offer all the attractions and the remarkable strength and variety of singing properties with which it seems to be abundantly endowed. A cylindrical lamp-glass mounted with a cork and wire-triangle on a Bunsen-burner serves to shield the mouth of the tube from draughts of air, and to preserve a steady flow of the entering gas. The tube is first lowered over this and lighted at the top; by raising it gradually sufficient air soon enters with the gas below to make the flame waver on the top of the tube, and finally descend to the wire-gauze, where it then burns most vociferously, especially if the wire-gauze is placed at the best position in the tube to produce some of its harmonic notes. The highest notes are sounded when it is above the middle, or even near the top of the tube, and the lowest when it is not far from the bottom of the tube; the stronger draught arising from the long column of heated air, which soon greatly assists the sound, appearing in the latter case to favour the production of notes of the deeper pitch. A glass tube about 2 ft. long and nearly 1 in. in diameter inside furnished a very powerful note, the wire-gauze being placed a short distance below the middle of the tube. By bending down the edges of a square or circular piece of wire-gauze over the flat end of a round ruler so as to fit the tube correctly, all passage of the flame between it and the tube is prevented, but when, as quickly happens with the increasing heat and updraught of the tube, the agitation of the flame grows more and more intense, it at length red-heats the wire-gauze, and passing through it lights the Bunsen-lamp below. A very instructive illustration is thus afforded of certain conditions in which the security of Davy-lamps in a fiery atmosphere can no longer be assured, where a sufficiently quick draught, or in this case the pressure of continued vibrations, carries the flame against the meshes of the wire-gauze until they are ignited. In one case danger arises of the wind carrying the flame of one side of the interior of the lamp over to the other side, which it red-heats; in the present case the vibrations carry the flame back upon itself. If in the former case a red-heated Davy-lamp is not turned round quickly to face the draught, explosion does not always follow; but in this case the current of explosive gas is immediately presented to the heated gauze, and not having undergone any previous combustion it is of course quickly kindled. On the other hand, another source of insecurity of safety lamps when exposed to sudden vibrations, or to the shock produced by a fall, is well shown, when it sometimes appears to happen, if the flame flutters very strongly, that it strikes through the wire-gauze without red-heating it, and lights the lamp below. This may, however, have occurred from imperfect fitting of the wire-gauze to the sides of the tube, and it would be interesting to repeat it if possible with precautions for making the surrounding junction quite secure. A lighted Davy-lamp suspended by a wire in a tin tube 3 ft. or 4 ft. long and wide enough to admit it easily, through which a stream of coal-gas mixed with air was passing made the tube hum very loudly, but no explosion followed, perhaps because it was not found possible to produce in the lamp a sufficiently violent agitation of the flame. A remarkable example of the ease with which the wire-gauze flame excites the notes of even very short, wide-mouthed tubes can easily be shown by inserting a well-fitting piece of wire-gauze 1 or 2 in. from the lower end of a straight lamp-glass, as shown in the sketch, and supporting this a few inches above an unlighted Bunsen jet. When the gas is lighted on the top of the wire-gauze and the heat of the glass chimney becomes sufficient to increase the draught, which may also be adjusted by varying the gas supply to the glass, its shrill treble note is sounded at once with overpowering loudness. The sensitiveness of the wire-gauze flame to acoustical impressions was, I believe, demonstrated very recently by Prof. Barrett, by many new and striking experiments on the depression of its luminous cap or top in obedience to the voice and to other sounds; and I have been assured both by Prof. Tait and by Prof. Marreco that the use of the smokeless wire-gauze burners, common in laboratories before the introduction of Bunsen's lamps, for exciting the hoarse music of singing flames in tubes of large calibre has long been familiar to them as a thoroughly effective means of reproducing the chemical harmonicon with common coal-gas. The easily inflammable nature of well aërated coal-gas combined with the conducting and quenching power of wire-gauze on flames which it supports, supplies an obvious explanation of the responsive vibrations of the flame to any description of rhythmical surrounding agitations and impulses. I was not, however, prepared for an equally remarkable and peculiar property of heated wire-gauze to the above, which, like the last experiment, was also shown to me by Mr. Haigh in some of his trials of the sounding tubes. When the flame had been sounding strongly and the gas was turned off



to extinguish it, instead of ceasing immediately the musical note continued for a considerable time, sometimes even gaining a little in strength before it died away, the tube then appearing to have the power of intoning spontaneously without the presence of any visible exciting cause. That the source of these prolonged vibrations is the heat communicated to the wire-gauze, which enables it to expand the air by impulses in the tube as the ascending current gradually passes through its meshes was confirmed by a variety of experiments, all pointing to this origin of the sound as its real explanation. It happened on one occasion, when the flame passed through the gauze, lighting the Bunsen-lamp below, and leaving the gauze red-hot, that on putting out the lamp the after-note sounded so long and loudly as quite to equal, if it did not even surpass what had just been emitted by the flame. To reproduce the same note it is in fact only necessary to red-heat a wire-gauze diaphragm inserted a few inches above the lower end of a pretty wide glass tube over a Bunsen-flame, and to remove it from the lamp, when the gravest note of the tube will immediately be sounded with all the strength and purity that can be desired. Somewhat coarser wire gauze than that used for the singing-flame succeeds the best, as, besides being more easily red-heated by the Bunsen-flame, it furnishes a larger store of heat to the ascending air-current, which, in passing through its meshes, produces the singing sound. If the tube is raised quickly, the draught through it being thus checked it stops, and as soon as it is brought to rest

it begins to sing again; by lowering it quickly the note is much strengthened, as it is also by turning on an unlit gas-jet under it, and especially by swinging the tube round horizontally, the lower end foremost through the air, which increases the draught and the strength of the note most considerably. The note is silenced when the tube is held at rest inverted, or horizontally, but it begins again as soon as the tube is restored to its erect position. A closely twisted coil of thin platinum wire was compressed in the tube in the place of the wire-gauze, and was made red-hot over the Bunsen-flame, which was then extinguished, and the gas again turned on immediately, causing the platinum wire to continue to glow by catalytic action. As long as its red-heat continued, the musical sound of the tube also continued to be produced. A glass tube 2 ft. long by $1\frac{1}{4}$ in. in diameter, stopped near one end with platinum wire-gauze, to the centre of which a small piece of spongy platinum is fastened, performs in this way over an unlighted gas-jet, when started by preparatorily heating the platinum gauze, for any length of time. Although unable to do so over ordinary coal-gas, yet it is very probable that over hydrogen (as a heat below redness is sufficient to maintain the sound) a tube thus fitted with pieces of platinum sponge laid upon wire-gauze would start and continue to sound by itself.

When a glass bulb is blown at the end of a glass tube it frequently happens that in cooling it emits a very clear and distinct humming sound. The note has appeared to me considerably graver than what would be expected from air vibrations in the small bulbs in which it occasionally occurs; thus in blowing the small candle-bomb, shown of its proper size on the left hand in the figure, a very loud note, of apparently about middle C pitch, or even lower, accompanied its cooling. In drying the glass bulb of a broken Wollaston's cryophorus, shown with its bent tube on the right in the sketch, by warming it very gently over a gas-flame to expel some adhering moisture, I was startled on removing it from the flame to hear the same humming note, although the bulb was scarcely hotter than could be touched with the hand, resembling in pitch (although its softness may have had a misleading effect upon the estimate) one of the lowest bass notes of an organ. Being familiar with the depth of tone obtainable with Helmholtz's spherical resonators, I am led to suppose that the combination of a bulb with a tube may have a much lower fundamental note than either of those cavities would have alone. But the acting source of the note requires also to be considered, and if, as appears evident, low beats and resultant tones cannot be reinforced without strengthening their primaries, the deep pitch of bulb-emitted notes may possibly arise from the nature of the air impulses by which they are produced. These appear to be of the same kind as the air-oscillations in the hot-gauze harmonicon. As the energy of the sound-waves cannot be produced without a corresponding motive cause, in the latter it is the ascending current of the rarefied, and in the former the in-draught of the contracting air, both produced by the dissipation or appropriation of a certain store of heat. The cold air entering the hot bulb or ascending through the heated wire meshes, expands in doing so, recoils upon itself, and throws the air column of which it forms a part into vibrations, which continue as long as the flow of air and heat together continue to support the motion. The rapid succession of explosions of the gas-flame harmonicon are, in fact, reproduced; the expansive force of the small puffs or explosions that produce the sound being merely derived from a limited stock of sensible heat, instead of from a constant supply of heat of combustion. Considering the volume and duration of the sound long after the wire-gauze has ceased to be visibly red-hot, the energy of the effect produced by the heated gauze seems to be out of all proportion to its magnitude; but the effects of the mechanical transformation of heat are, as is well known, always sufficiently startling, and sometimes even prodigious when the conditions under which it takes place are at all favourable to the process of the transformation.

I was not aware, when writing this description, that musical sounds produced by heating glass bulbs had been examined so long ago as the beginning of this century, as described in Prof. Tyndall's work on Sound, by the late G. De la Rive, who obtained them by boiling water in thermometer bulbs. The vapour in its passage along the tube is condensed, and by the collapse that accompanies its contraction throws the air column in the tube into vibration; this action is thus exactly the opposite of what occurs when fresh-blown strongly heated glass bulbs are allowed to cool, the expansion, instead of the contraction, then giving the necessary impulse. I am also disposed, since reading Prof. Tyndall's description and explanation, to ascribe the low note of the warmed cryophorous bulbs to the escape of aqueous vapour from it in the manner of De la Rive's experiment, rather than to the influx of cold air into the bulb to which I attributed it at first.

It is well known that at a nodal point of a vibrating air-column there is no oscillation, but alternate expansion and contraction of the air, while in the middle point of a vibrating segment the opposite is the case. Neither of these places is accordingly a suitable one for the combined air-pressures and oscillations to take place, which in a sounding flame or at a heated diaphragm can never occur separately or independently of each other, the strength of each little puff or explosion depending at once upon the direction and amount of the contributing oscillation; the position of the heating cause must accordingly be between the ventral and the nodal points. It is the same with the air-currents that excite the vibrations of a flute, railway whistle, common bird-call, or organ-pipe; the oscillations and throws of pressure of the air at the embouchures are not only simultaneous, but they must also be so related to each other that an inward oscillation accompanies increase of pressure, since a part of the blast is then thrown into the air-column and compresses it. From an easy law connecting together the changes of pressure with the motion of the air at any point of a stationary air-wave, it appears that in these instruments, exactly as in the hot-bulb, or in the hot-gauze and gas-flame harmonicon, the ventral point (as far as a true one exists) is not at the embouchures of the wind-instruments, nor at the heating and cooling points of the several kinds of heat-sirens or harmonicons, but outside of them in such a position as to place the exciting air-puffs between the nodal and the ventral point. Prof. Tyndall has truly pointed out in his sound lectures that whenever stationary undulations are kept up against friction, as when a stretched string is kept in uniform vibration by the hand, the nodal points are not absolutely stationary points, but present a little oscillation. It is equally true that the string does not remain accurately parallel to itself where it ought to show true ventral points, and accordingly resists a hand applied there to keep up its oscillations with a certain force; but this resistance is weak, and it acts through a wide excursion, while near the nodal points the necessary efforts of the hand are greater and exerted through very small displacements. In intermediate positions the nearer the string is held to a nodal point, and the smaller its excursions, the stronger must be the jerks given to it by the hand to keep up its oscillations. In air-instruments (including the harmonicon and flute) the jerks of the hand correspond to the explosive force of the small admitted puffs of air, depending in heat-harmonicons on the intensity of the heat or combustion, and also on the quantity of the matter burned or heated in the successive puffs; and in wind-instruments no doubt principally on the pressure and perhaps to some extent also on the quantity of the admitted blasts. According to the position of the embouchure (including a flame-jet or a heated gauze under the expression) in the vibrating segment of a wave of resonance, its beneficial action in maintaining the air-wave will be evoked or suspended in obedience to the particular conditions that exist in the air-wave at that point; the only absolute requirement for its activity being that entanglement of a fresh supply of blast must coincide with a moment of rising pressure at that point of the air-wave. This is easily accomplished in wind-instruments, the large excursions of the air at the embouchures ensuring a plentiful introduction of the entering wind-puffs at the proper time; the action in this case is quite free from complication, as without considering the small gains of pressure periodically given by the blast as it flows inwards, and a small suction that it exercises (to which I believe that Mr. Hermann Smith is the first to draw attention in his excellent communication on this subject in NATURE, vol. x. p. 161), as it retreats, nothing prevents the to-and-fro displacements at the mouth of an organ-pipe from so deflecting the current of the air-blast inwards and outwards as constantly to apply its useful energy to the best effect. Inward motion of air towards a node is accompanied by rising and outward motion by falling pressure, and as the losses of both of these kinds of energy are properly renewed by the blast in entering or retreating, the resonance of the wind-instrument is kept up. The friction and loss of energy in high harmonics is probably much greater than in graver notes, and, the air-excursions being also smaller, it is perhaps on this account that a stronger blast or a nicer direction of it by the mouth-piece

is found necessary to produce and to maintain them. In heat-harmonicons the action is less simple, the alternations of pressure as well as the oscillations of the air determining the admission of the entering puffs. To judge from the position in which a singing-flame sounds best in a chemical harmonicon, a certain "lead" like that used in admitting steam to the cylinder of a steam-engine is necessary for the flames to exert their expansive force, the gas perhaps not instantly igniting on its emergence from the jet; and this "lead" the mere oscillations of the surrounding air are unable to supply; but in the position which the jet occupies in the tube, the air-pressures, which return at periods answering to a half stroke of the flame before the oscillations, precipitate its development and enable it to exert its pressures at the proper times. The proportion of lead given to the flame increases as it approaches the middle of the tube, where only the variations of pressure act upon it, while at the lower end of the tube it is commanded entirely, like the air-blast of an organ-pipe, by the oscillations of the air. It is perhaps thus that a wire-gauze flame burning at the foot of a lamp-glass sounds so vociferously, because stationary alternations of pressure in the lower part of the tube cannot affect the transmission of gas through the gauze, while the extensive oscillations there produced have perfectly free action in extinguishing and replenishing the flame. By using a piece of thin glass connecting-tube about 4 ft. long, held vertically over an unlighted Bunsen jet, on lighting the gas escaping at the top, and carefully raising the tube so as to allow the flame to descend very slowly, it may be made to pause in its descent at the successive ventral points corresponding to the harmonic divisions of the tube, sounding the note of the section of the tube above it as it comes to each point of rest. On lowering the tube it ascends, stopping and singing at some higher point of rest, depending apparently upon the less instantaneous inflammability of the gas. With some difficulty, and by shielding the lower end of the tube as much as possible from draughts, the flame was sometimes made to drop quickly within a few inches of the bottom of the tube, stopping always at the same place and sounding there for a moment the lowest note of the tube, when by the strength of its vibrations it was either rapidly extinguished, or else lighted the Bunsen lamp below. The notes sounded by these means were, however, not nearly so loud and effective as those obtained when the gas-flame was held at its stationary points by making it come to rest upon wire-gauze.

I am indebted for almost all of the foregoing experiments to Mr. Haigh, who was very skilful in suggesting and devising modifications of them, leading to the immediate conclusions regarding the mode of their production to which they appear most distinctly to conduct. Other occupations have hitherto prevented me from attempting to extend and to examine them as thoroughly as they seem to deserve; but the field of research presented by the study of harmonic flames does not yet appear to be nearly exhausted, and the repetition of the above experiments by others will perhaps throw more light upon the doubtful questions with which they are still to some extent surrounded, enabling, it may be, the many significant and easily-recognised features of singing flames to be produced with even more than their present ease and certainty. A. S. HERSCHEL

SCIENTIFIC SERIALS

THE *Geological Magazine*, July.—In this number Mr. J. Croll commences an article On the physical cause of the submergence and emergence of land during the glacial epoch, which is to be continued. As far as it goes it is concerned with the conceptions we have of the thickness of continental ice. An attempt is made to estimate the thickness of the great antarctic ice-cap, about which "observation and experience to a great extent may be said to be a perfect blank." The condition of the interior of the antarctic continent is inferred from the little that we know of Greenland. The diameter of the ice-cap being taken at 2,800, the thickness at the centre is given at the lowest at 6 miles, reckoning a quarter of a degree only as the slope of the upper surface. Mr. Hopkins has recorded that he found one degree the least slope on which ice will move. An ice-cap of only 6 miles in thickness is to many an unfamiliar idea, and "few things," Mr. Croll writes, "have tended more to mislead geologists in the interpretation of glacial phenomena than inadequate conceptions regarding the magnitude of continental ice."—The other original articles are On the dawn and development of life on the earth, by H. Woodward, F.R.S.—Notes on carboniferous monomyaria, by R. Etheridge, jun.—The geology of the Nottingham district, by Rev. A. Irving.—There are two letters on the glaciation of the south-west of England, by Dr. Mackintosh and H. B. Woodward.—Mr. Mallet writes that he does not see how he can be charged with "misapprehending" Mr. Scrope in the discussion on the nature of volcanic heat, and asks that as he has reduced his own views to clear definition (Phil. Trans., vol. i. 1873) Mr. Scrope will do the same.

Bulletin de l'Academie Royale des Sciences, &c., de Belgique, No. 5.—M. Van Beneden contributes the first part (65 pp. in length) of a paper entitled "On the original distinction between the testicle and the ovary; the sexual character of the two primorial layers of the embryo; the morphological hermaphrodism of an entire 'individual'; an essay on the theory of fecundation." The "essay" opens with an introduction in which reference is made to Huxley's first pointing out that the organism of Zoophytes, Medusidæ, Polyps, Siphonophora and Hydroideæ consists essentially of two layers, endoderm and ectoderm, and also to other writers who have studied the relationships of endoderm and ectoderm in various aspects. The second part contains the history and bibliography of the subject, and the third (50 pp. long) describes the author's researches on *Hydractinia echinata*, made during a lengthened visit to Ostend. He first describes the characters which the male and female reproductive zooids have in common, and carefully details his methods of preparation. The microscopic description of the female and then of the male zooids or gonosomes is given in much detail, illustrated by plates. He arrives at the following conclusions:—The ovaries are developed entirely from the epithelial layer of the endoderm. Up to the time of maturity they remain entirely surrounded by the elements of the endoderm. The testicle and spermatozoa are developed from the ectoderm. The female sporosacs contain rudimentary testicular organs, and male sporosacs a rudimentary ovary. From a sexual point of view the ectoderm and endoderm have an opposite signification. If it is true that special organs have resulted from specialisation of function following division of labour, then we must believe that originally the whole ectoderm performed the male sexual function and the endoderm the female. The ectoderm is the animal and male layer, the endoderm the vegetation and female. Fecundation consists in the union of an egg, the product of the endoderm, with the product of the ectoderm, which brings chemical compounds of "opposite polarity" into union. The new individual is formed at the instant the elements of "opposite polarity" unite just as a molecule of water is formed by the union of atoms of hydrogen and an atom of oxygen.—M. Henry contributes papers on chloral and chlor-ethylic ethers, &c.—M. F. Plateau has sent in a communication on the digestion of insects, which is to be published in the memoirs.

Bulletin de la Société d'Anthropologie de Paris, t. vii.—In the seventh volume of this journal M. Hamy gives us the results of his examination of M. Janneau's officially conducted investigations into the anthropology of Cambodia. He begins by endeavouring to define the meaning attached to the three words, "Moi," "Kha," and "Penang," which have hitherto been used in Annamite, Laolian, and Kmer almost indiscriminately to indicate the wild tribes of the hills. By the first of these we must understand the negro tribes occupying the oriental chain of the Cambodian range; in the second a people not unlike the yellow races of Laos; and in the third the tribes in whom the flat-faced non-Caucasian type is strongly marked. The Cambodians themselves distinguish between races, known as Kuôi, who, they say, are the primitive people of the land but not savages, and the Rodê, the former being employed in the extraction of the ores of Kompong Svai, and the latter in the breeding and care of horses, while both are exempt from the yoke of slavery which presses heavily upon nearly all the other tribes. In the Cambodian language M. Janneau thinks he can trace evidence of identity with many of the primitive forms of the roots of the mother-tongue of the Indo-European languages. The Aryan name "Rama" appears among the ancient regal titles of Cambodia, and while the Sanscrit "Ramayana" includes the Cambodians amongst the offspring of the immaculate cow, Cabala, the people themselves have from the most remote antiquity made the cow the object of special adoration.—The question of the depopulation of certain districts, more especially in the Polynesian and other Australasian insular groups, has lately attracted especial attention among the members of the Anthropological Society of Paris. The Gambier Islands, which in

1838 had 2,000 inhabitants, had in 1872 only 650. M. Leborgne shows, however, that although alcoholism does not exist in these islands, where fevers and smallpox are unknown, rheumatic, neuralgic and nephritic affections are not uncommon, whilst phthisis and scrofulous degeneration are attended by a frightful mortality, which seems to point to the injurious results of consanguineous unions. M. Broca is disposed to attribute the gradual diminution of the Polynesian and other analogous peoples to the moral action of certain depressing influences to which savages are exposed when they find themselves brought suddenly in contact with civilised men. The very contact of civilisation seems to exert in and for itself a destructive action on their physical nature. M. de Quatrefages considers, in a separate paper, the same question in reference to the general diffusion amongst the Polynesian races of tuberculosis, which was not observed by the early discoverers, but has now attained such dimensions that its presence could scarcely escape the notice of the least observant travellers. In the universality of its destructive action on all the Australasian islands, M. de Quatrefages sees another and most incontrovertible evidence of the unity of the entire race.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, June 15.—In this number is commenced a review by Herr Fritsch of M. Poëy's "New Classification of Clouds," published in the *Annales Hydrographiques*. After insisting on the importance to sailors, farmers, gardeners, and others, of a knowledge of clouds with a view to prediction, M. Poëy has remarked how few observers have recorded the kind of cloud, the shape, rate of movement, course, and change of direction or shift, which differs with the height at which it floats. The ideas of men who have busied themselves with clouds, from Aristotle to Maury, are commented upon and criticised. Lamarck was the first to divide clouds into classes, and Howard's system, which followed independently a year later, differed but slightly in the main from that of the French naturalist. The stratus of Howard he regards as nothing but a fog, and the cumulo-stratus as a cumulus. His own fracto-cumulus resembles Lamarck's "attroupés," and his pallio-cirrus and pallio-cumulus, determined by observation in the Antilles, replace the nimbus of Howard. The sub-divisions of Admiral Fitzroy, based merely upon quantity, lead to error. As to the stratus, the first mistake arose from its being described as a mist by Howard himself, and the next from his followers raising the thin streak of fog to the dignity of a cloud. For Kämtz says of the cirro-stratus, that when seen at the zenith it appears to be made up of a number of cloudlets, but near the horizon like a long and very narrow streak. This cloud might therefore be confused with the stratus as represented, especially as both are common at sunrise and sunset. This error, namely, making the stratus anything but a fog, has been followed in all publications since 1815, including one of Kämtz in 1840, and the plates of Schübler, of the Smithsonian Institution, of Maury, and of the French Ministry of Marine (see NATURE, vol. ix. p. 163).

Reale Istituto Lombardo. Rendiconti: t. vii. fasc. vi., March.—The following papers are contained in this number:—In hydraulics there is a paper by M.E. Lombardini, On floods and on the inundation of the Po in 1872.—In experimental physics, Prof. Rinaldo Ferrin contributes a paper On the reversal of the current in Holtz's electric machine.—Prof. Alfonso Corradi contributes a paper to the history of medicine on certain unpublished writings of Morgagni.—Tome vii. fasc. vi., April, contains the following papers:—In the section of mathematical and natural science there is an anthropological paper by Prof. Cesare Lombroso, On tattooing amongst criminals in Italy.—In chemistry there is a note by Prof. Egidio Pollacci, On the action of sulphur on earthy carbonates, particularly on calcium carbonate as relating to geology and agriculture.—In mechanics, Prof. Giuseppe Bardelli contributes a mathematical note entitled "Researches on the moment of inertia."

Fünfzigste Jahresbericht der Schlesischen Gesellschaft für Vaterländische Cultur (1872).—This Society has its head-quarters at Breslau, and, according to the present report, numbers 443 acting, 32 honorary, and 198 corresponding members. It is at present under the presidency of Dr. Göppert. The account of proceedings, now before us, attests considerable vigour and industry during the year. In the department of natural science, perhaps the most important paper is that of Prof. Cohn, giving the results of his observations on Bacteria, and their relation to putrefaction and contagion.—Dr. Roemer reports on some bone-remains of rhinoceros found in the Trachenberg; and Dr. Göppert traces the history of the elk in Silesia.—The family of the Cirratulides is described by Prof. Grube; and we also find accounts of a collection of Javan birds, and Transcaucasian insects in the Society's museum, and of plant-eating Cetacea.—Dr. Poleck discusses the experimental bases of the so-called modern chemistry.—Prof. Cohn's report in the botanical section is of considerable length. We may note in it Dr. Stenzel's paper, On the Riesengebirge as a limit of vegetation. He finds that about thirteen species of phanerogam and cryptogram vascular plants belong only to the Silesian side, and about as many only to the Bohemian side of the range. The entire number of plant species in that highland region is estimated at about 200, so that about an eighth finds its limit at the watershed of the range.—There is also an instructive paper by Prof. Göppert, On the relation of the plant-world to weather.—Dr. Schröter communicates a list of the fungi he has met with at Rastatt during a four years' residence; and Dr. Göppert reports on the fungus collection in the museum of the Botanical Garden in Breslau.—Descriptions of flora of the Grünberg and other localities in Silesia are furnished by various observers.—The Society has a section specially devoted to horticulture, and the report on this, presented by M. Müller, contains a good deal that will be found of value by the practical gardener.

SOCIETIES AND ACADEMIES

London

Geological Society, June 24.—John Evans, F.R.S., president, in the chair.—The following communications were read:—New Carboniferous Polyzoa, by Prof. John Young, and Mr. John Young, Hunterian Museum, Glasgow University (see NATURE, vol. ix., p. 456).—On *Palæocoryne* and other polyzoal appendages, by Prof. John Young and Mr. John Young, Hunterian Museum, Glasgow University.—The steppes of Siberia, by Thomas Belt. The author described the portion of the Siberian steppes traversed by him as consisting of sand and loam. The best section seen by him was at Pavlodar, where he found 1 ft. of surface-soil, 20 ft. of stratified reddish-brown sand, with lines of small gravel, 8 ft. of light-coloured sandy silt, 15 ft. of coarse sand, with lines of small pebbles and one line of large ones, and 6 ft. of clayey unlaminated silt, with fragments of the bed-rock in its lower half, the bed-rock being magnesian limestone much crushed at the top. The generally accepted marine origin of the great plain was said to be negatived by the absence of sea shells in its deposits, whilst *Cyrena fluminalis* occurs in them. The author regards them as deposits from a great expanse of fresh water kept back by a barrier of polar ice descending far towards the south. In its greatest extension this ice-barrier would produce the crushing of the bed-rock; and as it retreated, the water coming down from the higher ground in the south would cover a continually increasing surface.—On the microscopic structure and composition of British Carboniferous dolerites, by S. Allport.—Additional remarks on boulders, with a particular reference to a group of very large and far-travelled erratics in Llanarmon parish, Denbighshire, by D. Mackintosh.—Note on the Bingera diamond-fields, by Archibald Liversidge.—Remarks on the working of the molar teeth of the *Diprotodon*, by Gerard Krefft, F.L.S.; communicated by the president. In this paper the author criticised a figure of the lower molars of *Diprotodon*, published by Prof. Owen, on the ground that the teeth are represented in it in an unabraded state, and stated that when the last tooth breaks through the gum the first of the series is always worn flat. He also remarked on the peculiar modification of the premolar in the genus *Diprotodon*.—Descriptions of species of *Chætetes* from the lower Silurian rocks of North America, by Prof. H. Alleyne Nicholson, F.R.S.E. In this paper the author accepted the union of *Chætetes* and *Stenopora* made by Milne Edwards and Haime, and stated that *Monticulipora* D'Orb. and *Nebulipora* McCoy, also seemed to him to belong to the same generic group, for which he proposed to employ the name *Chætetes*.—On the composition and structure of the bony palate of *Ctenodus*, by L. C. Miall; communicated by Prof. P. Martin Duncan, F.R.S.—Notes on a railway section of the Lower Lias and Rhætics between Stratford-on-Avon and Fenny Compton, and on the occurrence of the Rhætics near Kineton and the Insect-beds near Knowle in Warwickshire, and on the recent discovery of the Rhætics near Leicester, by the Rev. P. B. Brodie.—The resemblances of ichthyosaurian bones

to the bones of other animals, by Harry Govier Seeley, F.L.S. In this paper the author endeavoured to give precision to the term ichthyosaurian by analysing the characters of the Ichthyosaurian skeleton into the resemblances which it presents to skeletons of other vertebrates. Ichthyosaurian characters are subdivided into Mammalian, Avian, Crocodilian, Chelonian, Lacertilian, Camelonian, Rhynchocephalian, Ophidian, Urodelan, Piscine, Plesiosaurian, Dinosaurian, Dicynodont, and Labyrinthodont. By thus classifying the characteis it is anticipated that the affinities of the Ichthyosaurian type n ay be rendered evident.—The resemblances of Pleiosaurian bones with the bones of other animals, by Harry Govier Seeley, F.L.S. This paper is an attempt to make a similar analysis of the Plesiosaurian skeleton.—On the tibia of *Megalornis*, a large struthious bird from the London clay, by Harry Govier Seeley, F.L.S. The author considered that the skull named by Prof. Owen *Dasornis* might, if it belonged to a bird, be referred to *Megalornis*; but he detailed considerations which led him to suggest that *Dasornis* may possibly be a fish.—On cervical and dorsal vertebræ of *Crocodilus cantabrigiensis* Seeley, from the Cambridge Upper Greensand, by Harry Govier Seeley, F.L.S.—On the base of a large Lacertian skull from the Potton sands, by Harry Govier Seeley, F.L.S. This specimen was interpreted by the author as the anchylosed basioccipital and basisphenoid of a Dinosaur. The author did not regard the specimen as giving support to Prof. Huxley's hypothesis of the Avian affinities of Dinosaurs.—A section through the Devonian strata of West Somerset, by Harry Govier Seeley, F.L.S.—On the pectoral arch and fore limb of *Ophthalmosaurus*, by Harry Govier Seeley, F.L.S. After some remarks on the structure of the pectoral arch in *Ichthyosaurus* the author described parts of a skeleton discovered by Mr. Leeds in the Oxford clay, on which he founded the genus *Ophthalmosaurus*.—The glacial phenomena of the Eden Valley and the western part of the Yorkshire Dale district, by J. G. Goodchild; communicated by H. W. Bristow, F.R.S. This paper is a continuation, in a northward direction, of the investigation of glacial phenomena which formed the matter of a paper lately read before the Society by Mr. Tiddeman, and published in the Society's journal.—Geological observations made on a visit to the Chaderkul, Thian Shan range, by the late Dr. F. Stoliczka. In this paper the author gives an account of the geology of the district traversed by him in his journey from near Kashgar to Lake Chaderkul on the Russian frontier, a distance of about 112 miles, his route lying among the southern branches of the Thian Shan Range. Three principal ridges were crossed. The first, or "Artush ridge," consisted of newer Tertiary deposits of bedded clay and sand, mostly of a yellowish white colour. These "Artush beds" were traced by the author for a distance of 22 miles. The southern slopes of this range were covered with gravel from 10 to 15 ft. thick, which passes into a conglomerate with a thickness of about 200 ft. The second, or "Kokan range," is formed on the southern side of old sedimentary rocks, whilst the northern is occupied by newer Tertiary deposits and basaltic rocks, the former consisting of shales and limestones, in which the author found some fossils, inducing him to refer them to the Trias. These are succeeded by some dark-coloured shales, slates, and sandstones, dipping at a high angle to the north. On the denuded edges of these the new Tertiaries rest, consisting of sandstones interstratified with basaltic rocks. These latter increase in thickness till just beyond Kulja an old "somma" is reached, with perpendicular walls rising to a height of 1,500 ft. above the river. The cone of the volcano has disappeared by subsidence. The third ridge, "Terek-tagh," consists of old sedimentary rocks, chiefly limestones.—Note upon a recent discovery of tin-ore in Tasmania, by Charles Gould.—Note on the occurrence of a Labyrinthodont in the Yoredale rocks of Wensleydale, by L. C. Miall; communicated by Prof. Huxley, F.R.S. The author briefly describes a specimen, discovered by Mr. W. Horne, of Leyburn, in the Lower Carboniferous Rocks there, comprising casts of five bones. He considers that these bones belong to an animal of higher rank than any known fish, and thinks that the Lower Coal-measures of Glasgow, with *Loxomma*, may be of earlier date than the Yoredale Rocks.—Geological Notes on the route traversed by the Yarkund Embassy from Shahidulla to Yarkund and Kashgar, by Dr. F. Stolickza. The author described the rocks observed by him along the course of the Karakash river and through the Sanju pass as chiefly metamorphic, and very highly inclined, until near Yám sedimentary rocks rest unconformably on the schists. These are probably Palæozoic. Later rocks occur near the camp Kiwáz, some resembling the rocks of the Nahún group, and underlain by deposits containing Carboniferous fossils. At Sanju coarse grey calcareous sandstones and chloritic marls of Cretaceous age occur. True Löss occurs in some of the valleys.—The hematic deposits of Whitehaven and Furness, by J. D. Kendall.—Notes on the Physical Characters and Mineralogy of Newfoundland, by John Milne. Notes on the Sinaitic Peninsula and north-western Arabia, by John Milne.—Giants' Kettles at Christiania, by MM. W. C. Brögger and H. H. Reusch; communicated by Prof. Kjerulf. The authors first refer to the popular notices about giants' kettles, and describe in detail a number of these pits, which were examined and emptied near Christiania. They then mention the theory concerning their origin. From their own facts and reading they conclude that many of these remarkable pits were made at the bottom of "Moulins" during a glacial period, when the locality was covered with ice on the scale of existing ice in Greenland. The contents of these pits are traced to their parent rocks, which are higher up towards the great valley of Gulbransdal, in which glacial phenomena abound. They are inclined to conclude that moraine matter was washed off the glacier-ice from time to time, and left in the pits at last.

Geologists' Association, July 3.—Henry Woodward, F.R.S. president, in the chair.—On the deposits now forming in British seas, by G. A. Lebour, F.G.S. The author limited his present task to a brief description of the principal constituents of British sea-bottoms, with particular reference to their distribution and its causes. The materials are of mechanical, chemical, or organic origin.—*Rock-bottoms.* In some places no deposit occurs, the bare rock being left. The largest of these bare spots, in British seas, occurs in the western half of the Channel Valley. Their distribution is directly connected with that of currents, and this is strikingly proved by their being limited to no relative depth; for, in the Channel, their range extends entirely across the valley. Another bare area exists at the point where the Atlantic cable enters the yet deeper region of the Atlantic ooze in 500 fathoms water. The specimens brought up by the sounding instruments from such places consist of weathered and rotten stone, pointing to chemical rather than mechanical disintegration, even where powerful currents are present.—*Marine deposits.* These consist chiefly of sand, with occasional islands of clay, mud, gravel, and shell detritus. The broader the sea the greater the proportion of sand: thus the North Sea bottom is especially a sandy one, though towards the centre the sand becomes muddy over a considerable region. Sandy bottoms also largely prevail in the north-western seas and on the west coast of Ireland; but south of Ireland a large expanse of pure mud and muddy sand extends in a south-easterly direction.—*Organic deposits.* In the Channel the shell deposits attain their greatest development as regards British seas. There they form two long, occasionally broken lines, following at a short distance the English and French shores, and forming at the outer mouth of the Channel a vast shell bank. These deposits actually cross the broad sea-valley partly over and considerably to the west of the spread of bare rock previously mentioned. Beyond the ocean valley which lies between the Hebrides and the Rock-hall reef, there occurs a fish bank more than three miles in length, affording us an inkling of the manner in which some of our long-fossilised fish-beds may originally have been accumulated.—*Fluvio-marine deposits.* The Thames, Seine, and Tay form mud banks in a sandy sea. The submarine delta of the former has the shape of a triangle, of which the apex points seawards; that of the Seine is also triangular in outline, but the apex points landwards. Such submarine deltas can only be recognised when the materials of which they consist are distinct from those forming the prevailing sea-bottom. Although much of the above materials are at present incoherent, especially the sands, it is not probable that the larger features of the sea-bottoms are liable to important changes, whilst the surrounding geographical conditions remain unaltered. The same agencies, which sweep certain spots, have heaped-up material elsewhere, and the relative form of both covered and uncovered portions of the sea-floor is preserved by them. The points of the greatest violence of current action are shown by the bare rock patches, whilst the intermediate stages of agitation are represented by coarse shingle, sandy gravel, sand, and finally patches of mud or clay supervene, which, to a certain extent, indicate centres of calm.

Entomological Society, July 6.—Sir Sidney Smith

Saunders, president, in the chair.—Prof. Westwood exhibited specimens of *Haltica aurata*, which he had found to be very injurious to young rose-leaves. Also, a portion of a walnut attacked by a Lepidopterous larva, probably a Tortrix; but he was unable to name the species, as it produced only an ichneumon. It was the first instance he had known of a walnut being attacked by an insect in this country. Mr. F. Moore stated that he had on one occasion reared *Carpocapra splendana* (a species that usually feeds on acorns) from a walnut.—Prof. Westwood made some remarks on the Yucca moth (*Pronuba yuccasella* Riley), of which some fifty specimens had been sent to him, in the pupa state, by Mr. Riley; but he had succeeded in rearing only three. He exhibited a drawing of a portion of the insect, showing the extraordinary form of the pulpi, which was especially adapted for collecting the pollen, with which it impregnated the female flowers. He directed attention to a full description of the insect and its habits by Mr. Riley, in the sixth Annual Report of the Insects of Missouri.—Prof. Westwood also exhibited some bees which had been sent to him from Dublin, having been found attacking the hives of the honey-bees. They were smaller than the honey-bee, and black, and he considered them to be only a degenerated variety of *Apis mellifica*. He suggested the probability of their being identical with the "black bees" mentioned by Huber.—Mr. Champion exhibited *Amara alpina* and other beetles from Aviemore, Invernesshire.—The Secretary exhibited some specimens of a Dipterous insect which had been found in the larva state in an old Turkey carpet. The larva was very long, slender, and serpentiform; it was white and shining, and had something the appearance of a wire worm, but much longer, and without feet. The name of the insect was not ascertained.—Mr. Bond exhibited specimens of *Argas pipistrellæ* parasitic on a bat, and also some *Acari* from a small species of fly; both were from the Isle of Wight.—Mr. Boyd exhibited specimens of *Thecla rubi* from St. Leonard's Forest, differing in certain points from the ordinary type.—Mr. Wormald exhibited a collection of butterflies sent from Japan by Mr. H. S. Pryer.—Mr. W. Cole exhibited some galls of a species of *Cecidomyia*, found in West Wickham Wood.—Mr. F. Smith exhibited some earthen cocoons found on wet mud at Weymouth by Mr. Joshua Brown. They proved to belong to a Dipterous insect (*Machærium maritimum*), one of the *Dolichopidæ*.—Mr. S. Stevens exhibited specimens of *Asopia nemoralis* from Abbot's Wood, Lewes, and other Lepidopterous insects.—Mr. Butler exhibited a copy of a very rare (if not unique) book, which had recently come into the possession of Mr. E. W. Janson, entitled Lee's "Coloured Specimens to illustrate the Natural History of Butterflies" (London, 1806). He could not find that it had been quoted in any synonymic catalogue, and it contained coloured drawings and diagnoses of nineteen species of butterflies.—The Rev. H. S. Gorham read descriptions of species of Endomycid Coleoptera not comprised in his catalogue, "Endomycici recitati." Also, Some remarks on the genus *Helota* (*Nitidulidæ*), of which he described a new species from Japan.—Dr. Sharp communicated a supplementary paper On some additional Coleoptera from Japan.—Prof. Westwood communicated Descriptions of new species of *Cetoniidæ*, principally from the collection of Mr. Higgins.—The President announced that the library of the Society would remain for another year at 12, Bedford Row, and it was hoped that by that time some more permanent and suitable place would be obtained for it.—Part III. of the Transactions of the Society for 1874 were on the table.

PARIS

Academy of Sciences, July 13.—M. Bertrand in the chair.—The perpetual secretary announced the death of M. Angström, and the president made some remarks expressive of the regret of the Academy at the loss they had sustained. The following papers were read:—Observations relating to M. Tacchini's last note and to the recent memoir of M. Langley, by M. Faye. The author gave an extract from Langley's memoir, showing that this observer accepted, with certain restrictions, the cyclone theory of sun-spots.—On chemical actions other than metallic reductions produced in capillary spaces, by M. Becquerel. This is a continuation of the author's researches in electrochemistry.—Observations on the subject of the establishment of an inland sea in Algeria, by M. de Lesseps.—Memoir on the chronological classification of geological formations, by A. E. B. de Chancourtois.—On some applications of Abel's theorem to curves of the second degree relative to the elliptic functions, by M. H. Léauté.—On the observation of a phenomenon analogous to that of the "*goutte noire*," by M. Devic.—Observations on the obstacles to be opposed to the attack of vines by Phylloxera, a letter from M. Bourgeois to M. Dumas. The writer made four propositions relating to (1) the direct destruction of the insects; (2) the preservation of isolated stocks; (3) the preservation of a field of vines not attacked; and (4) treatment of a field partially attacked. Several members made remarks on the same subject. M. Elie de Beaumont suggested the use of snow.—Note relating to the *viriel* of M. Clausius, by M. F. Lucas.—Note relating to the theory of osculatory surfaces, by Mr. Spottiswoode.—Remarks on the pyrheliometric observations of Pouillet, a reply to the criticisms of M. Faye, by M. Duponchel.—On chemical achromatism, by M. Prazmowski. This was a note descriptive of the construction of the photographic objective to be used by M. Janssen for photographing the solar disc.—Second note on the electric conductivity of ligneous bodies, by M. Th. du Moncel.—On indications furnished by conjugate thermometers *in vacuo*, by M. Marié-Davy.—Qualitative research on arsenic in organic and inorganic substances, by MM. Mayençon and Bergeret. The authors have devised a new plan for detecting arsenic (depending upon the action of arsenetted hydrogen on mercuric chloride), which possesses extreme delicacy.—Action of heat on the isomers of anthracene and their hydrides, by M. Ph. Barbier. The author has extended his investigations to the following substances:—the two ditolyls, ethylene and diphenyl mixed, and benzyltoluene. Fritzsche's phosene appears to have been a mixture of anthracene and phenanthrene.—New experiments on human locomotion, by M. Marey.—New experimental researches on inflammation and mode of production of leucocytes of pus, by M. J. Picot. Action of salts of biliary acids, by MM. V. Feltz and E. Ritter.—Observations on the first phases of development of *Pelobates fuscus*, by M. G. Moquin-Tandon. These phases are in the main identical with those of the common toad.—Analyses of the samples of wine exhibited at the exhibition of the Pavillon du Progrès, by M. Ch. Mène.—On globular lightning, by M. Gaultier de Claubry. This was a description of some of the effects of the thunderstorm which broke over Paris on Thursday the 9th inst.

BOOKS RECEIVED

AMERICAN.—Baird's Annual Record, 1873.—Proceedings of the Boston Society of Natural History, vol. xvi. part ii.—Field Ornithology, comprising a Manual of Instruction for procuring, preparing, and preserving Birds, and a Check List of North American Birds: Dr Elliott Coues, U.S.A. (Trübner).—The Birds of Florida, Part iii.: C. J. Maynard (Ipswich, U.S.A.).—Bulletin of the Buffalo Society of Natural Science (Warren & Co., Buffalo).—Circles of Deposition of American Sedimentary Rocks: J. S. Newberry.—Theory of Arches: Prof. W. Allan (Van Nostram, N.Y.).—My Visit to the Sun: or, Critical Essays: Laurence S. Benson (J. S. Burton, N.Y.).—Annual Report of the Trustees of the Museum of Zoology, Harvard, Camb. U.S.A. for 1873.—Birds of Western and North-Western Mexico: G. A. Lawrence (Boston Natural History Society).—The Organisation and Progress of the Anderson School of Natural History (Welch, Biglow & Co., Camb. U.S.A.).—Sea Fisheries of the South Coast of New England: Spencer and Baird (Washington).—The Vertebrate Animals of Vineyard Sound: A. E. Verrill and S. J. Smith (Washington).—First, Second, and Third Annual Reports of the United States Geological Survey of the Territories for 1867-69 (Washington).—Geological Survey of Ohio, vol. i. Palæontology (Columbus).—Reports of the Geological Survey of Missouri, 1855-71 (Jefferson City).—Reports of the Geological Survey of Missouri Iron Ores and Coalfields, 1872 (N.Y.).—Atlas to Geological Survey of Missouri (N.Y.).

CONTENTS

THURSDAY, JULY 30, 1874

JOSEPH PRIESTLEY

DURING the present week the centenary of the birth of Modern Chemistry, as the discovery of oxygen on August 1, 1774, may justly be called, is being celebrated both in this country at Birmingham and Leeds, and in America at Northumberland, Pennsylvania; we have therefore thought it would be acceptable to our readers to be reminded of the principal events in the life of the author of this all-important discovery.

Joseph Priestley was born on March 13, 1733, at Fieldhead, near Leeds. At the age of six years he lost his mother, and his education was superintended by Mrs. Keighley, his aunt, a woman apparently of unusually wide sympathies. At an early age young Priestley distinguished himself at school by his great aptitude for learning languages; he was familiar with Chaldean, Syriac, and Arabic, and without the aid of a master acquired some knowledge of German, French, and Italian. A pupil of Maclaurin taught him mathematics. He took great interest in theological controversies, and his aunt's tastes provided him with many opportunities of gratifying his liking in this matter. Having studied for the Dissenting ministry, he was called to be minister of a small Unitarian congregation at Needham Market, in Suffolk, in 1755. Here he remained until 1758, when he went to occupy a similar post at Nantwich, in Cheshire. Here he opened a school, and by dint of rigid economy was able to buy some physical apparatus, with which he made, to his young pupils, a series of experiments that drew upon him the notice of the authorities of the Warrington Academy, so well known in connection with the name of Aikin. In 1761 he went to this Academy to take Dr. Aikin's place as teacher of languages and literature, and soon after married the daughter of a Welsh ironmaster. While at Warrington he published a number of works on various subjects, including the "Theory of Language and Universal Language" (1762-68), "Essay on a Course of Liberal Education for Civil and Active Life" (1765), "Chart of Biography" (1765), Chart of History" (1769), &c. A visit which he made to London during this period gave him the opportunity of forming a lasting friendship with Franklin and Price. He communicated to the former his intention of writing a history of discoveries in the department of electricity; and not only did he receive from Franklin a warm approval of the scheme, but also all the books and memoirs he required; and before the end of the year, by dint of persevering work, the first volume was published, under the title of "The History of Electricity" (London, 1764, 4to). Three editions of this were published by 1775; but it bears evident marks of having been written in haste.

Previous to the publication of this work, in 1766, Priestley was chosen a Fellow of the Royal Society, and about the same time the University of Edinburgh conferred upon him the honorary degree of LL.D. In the same year as the above-mentioned work was published, Priestley left Warrington and became pastor of Mill-hill Chapel, in Leeds. While here he was much occupied with theological controversies, but by no means neglected his scientific studies, as about 1768 his attention was drawn to chemistry, the result being that in 1772 he communicated to the Royal Society a paper entitled "Observations on different kinds of Air," for which the Copley Medal was awarded to him.

Meantime, Priestley had received an offer to accompany Capt. Cook on his second expedition to the South Seas; this he accepted gladly, but received an intimation that his nomination had not been confirmed by the Board of Longitude on account of his advanced theological opinions. In 1773, however, at the recommendation of his friend Price, he was appointed librarian to the Earl of Shelburne (afterwards Marquis of Lansdowne) at a comparatively liberal salary. In the following year, he accompanied this nobleman into France, Germany, and the Low Countries. At Paris his scientific reputation easily procured him the acquaintanceship of well-known men of science. Besides his salary, Lord Shelburne allowed him expenses for a laboratory, and it was on Aug. 1, 1774, that he made the discovery which marks so important an epoch in the progress of chemical science, and the centenary of which is being celebrated both in England and in America during the present week. The discovery was that of oxygen gas, which he announced in his "Experiments and Observations on Air," the first volume of which was published in 1774.

For some unexplained reason, Priestley and Lord Shelburne parted in 1780, the latter covenanting to allow the former till his death a pension of 150*l.* Priestley then settled in Birmingham, to which he was attracted, no doubt, by the prospect of meeting with men of kindred scientific tastes. Here he was chosen pastor of one of the principal Dissenting churches, his friends subscribing to defray the expenses of his scientific experiments and his theological controversies, for he was regarded as one of the greatest controversialists of his age. His opinions both on ecclesiastical and political topics were much ahead of his age; but this is not the place to enlarge on this aspect of the character of this remarkable man. We may only mention that he was brought forward as a candidate for the French National Convention, and was nominated a French citizen, a title of which he was very proud. For his unconcealed liberality and advanced opinions he was doomed, however, to suffer, as the populace of Birmingham, roused to a state of blind fury by the partisans of Government, rushed to Priestley's house, July 14, 1791, and set fire to it, reducing it and nearly all it contained to ashes. However, as the result of an examination, Priestley subsequently received an indemnity of 2,000*l.* for this mad act, this sum being considerably increased by the liberality of his private friends.

Although no word of complaint escaped Priestley concerning this misfortune, it no doubt influenced him to a considerable extent in deciding him to quit his native land for republican America. After spending three years in a college at Hackney, as Professor of Chemistry and minister, he embarked on April 7, 1794, and fixed his residence at Northumberland, in Pennsylvania. Even here it was some time before he was allowed to remain at peace, as a spiteful rumour had been circulated that he was a secret agent of the French Republic. Here he lost his wife and

his youngest son, and here he himself died on Feb. 6, 1804.

Turning now from the external aspects of Priestley's life, let us consider the position he held as a philosopher and the influence that his discoveries had on the science of his time. The ever-memorable discovery of "dephlogisticated air" on Aug. 1, 1774, marks an epoch in the annals of chemistry with which the name of Dr. Joseph Priestley will be always associated. He obtained it by exposing a quantity of red precipitate of mercury to the action of the sun's rays concentrated upon it by a lens; the red precipitate was contained in a flask filled up with mercury and inserted in a basin containing the same metal. "I presently found," he says, "that by means of this lens air was expelled from it very readily. Having got several times as much as the bulk of my materials, I admitted water to it, and found that it was not imbibed by it; but what surprised me more than I can well express, was that a candle burned in this air with a remarkably vigorous flame, very much like that enlarged flame with which a candle burns in nitrous air exposed to iron or lead of sulphur; but, as I got nothing like this remarkable appearance from any kind of air besides this particular modification of nitrous air, and I knew no nitrous acid was used in the preparation of *mercurius calcinatus*, I was utterly at a loss how to account for it." He then goes on to show that red lead and nitre also afford oxygen at a red heat, and calls it, consistently with the theory of combustion which was then prevalent, *dephlogisticated air*, regarding it as common air deprived of phlogiston, and consequently possessed of a powerful affinity for that imaginary principle.

This discovery, however, though unquestionably brilliant, must not be allowed to eclipse those other numerous and valuable contributions to science with which this indefatigable worker enriched the stores of natural knowledge during a period ranging from 1768 to 1800. There are indeed few branches of natural science which did not reap some benefit, direct or indirect, from the discoveries of the experimenter whose memory we now recall.

On the 17th of August, 1771, Priestley enclosed a sprig of mint in air in which a taper had been allowed to burn out, and he found on the 27th of the month that the same air then permitted the combustion of another taper with perfect facility. Thus was the secret of vegetable respiration first made known. In the discoverer's own words: "This restoration of air I found depended upon the vegetating state of the plant; for though I kept a great number of the fresh leaves of mint in a small quantity of air in which candles had burned out, and changed them frequently for a long space of time, I could perceive no melioration in the state of the air." In pneumatic chemistry (of which the germs had been originated by Black, Mayow, Hooke, and Hales), Priestley found a new engine of research, and in his hands this Οργανον yielded vast results. His productions in pure chemistry are too well known to be discussed fully here, even did space permit. In addition to oxygen he discovered nitrous oxide (1776), sulphurous anhydride (1774), ammonia gas (1774), carbonic oxide and hydrochloric acid gas (1772): he was also the first to investigate the properties of nitric oxide. We may point to nitrous oxide *en passant* as one of the many instances in which pure science has furnished a substance of practical utility to man: the discoverer of "dephlogisticated nitrous air" little dreamt that the lapse of a century would see this substance used as an anæsthetic for the purposes of dentistry. The pneumatic and mercurial troughs, now indispensable parts of our laboratory "plant," were also bequeathed to us by the philosopher of Fieldhead. Although chemistry received the greater part of Priestley's attention, other branches of science, as before stated, received the benefit of his thoughts. Thus we find a work by him bearing the date 1772, entitled "The History and Present State of Discoveries relating to Vision, Light, and Colours," and we have already referred to his "History of Electricity." From a catalogue of Priestley's works, printed at the end of his "Experiments and Observations relating to various branches of Natural Philosophy," we find that this extraordinary man was the author of no less than thirty-six volumes on various subjects; among others, the theory and practice of perspective, charts of history and biography, rudiments of grammar, observations on education, a course of lectures on oratory and criticism, an essay on the first principles of government, and on the nature of political, civil, and religious liberty, together with large numbers of works on metaphysical subjects and on theology.

But it is with the *chemical* aspect of Priestley's life that we are more particularly concerned at present. The anniversary about to be celebrated is that of a purely chemical discovery, and one which to us appears doubly important, first, from the great flood of light which it shed on the processes of combustion and of respiration, both animal and vegetable, aërial and aquatic; and secondly, from the powerful illustration which it affords of the value of a new method in scientific investigation. The purely practical results which in after years flowed from the discovery of oxygen, such, for example, as the oxy-hydrogen blowpipe, which enables large quantities of platinum and of the most refractory metals to be smelted with ease, are at present of minor interest. Is it not this over-anxious regard for "practical results" that has led to the complaints, too frequently made, about the decline of chemical research in England? The spirit of the old investigators of the school of Priestley, Cavendish, and Black seems to be forsaking us, and, with certain exceptions, our most efficient workers are devoting their time and energies to effecting permutations and combinations among the elements—in seeing in how many ways certain atoms of carbon, hydrogen, and oxygen can be combined, or in locating atoms to certain imaginary positions in space. It must not be for a moment supposed that we advocate the entire cessation of this kind of work—it is useful in its way as supplying facts, but by itself it is not sufficient to lead us to hope for any great advancement in our knowledge of chemical laws. The greatest advancements in chemistry have been the results of the application of *physical* discoveries—witness the vapour-density control for the formulæ of compounds and the atomic weights of the elementary gases; or the determination of specific heat as a means of controlling the atomic weight; or turn again to that great engine of modern research, the spectroscope, which has enabled us to extend our list of known elements, and which reduces

the chemistry of this globe and of suns infinitely remote to one common basis. So also is isomorphism an essentially physical phenomenon and one for the explanation of which we shall doubtless be hereafter indebted to physics. The Newton of chemistry may be looked for in the ranks of physicists. In the meantime let us only hope for "new methods" of research—let investigators seek for some method bearing the same relation to our chemistry that the "pneumatic chemistry" of Priestley did to that of his time.

ON TESTIMONIALISM

JUST now, there must be several scientific men asking themselves what can be the conceivable value of testimonials in determining the relative fitness of a number of candidates for any appointment of such importance as a Professorship of a most important branch of natural science in a great seat of learning.

It is not a point of any great difficulty to determine, to one's mental satisfaction, in what cases testimonials are of value—for they are sometimes most useful—and when they are worthless in comparison to other methods for testing the relative efficiency of different men.

Testimonials, or an examination, or the two combined, are no doubt necessary, when the post to be competed for is one, the qualities required for which are not capable of being exhibited to an electoral body by the competitors in any other way. For minor appointments, therefore, such as clerkships, smaller educational posts and the like, they are indispensable; as they are in cases where the intimacy of the relationship between the holder of the post and those he is placed above is close. But for appointments so honourable and responsible as the Professorship of Physiology in the University of Edinburgh, or that of Chemistry in the University of Glasgow, we cannot help thinking that testimonials are a farce. Candidates for such chairs are not youths; they must have had the opportunity of maturing their minds by careful training, during which time frequent opportunities must have occurred for them to take up some fresh branch of their subject and work it out independently, with some originality in the methods they employ. Their confidence in their methods and results ought to have been sufficient to make them publish them, and so expose them to the criticism of the scientific public, who do not generally take long to form a fairly correct estimate of the abilities of authors. If all candidates for important posts were compelled to rely for their election on their works alone as testimonials, we are sure that the electors would be less trammelled, and more in a position to make judicious selections.

By some it may be remarked that what is wanted in the cases above instanced is good teachers, and that if men with original power can be obtained at the same time, so much the better; this requirement makes the general ability of the professor a secondary consideration in comparison with his teaching powers. We are of opinion that this is a mistaken view of the subject. Very frequently the most talented followers of scientific inquiry are not such effective lecturers at first sight as their less-gifted colleagues; still, we never knew a case in which there was not a peculiar charm about the teaching of a master-mind that gives an impulse to study on the part of the student, producing in the long run more beneficial results than the routine discourses of a mere expositor of other people's work. Another thing is that the connection of great names with a seat of learning in itself gives a stimulus to younger workers, raising success in mental work to a position which it is not easy for it to attain, on account of the fact that its results have frequently no immediate practical bearing.

In one at least of the cases we are referring to it is unfortunate in some respects that the electors have no special interest in the science they have so great a power indirectly to advance. In consequence of this their knowledge of the respective merits of the candidates must be uncertain, and we do not think that it will be much increased by the showers of testimonials which it is evidently the intention of more than one of the candidates to submit. One candidate has sent broadcast a lithographed form, sometimes even to men his junior in position and age, courting testimonials. What possibly can be the value of the pound's weight of paper he will probably thus accumulate? He ought to remember that no number of shots from a smooth-bore gun will send a ball as far as a single one from an Armstrong, and on that principle reduce the number and endeavour to increase the quality of the testimonials he sends in; by which means he will save the adjectives as well as the temper of his acquaintances.

Another candidate sends us the printed list of his published works, and to that we see no particular objection. But appended to each is a selected series of reviews, from which all the unfavourable ones are carefully omitted. It is, no doubt, unpleasant to print adverse criticism, but how can the electors be expected to form a correct estimate of the value of the works reviewed, if those in their favour only are introduced? The reviews, as one-sided, had been much better omitted, or, if printed, had much better have been inserted without selection. It is this extreme mode of action thus adopted which has called our attention to the subject.

On the whole, we think that the electors for the Scotch Science Chairs have a by no means easy task before them, and we sincerely hope that in their selection they will lay stress on soundness of judgment and scientific thought rather than on quires of testimonials wrung out of acquaintances and friends, who would much rather have been otherwise employed than in putting pen to paper for the purpose.

Moreover, we are of opinion that not only should a man's researches be taken into account in making an appointment to any science chair, but also that no election should be made without taking the opinion of those competent to form an estimate of the value of these researches.

THE RAINFALL OF BARBÁDOS

Report upon the Rainfall of Barbados, and upon its influence on the Sugar Crops, 1847-1871. With two Supplements, 1873-74. By Governor Rawson, C.B.

THIS Report gives the result of observations made since 1847, at a large number of stations well distributed over the island. The total area of Barbados s 166 square miles; in 1847, only three stations had

been established, in 1873 there were 178, so that at present there is more than one gauge to every square mile. By this system the conditions of local rainfall have been, as it were, put under the microscope; and the store of information obtained after the suggestive manner in which it has been analysed in this Report, will be not only valuable to the sugar-planter, but interesting to the meteorologist.

The north-east trade-wind prevails at Barbados during three-fourths of the year, and most of the rain comes from that quarter. Heavy showers come at certain seasons from south-west and north-west, but generally fail to reach the eastern districts. Indeed it very rarely happens that rain falls at the same time, or in equal proportions, over the whole island; it has, therefore, been divided into two main districts, the windward, and chiefly highland, and the leeward, or lowland section.

With regard to the yearly rainfall of the whole island from 1847 to 1871, it has been found, among other results (1), that the rainfall of fifteen years was above the mean, that of ten years below it; (2) that the deficiencies were generally greater than the excesses above the mean, that is, droughts, when they happen, are heavy; (3) that, taking the thirty years 1843-72, no succession of wet or dry years in cycles can be traced, but rather an alternation of wet and dry years. No more than two dry years have occurred together, but as many as three and four wet years.

With regard to the monthly rainfall: the mean of all the months is under 5 in.; March is driest, October wettest. In wet years May contributes most to the excess, March least. March is the only month of which the mean rainfall in dry years has exceeded the average. In dry years the deficiency is generally spread over the whole year; in wet years the excess is generally confined to the rainy season (autumn). On the other hand, taking the seven wettest and the seven driest years of the period, we observe that in the wet years two-thirds of the excess proceeds from heavy rains in the dry season, and that in the dry years more than two-thirds of the deficiency is caused by three out of the same four months, viz. June, July, and May, and by October and May.

A comparison between the three highest and the three lowest rainfalls belonging to each month during the whole period of twenty-five years shows a remarkable uniformity of the relation between the percentages of the extremes; thus the difference between each average of the lowest months and each average of the highest amounts in none of the twelve months to more than 90 (May) or less than 65 per cent. (August and September).

Of the two stations, Binfield and Halton, lying respectively at 1,065 and 280 ft. above the sea, the former received on an average nearly 11 in. more rain in the year, and showed a greater monthly variability. The influence of elevation is interesting. A table of rainfall in 1870 and 1871, at various heights from 100 ft. up to 1,000 ft., shows an increase at every step of 100 ft. but one, and the total increase at 1,000 ft. amounts to 20·73 in. on the mean of two years. Two exceptions to this regular increment in the means for 1871-73, in supplement No. 2, are ascribed to the lower stations catching the westerly rains, which do not penetrate far inland.

In March, one-half more rain fell at night than by day. From June to November, the days are slightly the wetter, from December to May, the nights.

One of the objects of this inquiry is to assist those who are interested in calculating the character of coming seasons. For such a purpose the annual averages of, each month are taken, after eliminating the exceptional months of very great or of very slight rainfall. The original averages are not affected more than 6 per cent. by this removal. Having the ordinary limits of monthly rainfall tabulated, and observing the general appearance of the weather, every planter can form *some* conjecture whether the coming month will be wet or dry.

Appendix No. 36 shows the influence of each month according to the rainfall, upon the crop of the same year, and upon that of the following year. Thus a man might fairly bet 9 to 3 that a wet February will be followed by a bad crop, and 8 to 1, the highest odds of all, that a wet September will give a good crop next year.

A wet year is followed almost invariably by a good crop in the following year; and it is found that by multiplying the total rainfall of the preceding year by 800 and adding $7\frac{1}{2}$ per cent. if that year was a dry one, or subtracting $7\frac{1}{2}$ per cent. if that year was a wet one, the crop may be calculated in most instances within 3,000 hhds., the average yield of the island being 45,000 hhds. The good chance of predicting so nearly the total exports of Barbados for the coming year cannot fail to be of value, and further experience will no doubt reduce the probability of error. Let us hope that other States may be led to undertakings of the same kind by this example.

F. A. R. RUSSELL

OUR BOOK SHELF

Manual of British Botany, containing the Flowering Plants and Ferns arranged according to Natural Orders. By C. C. Babington, M.A., F.R.S., F.L.S. Seventh Edition; corrected throughout. (London: J. Van Voorst, 1874).

WE cordially welcome this new edition of a "Manual of British Botany" which continues to hold its ground against all its competitors. We do not propose to discuss the rival merits of Hooker's, Bentham's, and Babington's hand-books; each has specialities in which the others are wanting; and each will, no doubt, long have its advocates and admirers. A special claim to popularity as a *field-book* is advanced by the present work on the ground of its portability; and a great advantage is alleged by those who use it to be presented by the practice of placing in italics a few words in the description of each species referring to the character by which it is more readily distinguished from its nearest allies. Comparing the work with the most recent of the earlier editions which we have at hand—the 4th, published in 1856—we find that it extends only to twenty-six pages more, notwithstanding the numerous additions made since that time to British botany, of which ample account has been taken in the present edition. The only alteration made in the primary classification (comparing these two editions) is the separation of Cannabinaceæ from Urticaceæ. The number of natural orders is six more than in Hooker's "Student's Flora," notwithstanding the union of Salicaceæ, Myricaceæ, Betulaceæ, and Cupuliferæ into the somewhat artificial group of Amentiferæ. The location of individual genera has also been in some cases revised, as the removal of *Narthecium* from Juncaceæ (Babington, 4th ed.) or Liliaceæ (Hooker) to Melanthaceæ. Referring to some of the more difficult genera, in which Prof. Babington is

an acknowledged authority, we find the number of species of *Rubus* increased from 41 to 45, while that of *Rosa* is reduced from 19 to 11, and of *Salix* from 32 to 29. We have never been able to understand on what principle Characeæ find a place in a work devoted to "Flowering Plants and Ferns," by the latter term being apparently meant Vascular Cryptogams. Prefixed to the work is a useful Glossary not found in the earlier editions; but the author has wisely refrained from acceding "to the wishes of some young botanists by prefixing a short Introduction to Botany." With the numerous admirable works now at their disposal, students ought to have no difficulty in making themselves acquainted with the Flora of the British Islands. A. W. B.

Eclipses, Past and Future, with General Hints for observing the Heavens. By the Rev. S. J. Johnson, M.A., F.R.A.S., Rector of Upton-Helions, Devon. (Parker, 1874).

THIS little book is a combination of two distinct treatises; one a description of past and future eclipses; the other, a catalogue of celestial objects falling within the range of such small telescopes as amateurs frequently possess. Each of these, it seems, was originally of greater bulk, and intended for separate publication, but they have now been condensed into a single small volume. This has the merit, not very common in these days, of being more than a mere compilation; the ancient eclipses, including those in the "Saxon Chronicle" (of which the author tells us no description has hitherto been published), having been approximately computed for the purpose from the tables in the "Encyclopædia Britannica;" and the notices of the planets, double stars, &c., being derived from actual observation. The book is pleasantly written, and without professing to go deeply into the subject, may well find readers among those who feel a general interest in astronomy, but have no intention of making it matter of serious or accurate study, or of going much beyond the limits of a 2½ in. telescope. It would have been improved (without departing from its sketchy character) by a little more fulness and explicitness of treatment in some places; for instance, in the description of the belts and satellites of Jupiter, and where the abbreviated symbols of the Palermo Catalogue are left unexplained. Some misprints, too, have escaped in the revision. The following extract may interest our readers:—"For those who have very large telescopes, and who are not disposed to take them to oriental climates, it would be useful to have records of the number of clear nights in different parts of the kingdom. By clear nights, let us understand nights cloudless, or nearly so, till 11 P.M., or else clear for a full hour or two. Formerly my observations were taken in South Lancashire, but since the early part of 1870 in Devonshire. In 1859, the number of nights clear, partly or throughout, was 60; in 1860, 43; in 1861 and 1862, 46 each; in 1863, 47; in 1864, 83; in 1865, 82; in 1866, 77; in 1867, 55; in 1868, 62; in 1869, 58; in 1870, 112; in 1871, 98; in 1872, 90; in 1873, 82."

The Human Eye. By W. Whalley. (London: J. & A. Churchill.)

IN this small work the author tells us that he has incorporated the substance of a lecture on the subject, together with additions in various directions. He discusses, in a popular manner, the eye in man, and adds many facts with regard to its structure in other animals. His remarks are mostly anatomical, and we are disappointed to see so little notice of many physiological phenomena connected with the power of sight, which bring out the beauty of the organ of vision in a way which can be understood by the most amateur of readers. There is a want of consecutiveness in many of the paragraphs and chapters, though as a whole the book is a very readable one. Many of the instances given are wanting in grasp; for instance it is remarked that "In some of the ichneumons or 'Pharaoh's rats,' as the Egyptians call them, in the coatimundi, which somewhat resembles the racoon, and in the mangre, the osseous orbital ring is incomplete, and in a group of minor quadrupeds, entitled the Hyracidæ, the malar, or cheek bone, constitutes a perfect orbital ring." It is well known that the orbital ring is complete in all the Quadrumana and many Ungulata, and that it is absent in most other mammals; why then take the particular examples, which are not particularly good ones, and lay special stress on them. The deductions drawn are of a strongly teleological nature, and we cannot do better than recommend the author's reperusal of his work for the refutation of one of his concluding remarks, namely, that "In reviewing this very imperfect and disconnected sketch of the structure of the eyes of the different classes of animals, we cannot fail to recognise the fact that the human eye far transcends, both in mechanism and power, that of every other animal." We however deduce that the condor can see further, that many animals have an extra eyelid, and some bigger eyes than man himself, showing that his is inferior instead of superior in many respects.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Early Contributions to Spectrum Photography and Photo-chemistry

1. MY first attempt at photographing the fixed lines of the spectrum was made in 1834. It was on paper covered with silver bromide. As mentioned in the *Philosophical Magazine*, May 1843, it proved to be a failure. In the summer of 1842, simultaneously with M. Becquerel, by using daguerreotype plates, I succeeded, and in the following March sent a drawing of the photograph to the *Philosophical Magazine*, which was published in May. At that time I did not know that M. Becquerel was experimenting in the same direction.

The great lines α, β, γ, less refrangible than the rest, and which M. Lamansky has recently re-detected by the aid of the thermo-multiplier, are given in that drawing. These in the diffraction spectrum must be bands of very considerable width.

2. Sometimes a person is deprived of fair credit for his labour by what may be termed public perversity. I experienced this in the case of the chlorine and hydrogen photometer. The principle of this instrument is, that chlorine and hydrogen obtained in equal volumes by the electrolytic decomposition of hydrochloric acid, are made to reunite by exposure to light. I described a simple instrument of the kind in the *Philosophical Magazine* for December 1843. It still remains the most sensitive of all photometers. Twelve years subsequently, Professors Bunsen and Roscoe modified it, and used it in their photo-chemical researches. In their memoirs, published in the Transactions of the Royal Society, they give full credit for the invention to me, and remark that by its use I had "succeeded in establishing experimentally some of the most important relations of the chemical action of light." They did justice in the matter, but not so the public. The instrument currently passes as their invention, not mine.

While speaking of photometers there is another to which I may allude. It depends on the principle that a solution of ferric oxalate is decomposed with evolution of carbonic acid on exposure to light. The carbonic acid may be measured or weighed by any of the ordinary methods. I described such an instrument in the *Philosophical Magazine*, Sept. 1857. Quite recently M. Marchand has published in his *Annales de Chemie* several experiments by its use, evidently unaware that it had been employed by me many years ago.

3. In 1843 I made photographs of the diffraction spectrum formed by a grating both by reflection and transmission, and published drawings of them. An account of this may be seen in the *Philosophical Magazine* June 1845 and March 1857. These were the first diffraction photographs ever made. They therefore preceded those of M. Mascart by many years. Of course they were not at all comparable with the very fine ones obtained recently by my son, Dr. Henry Draper.

4. In my memoir "On the production of light by heat" (Phil. Mag., May 1847), I established experimentally the following facts:—

(1) All solid substances and probably liquids become incandescent at the same temperature.

(2) The thermometric point at which some substances become red hot is about 977 Fahrenheit degrees.

(3) The spectrum of an incandescent solid is continuous; it contains neither bright nor dark fixed lines.

(4) From common temperatures nearly up to 977 F., the rays emitted by a solid are invisible. At that temperature they are red, and the heat of the incandescing body being made continuously to increase, other rays are added, increasing in refrangibility as the temperature rises.

(5) Whilst the addition of rays so much the more refrangible as the temperature is higher is taking place, there is an augmentation in the intensity of those already existing.

This memoir was published in both American and European journals. An analysis of it was read in Italian before the Royal Academy of Sciences at Naples, July 1847, by M. Melloni, which was also translated into French and English.

Thirteen years subsequently M. Kirchhoff published his celebrated memoir "On the relations between the coefficients of emission and absorption of bodies for light and heat." A translation of this memoir may be found in the *Philosophical Magazine*, July 1860.

In this memoir, under the guise of mathematical deductions, M. Kirchhoff, taking as his starting-point the condition discovered by Angström in 1854, respecting the relations between the emitting and absorbing powers of different bodies for light and heat, among other things deduces the following facts. I give them as they are succinctly stated by M. Jamin in his "Cours de Physique de l'école Polytechnique" (1869).

(1) All bodies begin to be red-hot at the same moment in the same space, and become white-hot at the same time.

(2) Black bodies begin to emit red rays near 525 C. (977 F.)

(3) The spectrum of solids and liquids is devoid of fixed lines.

(4) The rays first emitted by black bodies are red; to these are added successively and continually other rays, increasing in refrangibility as the temperature rises.

In his celebrated memoir, and in subsequent publications on the history of spectrum analysis, M. Kirchhoff abstains from drawing attention to the coincidences I am here pointing out, except that in a foot-note to his memoir he makes in a single word allusion to mine. But from this no one would infer what were really the facts of the case, and accordingly in the bibliographical lists subsequently published, in works on spectrum analysis, such as those of Prof. Roscoe and Dr. Schellen, my memoir is not noticed.

I earnestly solicit those who take an interest in the history of spectrum analysis to compare my memoir in the *Philosophical Magazine*, May 1847, with those published by M. Kirchhoff thirteen years subsequently, on the radiating and absorbing powers of bodies (Phil. Mag., July 1860), and on the history of spectrum analysis (Phil. Mag., April 1863).

JOHN WILLIAM DRAPER

University, New York, July 8

Sounding and Sensitive Flames

In NATURE, vol. x. p. 223, Prof. Herschel describes some experiments recently made at the Newcastle College of Science, whereby sonorous vibrations are produced in tubes by means of heated wire-gauze instead of the ordinary gas flame. Interesting as are these experiments, they are, however, by no means new. The influence of heated wire-gauze in giving rise to vibrations of air within tubes was, I believe, first published by Prof. Rijke of Leyden. In Kœnig's catalogue for 1865, Rijke's tube is advertised (No. 27) and the method of experiment described. The readiest way of making the experiment is to cut a piece of the ordinary fine iron-gauze to the size of a sixpence or shilling, and press it some three inches up a glass tube of corresponding bore. Almost any length of tube over one foot may be employed, so that notes of varying pitch can be obtained. The gauze is easily heated by a little alcohol flame at the end of a bit of quill tubing. Employing platinum-gauze heated by an electric current, or a gas flame resting above the gauze, the sounds can be rendered permanent. By one or other of these methods no doubt many of your readers have, like myself, often repeated this experiment during the last six or seven years.

I notice also that Prof. Herschel has kindly attributed to me a modification of the ordinary sensitive flame; the credit of this belongs to Mr. P. Barry, of Cork. This arrangement simply consists of a sensitive flame burning on wire gauze, instead o directly from the gas jet. It was described in NATURE, vol. v. p. 30, and some further experiments on this kind of flame are to be found in the journal of the Franklin Institute for April 1872.

Perhaps it is not out of place to add here that when a sensitive flame under the influence of sound is viewed in a moving mirror, the state of its vibration, thus seen, reveals some interesting facts. Under such circumstances, the flame is capable of showing the nature of the different vowel sounds, and further, by the broken appearance of the flame one is able to detect sonorous vibrations too faint to be heard and too feeble otherwise to affect the flame. I have given a representation of the flame seen in a moving mirror on the plate appended to an article in the *Popular Science Review* for April 1867. The flame that is most suited for the vowel experiments happens to be the parent of the family of sensitive flames, and is described in a little paper of mine in the *Philosophical Magazine* for March 1867.

W. F. BARRETT

Science Schools, South Kensington, July 27

Aid to Private Research—Circulation of Scientific Memoirs

THERE are many scientific students scattered through the country, as science-masters in schools, and in other capacities, who are willing and competent to undertake original researches in their special branches of science. The great obstacle to their attempting it is, in most cases, the cost of the necessary instruments. It is of course impossible to expect such apparatus as is required for original work to be supplied from the science funds of a school, these being properly applied to provide only what is requisite for teaching the pupils; so that if an investigation is to be attempted, the whole cost falls upon one who is probably just beginning life, and is quite unable to afford it. The work is therefore postponed for a considerable period, and perhaps is given up altogether. Now the Department of Science and Art grants aid in fitting up the schools which are under its control. If the Department would give similar aid towards purchasing expensive apparatus for research, or would allow competent workers to hire such instruments for the period they require them, much of the difficulty to which I have alluded would be removed. Many, I am sure, would be glad to avail themselves of the opportunity, and would willingly fulfil the conditions necessary to ensure the safety and proper use of the apparatus. I may remark that by this means it would probably be easy to organise to a certain extent the investigations to be carried on, and thus render the results far more valuable than they would be if isolated. Looking to the national importance and the unremunerative character of this kind of work, few will think that this appeal is exorbitant.

I wish to allude to another point, to which attention has already been drawn in your correspondence columns (NATURE, vol. viii. pp. 506, 550). A scientific man, unless he is fortunate enough to be within easy distance of a large scientific library, is practically debarred from reading even the most valuable memoirs that are published. Abstracts, indeed, he may see; but these only serve to remind him that if he would get the original memoir for himself, he must purchase with it matter which is useless to him, but perhaps of the highest value to a worker in another branch. If these memoirs could be purchased in a separate form—or even if collections of papers bearing upon closely related subjects could be obtained—another cause of the costliness of science would be removed.

It has occurred to me that something ought to be done amongst ourselves to remedy our position as regards the transactions of the learned societies and the scientific periodicals. Could not a book-club be instituted, the members of which, upon paying a small annual subscription, should receive in turn the chief scientific periodicals? Or would it be more easy for a number of us who happen to take in different journals, to exchange them? If any of your readers should be inclined to co-operate with me in initiating either of these schemes, or to furnish any suggestions on the subject, I should be glad if he would communicate with me.

Sherborne, Dorset, July 11 H. W. LLOYD TANNER

Photographic Irradiation

As the question of whether irradiation is due to the imperfection of the instruments, or to an action taking place within the thickness of the collodion film, is a matter of considerable importance in all cases in which photography is made use of for the purposes of accurate measurement, I have repeated and somewhat varied the experiments which have lately been described in NATURE, vol. x. pp. 205, 223, by Mr. Ranyard. I therefore laid on a uranium dry plate a piece of platinum foil, and with full aperture of lens took, with an exposure of twenty-five minutes, a photograph of a piece of cardboard, in which were four parallel slits, hung against a background of bright sky. In spite of the long exposure, the images of the slits are sharply cut off at the place occupied by the edge of the platinum foil, though at the same time there are very marked traces of the outer hazy irradiation arising from reflection from the back of the plate. I then took with the same exposure, and under what seemed to be similar conditions of illumination, a photograph of the same cardboard sheet, on an extra-sensitive Liverpool plate, and again found that the images of the slits were sharply cut off. This seems to me to decisively show that the irradiation cannot be due to a spreading within the film, caused by the light dispersed from the highly illuminated particles in the collodion, as suggested by Mr. Aitken; and I feel inclined to agree with Lord Lindsay and Mr. Ranyard that it must be due to some cause that has its seat of action in front of the collodion film.

Bedford W. C. CROFTS

Feathering in Flint Weapons

IT is now some years since I first noticed the fact that in a number of flint weapon heads in my possession a distinct spiral could be traced in the form, this being evidently due in part to the direction of the line of fracture in the flint, but also in part to an exaggeration of this by the hand of the workman. In the last number of the *Scientific American* is d picted an arrow-head with the edges very distinctly feathered, so that if the weapon with which it was armed was propelled with any great rapidity, its revolution would be a matter of necessity and would result in a greater steadlness in its line of trajectory.

After having ascertained that my own weapons were all twisted, I examined a number of others with the view of ascertaining if the same spiral existed in them, and in all I found that there was something like it, and the more finish they presented the more twisted they were.

A very simple method enabled me to show the twist well. I pressed a flint between two pieces of greased pipeclay, then removed it carefully and filled its place with liquid plaster of Paris. Cross-sections of this cast in various directions showed the twist to perfection, and I found that the two wings of the flint were twisted in opposite directions though identical in relation to the axis of rotation), and that the curvatures were identical with those seen in the iron arrow-heads provided with wings which are used in many savage countries to this day, and were till lately, if indeed they are not still, made in large quantities in Birmingham. The most perfectly twisted stone arrow-head which I have yet seen is one made of quartz, where the line of fracture could not help the manufacturer in the least, and where it must have been the result of deliberate workmanship. It was an American weapon. The line of fracture of flint always gives a more or less pronounced spiral, and this may be one of the many reasons for its having been almost universally selected as the material for arrow-heads when it could be got. In fact, it is a difficult thing to find a flint flake of any size which has not a very evident spiral form, and I have a photograph in my possession of two weapons which I have examined and which are almost identical, one found without its shaft near Bridlington, in Yorkshire, and one with its shaft found in the hands of a native of New Zealand; and it would be impossible to tell, from the style of manufacture, which weapon belonged to which country. It is impossible to regard this as mere coincidence, but we must look on it, in each case, as an independent discovery of the principle of the rotation of the rifled projectile. LAWSON TAIT

LOCALISATION OF FUNCTIONS IN THE BRAIN

AT one of the last meetings of the Royal Society, Dr. Burdon-Sanderson related the results of experiments he had recently made with a view to the further investigation of the important discovery of Hitzig and Fritsch, that there are certain spots on the surface of the cerebral hemispheres by the excitation of which the muscles of the opposite side of the body can be thrown into combined action.

It is well known that Dr. Ferrier, of King's College, who has studied the topographical distribution and limitation of these active spots or areas with great minuteness on a considerable variety of animals, has founded upon his experiments a theory that these spots correspond to organs situated at or near the surface of the hemispheres, and that it is the function of these organs to originate combined voluntary movements. Dr. Ferrier has accordingly proposed to call them "motor centres."

As, however, the facts appeared to Dr. Sanderson to be quite as consistent with the view previously entertained by physiologists that the function of co-ordinating voluntary movements is localised lower down in the cerebro-spinal centres, he thought it necessary to ascertain, with reference to some of the most characteristic combined movements produced by stimulation of the surface of the brain, by the interrupted voltaic current (Hitzig and Fritsch), or by induced currents (Ferrier), whether the very same combinations of movements could not be produced after ablation of the grey substance in which the "centres" for their production were supposed to be contained. If it could be shown that after complete removal of the "centres," the effects to the production of which they were supposed to be essential could still be observed, this would go far to prove that the facts had been misinterpreted; and if it could be further shown, not only that the phenomena might present themselves in animals deprived of the centres from which they were supposed to originate, but that they could be produced in such animals by the same methods and under the same circumstances as in normal animals, this would go far to negative the existence of any organs at the surface of the brain to which the term "motor centre" could with any propriety or accuracy be applied.

In accordance with these considerations, Dr. Sanderson planned experiments, in some of which the superficial convolutions containing "centres" were removed, while in others the whole of the anterior part of the left hemisphere as far down as the outer portion of the *corpus striatum* was taken away with the aid of a sharpened spoon. In each case it was found (1) that when after the removal of the cortical grey substance, the cut surface of white substance is excited by induced currents, movements of the opposite side of the body are produced, which are of the same character as those which result from excitation of the natural surface; (2) that the excitability is limited to certain spots, which can be as sharply defined as those demonstrable on the natural surface; and (3) that the relative positions of the active spots on the cut and natural surfaces respectively correspond closely with each other.

Simultaneously with the publication of Dr. Sanderson's communication, a paper appeared in Eckhardt's *Beiträge*, in which an account was given of very similar experiments, of which the results, though incomplete, corresponded, so far as theory went, with those above related. We learn also that Prof. Hermann of Zürich has also made experiments which have led him to reject in the most unequivocal manner the conclusions of Hitzig and Fritsch.

THE FORM OF COMETS *

II.

LET us see what ideas, what explanations have been suggested by the aspect of these monstrous phenomena, so evidently subject to the influence of the sun.

On examining comets, the first idea which is pre-

* Continued from p. 229.

sented to the mind is that the head of a comet is the seat of an emission of matter which takes place in a direction opposite to the sun; it seems as if the comet fused at one end, and that the matter thus thrown off is arranged into an immense plume, exactly like the smoke which escapes from the chimney of a steamer at full speed. Let us examine this analogy more closely, and suppose, first, the boat to be motionless, with the smoke ascending vertically in a perfectly calm atmosphere. Each puff of this smoke is sent into the air with a certain speed, and the successive sections of the vertical plume thus formed will represent the positions which these puffs will have reached at the same instant. The puffs first emitted will be the highest; the latest ones will be lowest; if then we knew the law of the ascending movement of any puff, we should thus be able to assign the instant at which each section of the vertical plume was shot forth. Meantime, should we set the steamer moving in the motionless air, the place at which each section is emitted will gradually advance; each of these will ascend almost vertically over its place, for the speed of the horizontal movement which the boat communicates to it will be very rapidly exhausted in resisting the motionless air, and at the end of a certain time these puffs will be found dispersed in an inclined plume, presenting a curvature more or less marked. At first, this curvature will assume a vertical direction, *i.e.* the direction of emission.

On the other hand, the successive puffs, in ascending, tend to spread out; the earliest and highest must then become rarefied and disappear from sight. The tail,—no, I should say the plume of smoke thus formed, must become less and less dense, at the same time becoming less and less distinct and gradually getting obliterated.

Does it not seem as if here we had put our finger upon a complete analogy? The comet proceeds on its way like a steamer; it describes round the sun an orbit elongated like the path of a bomb; heated more and more by the solar rays, its matter is expanded and escapes into space, like that of a rocket. Is it not natural that it should send off a plume analogous to that which escapes from the funnel of a machine in motion? If we knew the rate of emission of each puff of cometary vapour, would we not be able to calculate the place which it must occupy in the tail, and even the form of the tail itself? Reciprocally, after having carefully determined the figure of this tail, would we not be able to form some estimate of the rate of the nucleal emission of the comet? Such, very nearly, was Newton's point of view in studying these magnificent phenomena. The comet of 1680, which appeared in the time of Newton, had a tail of 25,000,000 leagues in length; it forcibly impressed this great geometer, and originated in his mind views similar to the analogy which we have just indicated.

But analogy is not always a perfectly trustworthy guide. Here the differences preponderate considerably over the likenesses. We have certainly in the heavens a heated body which in its progress emits vapours like a gigantic steamer; but where is the funnel, where is the atmosphere? And, remember, the atmosphere here plays an important part, for it is its presence which determines the ascent of the puffs of smoke. If these ascend, it is from the same cause as balloons, because they are lighter than air. Take away the air, instead of mounting they will fall. Well, in the sky there is no air; space is void of matter forming a continuous and ponderous medium, layer on layer, until the surface of the sun is reached. Moreover, Laplace has shown that the power of the sun in attracting a ponderable fluid will not extend beyond a very narrow limit. As to the ether of the physicist, it need not engage our attention for an instant, since, by definition, this hypothetical ether is imponderable. We shall not be much astonished that the genius of Newton should have been content with a similar analogy, if we only reflect on all the difficulties which the doctrine of attraction raised in the minds of the eighteenth century, and on the Cartesian prejudices which greeted its first appearance on the Continent. What would have happened if, at the first, the too absolute terms of this doctrine had seemed to be contradicted by the phenomena of the figure of comets? It was then necessary, at any cost, after having incontestably connected the movement of these bodies with the new doctrine, to let it also be seen, even though it was by an analogy somewhat forced, that their figure could be explained in the same manner.

Now that the doctrine of attraction is established on an immovable foundation, our mind is able to detach itself from the purely metaphysical part of the original affirmations, which presented it to us as the single force to which all celestial phenomena ought to be subordinated. But before invoking another force, it is necessary at the very outset to draw from attraction all the consequences applicable to comets; and we shall do so by showing that the force, which seems constantly to tend to unite, to agglomerate scattered material, is, in reality, also quite capable of producing in certain cases the opposite effect, viz., of undoing existing agglomerations.

To proceed in order, let us ask, first, why comets have tails while planets have not. Is it because comets approach closer to the sun and are thus subjected to a very powerful heat? Certainly not; for the planets Venus and Mercury, especially, are constantly closer to the sun than most of the comets at their perihelion, and yet neither Venus nor Mercury has the faintest trace of a tail. Must we attribute the figure of comets to the parabolic nature of their orbits, in virtue of which their distance from the sun varies enormously, while the planets remain always very nearly at the same distance from the centre of our solar system? An illustrious poet, Lamartine, wishing to depict a creator of the earth, indifferent to his creature, has beautifully said—

> Et d'un pied dédaigneux la lançant dans l'espace,
> Rentra dans son repos.

If the kick had been stronger, the earth would have been sent to describe a cometary orbit round the sun, *i.e.* an elongated ellipse or a parabola, instead of the circle which it now describes; but, for all that, it would not have become a comet, it would have had no tail. Do you know what shape would be the result on this supposition? The imperceptible solar tides of the ocean would be gradually restrained in proportion as the earth increased its distance from the sun, and soon would disappear altogether; our atmosphere would be more and more condensed into layers always spherical and concentric with the earth; our planet would be lost in the depths of infinite space without any other change than a more marked contraction due to the predominating cold of space.

Are comets, then, formed of matter different from that of the planets? No; such an idea cannot be accepted now that spectrum analysis has told us of the existence of sodium, magnesium, and calcium in the sun, hydrogen in the stars, and our ordinary gases even in the most distant nebulæ. Above all, we find the same elements subject to the same mechanical, physical, and chemical laws.

The truth is more simple. If our planets have no tails, it is because they have an enormous mass; if comets have tails, it is because their mass is extremely small, and because the attraction which this mass exercises upon their materials is not sufficient to hold them back and to overcome the external forces which tend to decompose them.

Now have we hit upon a notion which I must dwell upon all the more that it has not hitherto been sufficiently popularised. You have heard of a general law in the world of organised and living beings, called "the struggle for life," the fight or effort which it is necessary to make

in order to live, *i.e.* to resist the external forces which tend to death. Those that have in themselves a sufficient resisting force are developed and found persistent races; the feeble succumb and disappear.. The same law reigns in the heavens. A body would subsist eternally by virtue of its internal forces if it were alone; but every neighbouring body becomes for it a dissolving cause by virtue of the attraction which the former exercises on the latter. The strong resist; they are the planets: the weak yield and end by succumbing; they are the comets.

Mechanics will convince us of this. Let us take a comet far away from the sun, leaving out of consideration at first the very weak attraction to which the former is subject; we can do this, for it is then sensibly the same for all its parts. Its solid, liquid, or gaseous materials are under the influence of their mutual attractions and of the feeble heat which they receive from without, freely disposed in regular layers, superposed so as to form a globe spherical like the earth, a globe whose centre will be occupied by the most compact parts and whose surface will be formed of the lightest parts. Whether this globe be at rest or in motion, if things remain thus, the comet will subsist; you will see its bright nucleus surrounded by a less luminous but quite sunny nebulosity, and this same form will indicate to you a body in which the forces which act on all its parts are directed towards the centre. Such is the first form in which we have represented Donati's comet (Fig. 3).

But if the comet comes nearer to the sun, the solar attraction will rapidly modify this state of things. The parts nearest to the sun will be attracted more strongly than the centre, and will have a tendency to separate from it; the difference of the solar attraction on the various parts of the comet will have the effect of elongating that body somewhat in the direction of the radius vector; this is a phenomenon quite like that of the tides. The second sketch (Fig. 4) of the comet of 1858 offers an example of this; but already the eccentricity of the nucleus ought to put us on our guard against any incompleteness in our present reasoning, founded upon the sole consideration of attraction. Nevertheless, you see, the body remains entire; the solar action being very feeble, at that great distance, the attraction of the comet on its exterior strata still preponderates, and the resultant of these various forces at each point is still turned towards the interior; the layers which compose it are everywhere convex externally, and do not show any symptoms of dissolution.

But bring the comet still nearer to the sun; the attraction of that body will no longer be limited to the production of an elongation; you will see the external layers become still more deformed and finally open out so as to let matter escape.

There exists, for every body placed within the sphere of action of our sun, a surface limit beyond which its matter may not pass, under pain of escaping to that body and falling within the domain of the solar action. This surface limit depends on two things—the mass of the body and its distance from the sun. For a planet like the earth, whose mass is so considerable, this surface limit is very distant, and yet, within the still terrestrial region of its satellite, the moon, a child could lift, without much difficulty, a body which would weigh for us 36,000 kilogrammes, so feeble does the attraction of our globe become at that distance of 60 terrestrial radii. A little beyond the lunar orbit, a body would cease to belong to the earth, and would enter the exclusive domain of the sun. But for a comet, this surface limit is much nearer the nucleus, and, moreover, it draws nearer and nearer, in proportion as the comet approaches the sun. One of the most eminent professors of the high education, M. E. Roche, of Montpellier, has submitted this question to analysis, leaving aside accessory circumstances such as the rotatory movement of the body under consideration and the curvature of its trajectory; he has thus been enabled to discover that the surface which so limits a body in the vicinity of the sun presents two singular points in the direction of the radius vector, setting out from which this surface is widened out into conical network, in such a manner that the dissolution of a body the matter of which reaches or passes beyond these boundaries, is effected principally in the vicinity of the points referred to, flying, so to speak, into two pieces, thus obeying at once the attraction of the comet and especially the thenceforth preponderating attraction of the sun.

And it ought not to be objected to this that there is no reason why the matter of a body should tend thus to be separated from its centre and to fill a volume greater and greater, so as to reach or surpass the fatal limit. This tendency exists; it proceeds from the increasing heat which a body that approaches nearer and nearer to the sun experiences, and from the progressive expansion which thence follows in the matter. Certainly if the earth were drawn nearer to the sun, the dilatation of its solid nucleus would be a small matter, but thenceforth the seas would be reduced to vapour and would pass wholly into the atmosphere. In the case of comets, in which the matter presents a much less marked degree of aggregation —doubtless because its original heat, due to the union of the particles which compose it, was not sufficient to bring about all the chemical reactions—the solar heat produces an expansion comparable to that of gases. According to my calculations, this expansion dilates the radius of the concentric zones which we can distinguish so well in the head of Donati's comet, at the rate of 19 metres per second. So long as these zones remain in the interior of the surface-limit, they are not dissolved; but if they should happen to go beyond it, their materials go off at the bidding of the sun's attraction.

Thus all the conditions of instability are found united in comets. Their mass is extremely small, and, consequently, the surface limit is very near the centre of gravity. Their distance from the sun diminishes rapidly in the descending branch of their trajectory; consequently this surface limit becomes more and more contracted. Finally, their enormous volume tends unceasingly to dilate, because of the increasing heat of the sun, and to cause the cometary matter to shoot out beyond this surface limit.

What becomes of this matter after it is set free by the action of the sun? Having escaped from that of the comet, it will none the less preserve the original speed, *i.e.* the speed which the comet itself had at the moment of separation; this speed will scarcely be altered by the feeble attraction of the cometary nucleus, or by the internal movements of which I have spoken, since these are measured by a few metres per second, while the general motion round the sun takes place at the rate of 10, 15, 20 leagues and more per second. The molecules, separated and thenceforward independent, then describe isolated orbits around the sun, differing very little from that of the comet. Those which are found in advance go a little faster and take the lead; those which are behind remain a little in the rear; so that the abandoned materials are divided along the trajectory of the comet in front and in rear of the nucleus. In time these materials are separated considerably from the body from which they emanate, and are more and more disseminated; but considered at the moment of emission, they will form two visible appendages, two sorts of tails opposed and stratified on the orbit of the comet.

We touch here on the decisive point of our research. To take the final step it will be sufficient for us to consider the two figures 6 and 7. The first represents the successive shapes C, C′, C″, which a comet must take, according to the preceding theory, if there were no other force in play than that of attraction. Fig. 7 represents the actual fact, *i.e.* the forms which a comet assumes in

reality according to its progress in its orbit round the sun, S. Evidently there is no resemblance between these two series of figures. Then the preceding theory fails in some point, and as the error will not have been in the part attributed to attraction, it must be found in the assumption that this is the only force. In other words, it is sufficient to compare the effects of attraction with the real facts, to be convinced that there must be another force at work in the cometary phenomena. And as the former would be capable only of disseminating the matter along the orbit, the new force must be capable of driving this same matter in the direction of the radius vector; it must then be opposed to attraction; it must repel and not draw. What may this force be? Ought it not to make itself felt elsewhere than in the gigantic tails of comets? How can the same body, the sun, at once attract and repel matters of the same origin? And how does it come to pass that since it acts so powerfully on the matter of these bodies, this repelling force of the sun does not change the movement of their nuclei which appear to follow so faithfully the laws of solar attraction? This last question will put us on the right track.

And first, do comets follow rigorously, like planets, the laws of attraction? That the law has been firmly established in the case of the planets, I cannot doubt, for we have for these bodies a historic series of observations going back to the Chaldeans and including thousands of revolutions of each of them. If there had been the least disagreement between the phenomena and the law to which they are assigned, the disagreement, no matter how small, must at length have become sensible, after accumulating during so lengthened a period. But comets, in general, appear only once; we only see them and can only observe them in a very restricted part of their orbit; so that should a very slight influence alter their movements, its effect would be confounded with the inevitable errors of observation, and astronomers would not be able to distinguish it. There are, no doubt, some periodic comets, such as those of Halley, Biéla, Encke, &c., but the first has a period of seventy-five years, so that in going back to its earlier appearances, we very soon reach the time when comets belonged to the domain of astrology. That of Biéla has a period of $6\frac{3}{4}$ years, but its first certain appearance dates only from the end of last century, and in the course of that time a singular accident has happened to it: it has been divided in two. There remains Encke's comet, the only one which can be subjected to the verification of which we have spoken, on account of the numerous revolutions which it has accomplished since its discovery in 1786. Well, it is found that this comet, the only one which can be tested in the way we speak of, does not follow exactly the laws of gravitation. According to these laws, when we have taken account of the perturbations caused by the neighbouring planets, the time of revolution ought to be constant, while, in fact, it diminishes regularly during each revolution; the effect established in this instance is of considerable magnitude, about half a day.

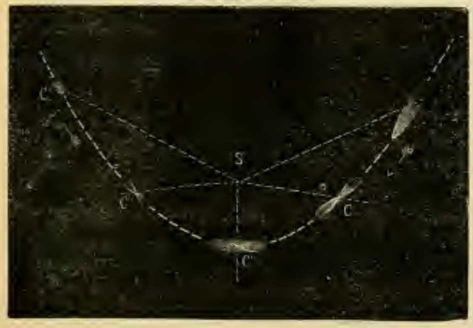


FIG. 9.

In face of such a fact there is room for the question under consideration, viz., Is attraction the only force which governs the universe? But how can we formulate such a doubt, when the carefully-studied movements of the planets may be perfectly accounted for, for thousands of years past, exclusively by the theory of attraction? We can escape the difficulty by an artifice identical with that which enabled Newton to account for the tails of comets by attraction alone: I refer to that vast and rare atmosphere which Newton placed in space around the sun, and in the midst of which the cometary materials are elevated, according to him, exactly as the smoke of our chimneys in our terrestrial atmosphere. Geometers, then, introduced the resistance which this general medium ought to oppose to the progress of a comet on account of its small density, while the same medium would oppose only an insensible resistance to the planets on account of their relatively small volume and their enormous density. It is a remarkable fact that the analysis founded on this impossible hypothesis perfectly accounts for the anomaly proved to exist in the orbit of Encke's comet, viz., its progressive acceleration. I feel bound to question this analysis, and to show (1) that its primary basis is radically false, since it leads to the admission that a material and ponderable medium may remain immovable around the sun; (2) that the conclusion of this analysis, so far as it is valid and conformable to observation, simply proves that there must exist an action opposed to the movement of the comet and directed along the tangent to its orbit. Various causes, moreover, may lead to the same conclusion, and differ only, as to other effects, in quantities difficult to appreciate. But we learned above, from the phenomena of the tails, that there also exists an action in the direction of the radius vector. The resisting medium of Encke, or the immense solar atmosphere of Newton, being physically impossible, I have been led, by two different ways, to a new force which would satisfy these data by producing the two actions or components above mentioned: that which expels the cometary molecules in the direction of the radius vector, and that which acts upon the comet in the inverse ratio of its tangential velocity.

FIG. 7.

(*To be continued.*)

REPORT OF PROF. PARKER'S HUNTERIAN LECTURES "ON THE STRUCTURE AND DEVELOPMENT OF THE VERTEBRATE SKULL" *

VI.

IN no animal has the study of cranial development yielded richer results than in the frog. In tadpoles, from the time of hatching onwards, such points as the true nature of the trabeculæ, and their distinctness from the investing mass, the fact that the stapes is a segmented portion of the ear-capsule, and not the apex of the hyoid arch, and the relations of the pterygo-palatine arcade have been demonstrated with certainty. Most instructive, also, is the way in which the various arches become segmented, altered in shape, direction, and relative size, and made to subserve the most various functions.

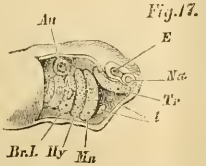


FIG. 17.—Head of Tadpole 2—3 lines long, with the facial arches exposed by removal of the skin from the left side (× 6½).

Besides the adult, nine stages of the frog's skull were described.

1. (Fig. 17).—In tadpoles at about the time of hatching the whole organism is in a very rudimentary condition. The mouth and the gill-slits are closed, the dehiscence of the tissue between the facial arches by which they are formed not having yet taken place. On the first and second branchial arches small papillæ, the rudiments of the external gills, have made their appearance (see Fig. 17). The little creature, now about a quarter of an inch or less in length, is usually found attached to water weeds by the horseshoe-shaped sucker beneath its throat, which, though serving the same purpose, must on no

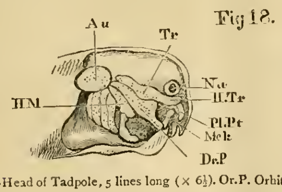


FIG. 18.—Head of Tadpole, 5 lines long (× 6½). Or.P. Orbitar process.

account be confounded with the suctorial mouth of the lamprey. The facial arches are in a perfectly simple and undivided condition, all those behind the mouth are curved slightly backwards in the lower half, while the trabeculæ incline forwards and are thus made to diverge considerably from the mandibulars, although in their upper portion they have almost exactly the same inclination as their successors in the series. The investing mass consists of two small patches of nascent cartilage, one on each side of the notochord. The auditory are the only sense-capsules which have undergone chondrification, and in them the process is quite incomplete, a large membranous space being still left uncovered by cartilage. Two pairs of labial cartilages (l) are formed, and probably answer in a general way to the first and fifth of the series described in the shark (see Fig. 2, l^1, l^5).

* Continued from p 168.

2. Tadpole about ⅓ in. long). The external gills have now (four or five days after hatching) become plumose and the mouth and branchial clefts open freely into the pharyngeal cavity. The most important advance is in the commencing separation of a small segment (hypo-mandibular) from the second arch, which in the next stage has become Meckel's cartilage. The hyoid has also begun to diverge from its predecessor in its lower part, and a fourth branchial arch has appeared in addition to the three observable in the first stage.

3. (Tadpole about ½ in. in length, Fig. 18.) The trabeculæ have now united with the investing mass and with each other before and behind the pituitary body, and have become almost horizontal; they likewise begin to foreshadow some of the changes which afterwards take place in them, becoming slender anteriorly, to form the cornua trabeculæ (H.Tr), and just behind the olfactory sac

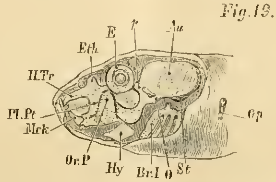


FIG. 19. -Head of Tadpole, 1 in. long (× 4½). Op. Opercular aperture.

being thickened slightly in the future ethmoidal region. Meckel's cartilage now forms a true articulation with the fixed or suspensorial portion of the arch to which it belongs; slightly above the articulation two processes are sent out from the suspensorium; the outer (Or.P) is the *orbitar process*, while the inner (Pl.Pt), uniting with the trabecula, forms a commissural band of cartilage, the rudiment of the pterygo-palatine arcade: between these two processes, the second and third divisions of the trigeminal nerve run. The hyoid arch has assumed a wonderfully shark-like character (see Fig. 2), having divided into an upper and a lower segment, the former of which (hyo-mandibular, H.M) has come into close relation

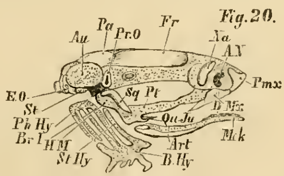


FIG. 20.—Skull of Young Frog, with tail just absorbed (×) 5).

with the preceding arch, while the latter hangs free, forming an open angle with the mandible, and unites with its fellow of the opposite side by means of a median basihyal. The investing mass and ear-capsules are now completely cartilaginous.

4. (Tadpoles 1 in. long, Fig. 19.) At this stage the hind limbs have made their appearance, and the opercular fold has completely grown over the gill arches on the right side, a small slit (Op) still remaining on the left. The cranial elements have now assumed somewhat the appearance of a skull, which however differs most markedly from that of the adult frog. The trabeculæ, by complete union in their hinder two-thirds with each other and with the investing mass, have formed a solid *basis cranii;* they have also sent up a low wall on either side of the brain, thus tending to inclose it, and just in front of their union with the pterygo-palatine have developed a prominent transverse ridge (Fig. 19, Eth), the rudiment of

the ethmoid. The suspensorium is still greatly inclined forwards, so that the quadrate lies immediately under the ethmoidal region, and, consequently, the palato-pterygoid and Meckel's cartilage, though lengthening, are still extremely short. The hyo-mandibular has completely coalesced with the suspensorium, which is now therefore a compound structure, and presents above two of the three processes mentioned in the axolotl, namely the pedicle (p) and the otic process (o), the latter at this period belonging equally to both arches, the pedicle to the mandibular only. The branchial arches have united with one another above and below to form a perfect branchial basket. The stapes (St) is now completely cut out of the wall of the ear sac, and the first ossification has made its appearance on the base of the skull, in the position of the para-sphenoid.

5. In tadpoles in which the legs have increased greatly in size and the tail has begun to shrink, a marked advance has taken place in the proportion of the jaws to the rest of the skull; the mandibular pier has moved downwards and backwards so as to lie at an angle of 45° with the skull-flow, and the palato-pterygoid and lower jaw are correspondingly lengthened. (Fig. 20 shows the process further advanced.) The orbitar process is greatly decreased in size and lies higher up on the suspensorium, and the ethmoidal cartilage has sent out a vertical keel-like plate (the septum nasi) between the olfactory sacs.

6. The tadpole has now moulted its larval skin, so as to expose the fore-limbs, and the tail is reduced to half its original size. The walls of the brain-case, commenced in the fourth stage, are now complete, and by their union above have formed a roof, interrupted only by their membranous fontanelles, which are persistent in the adult, one in the frontal, and a symmetrical pair of smaller ones in the parietal region. The septum nasi is complete, and two wing-like processes growing from it have inclosed the nasal capsules by uniting with the floor formed by the greatly expanded hypo-trabeculars. The hyoidean portion of the otic process (Fig. 19, o) has now freed itself from its connections, and appears as a triangular nodule of cartilage, the pharyngo-hyal (Fig. 20, Ph.Hy), or detached apex of the arch; at the same time the remainder of the coalesced portion (Figs 18 and 20, H.M) begins to show signs of separating once more from its union with the mandibular pier. Besides the para-sphenoid, the parietal, frontal, nasal, pre-maxillary, maxillary, squamosal, articular, and dentary ossifications have appeared.

7 (Fig. 20). The skull of young frogs in which the tail has just disappeared differs from that described in the last stage, chiefly by the extension of the centres of ossification already mentioned, and the appearance in addition of the exoccipital, prootic, pterygoid, quadrato-jugal, and septo-maxillary. The free portion of the hyoid (St. Hy) has assumed the slender proportions which characterise it in the adult, and it is united by fibre to the upper part of the arch (H.M), which, although still fused with the suspensorium, is marked off from the latter by a distinct depression, and shows unequivocal signs of commencing separation.

8. A most important metamorphosis has taken place in this stage, which includes young frogs just commencing their first summer. The pharyngo-hyal or nodule of cartilage separated from its arch in the sixth stage (see Fig. 20, Ph.Hy) has now come into close contact with the stapes, although it does not actually articulate with it until the succeeding stage; this freed apex of the hyoid arch thus becomes the inter-stapedial piece (Fig. 16, p. 168, i.st) of the ossicula auditus, the representation of the *os orbiculare* of mammals. At the same time the next segment of the same arch (Fig. 20, H.M) has become completely separated from its connection with the suspensorium, and has taken on the form of the other three elements of the chain of ear-bones, the medio-, supra-, and extra-stapedials (Fig. 16, m.st, s.st, e.st), which together are the homologue of the mammalian *incus*. The malleus, although having its functional analogue in the extra-stapedial (the end of the chain fitting into the drum-membrane) is represented morphologically by the frog's suspensorial cartilage, being, as will be shown in a future paper, the proximal end of the mandibular arch.

9. The embryonic characters are now (first autumn) fast disappearing. The suspensorium is at right angles with the long axis of the skull, or almost exact half-way between the positions it occupies in the seventh stage (Fig. 20), and in the adult (Fig. 14, p. 168). The ossicula auditus have come into union with the stapes, and the stylo-hyal instead of being attached (as in Fig. 20) to the suspensorium, has grown backwards to its adult position, where, however, it is united only by fibrous tissue. The parietals and frontals are still separate, and the maxilla has not extended backwards to the quadrato-jugal, although the fibrous space between them is now quite small. The girdle-bone (Fig. 19, G) is singularly behindhand in its ossification; even at this stage it is represented only by a slender plate of bone immediately anterior to the frontals. At a further stage endosteal ossification sets up in the cartilage on either side of this region, so that the girdle-bone is formed by the coalescence of three separate centres.*

THE STRICKLAND CURATORSHIP IN THE UNIVERSITY OF CAMBRIDGE

THE Vice-Chancellor of the University of Cambridge has approved the nomination, by Miss Frances Strickland, of Apperley Court, of Mr. Osbert Salvin, F.R.S., to the office of "Strickland Curator," lately founded and endowed by that lady, and the Museum of that University will therefore reap the benefit of having attached to it one of the best English ornithologists of the day. Mr. Salvin, being then a scholar of Trinity Hall, graduated in mathematical honours in 1857, and immediately afterwards proceeded to join Mr. (now Canon) Tristram in the natural history researches he was making in Algeria, the important results of which are known to many of our readers. In the following autumn he sailed for Central America, and there began that series of scientific observations which has made him the chief authority on the zoology of that part of the world. How many times he has since visited it we cannot say, but he only returned from his last expedition some two months ago, and he has besides been all the while well occupied. In addition to the many papers he has published, mostly on the birds of the Neotropical Region, he has, in conjunction with Mr. Sclater, brought out an illustrated "Exotic Ornithology," intended as a sequel to the celebrated works of Daubenton and Temminck, and in 1870 was chosen editor of the *Ibis*, the leading ornithological periodical of the world.

But our object here is not to sound the praises of Mr. Salvin, who, it will be seen from what we have said, does not requre them, but to point out the advantages that would accrue to science if posts for the study and promotion of its various other branches, similar to the recent foundation, were established in our Universities. We are greatly mistaken if the "Strickland Curatorship" is not the very first step that has been made towards a fulfilment of that idea of the endowment of research which has been often urged in these columns, and was especially recommended in the late Report of the Royal Commissioners on Scientific Instruction and Aid to Science. Admitting that the intention of Miss Strickland was mainly to secure the proper keeping of her late brother's ornithological collection, which was some years ago given by his widow to the University, what will be the effect of the foundation? The merely mechanical part of the curator's

* It should have been stated in the last paper that Fig. 13 is taken from a drawing kindly furnished by Prof. Huxley.

duties is slight. A collection once put in order is easily so retained. Even the cataloguing of it is a task that may not be expected to occupy an ornithologist of Mr. Salvin's ability, knowledge, and experience, a very long time—though catalogues in these days, to be worth anything, are more serious affairs than most people would fancy. The regulations of the office prescribe that its incumbent should then turn his attention to the other ornithological collections possessed by the University; and, even if the rest be trifling, the Swainson Collection may be expected to form a formidable undertaking—to say nothing of others that may be acquired from time to time. We take it for granted that the University will not allow such catalogues to remain in manuscript, but will print and publish them as they are completed. If so, it will be promoting the advancement of science in this particular direction in the most efficacious mode possible, and yet, be it remembered, not in a way that by any means can be termed "educational." The compilation of these catalogues will be purely a matter of research, and the amount of aid they will furnish to scientific ornithologists cannot be calculated. There can be little doubt that to the centre in which such good work is being done, many other collections will gravitate, and thus Cambridge will be for many years to come a recipient and disseminating focus of Ornithology.

Now, even the most ardent ornithologist will hardly maintain that his favourite study is the most important in the wide round of the sciences, or even of those which have to do with biology. The moral of the "Strickland Curatorship" is, that similar appointments ought to be established to do for other sciences what that will do for Ornithology. And even now we have to mention a curious fact which should be an encouragement for future founders or foundresses to cast their bread upon the waters: two other benefits to this branch of science have unexpectedly been the result of Miss Strickland's endowment. The naturalist first selected by her for the new appointment was the learned Dr. Finsch, who, until the last few months, had been pursuing his unwearied labours on a scanty and uncertain pittance at Bremen. When the good people of that city learned that they were likely to lose his services, they bethought them that it was expedient to retain him, and to do this they resolved upon raising his stipend and making his office in their museum permanent. In like manner it happened that Miss Strickland's next selection, a young naturalist of great promise, was induced to stay at Berlin by the creation of a post in the museum there specially for him. Thus the benefactress of Cambridge has the satisfaction of knowing that her bounty has been the means of providing for two meritorious men, besides accomplishing the object she had directly in view. Will no one come forward to further the good work she has so well begun? Now that there is a rumour that one of our greatest living naturalists is likely to be tempted by a glittering bait to the other side of the Atlantic, it is in the power of many a one to preserve the glory of his services to England by founding a Professorship of Biological Research in the University of John Ray and Charles Darwin!

A NEW ORDER OF HYDROZOA

ON the southern shores of France, at a slight depth below the surface of the sea, there may be found attached to stones small patches of one of the horny sponges which will probably arrest the attention of the zoologist by what will appear to him as an unusually obvious and well-defined condition of their efferent orifices or oscula.

If one of these patches be transferred to a phial of sea-water, the observer will soon be astonished by seeing that from every one of the apparent oscula a beautiful plume of hydroid tentacles will have become developed, and he will naturally believe that the form has at last been found which will remove all doubt as to the zoological position of the sponges, and decide in favour of the hydroid affinities recently assigned to them.*

A more careful examination, however, will show that the orifices on the surface have been incorrectly regarded as oscula, and that the tentacles form no part of the sponge, but proceed from an entirely different organism which is imbedded in its substance.

It will be further seen that the organism with which the sponge is thus associated is contained in a congeries of chitinous tubes which permeate the sponge-tissue, and open on its surface in the manner of genuine oscula, and it will be still further apparent that this organism, while undoubtedly a hydrozoon, and even presenting quite the aspect of a hydroid trophosome, is no hydroid at all, and cannot indeed be referred to any of the hitherto recognised orders of the Hydrozoa, but must take its place in an entirely new and as yet undefined order of this class.

The chitinous tubes and their contents are united by a common tubular plexus which lies towards the base of the sponge, and they thus constitute a composite colony of zooids. The tubes, towards their free extremities, where they open on the surface of the sponge, become much increased in width, and here their contents become developed into a very remarkable body, which has the power of extending itself beyond the orifice of the tube, and of again withdrawing itself far into the interior exactly like the hydranth or polypite of a campanularian hydroid in its hydrotheca. When extended, it displays from around the margin of a wide terminal orifice its beautiful crown of tentacles; but when withdrawn into the interior of the cup-like receptacle, the tentacles are greatly contracted and thrown back into the cavity of its body. Its general appearance, indeed, is very like that of a campanularian hydranth, and a careful examination is needed in order to show that it possesses all the essential characters, not of a hydranth, but of a medusa. It has a circular canal surrounding the terminal orifice and supporting the tentacular crown, and it has four symmetrically-disposed longitudinal canals extending from the circular canal backwards in the walls of the body. No manubrium could be detected, though this was carefully sought for at the point where it might be expected to be found, namely, where the medusiform zooid passes into the common cœnosarc which occupies the narrower portion of the tube; neither was there any appearance of a velum, nor of lithocysts or ocelli; but these are comparatively unessential modifications.

The reproductive system is probably developed in the walls of the longitudinal canals, but in none of the specimens examined was this part of the organisation sufficiently mature to admit of a satisfactory demonstration.

For the little animal thus constructed I propose the name of *Stephanoscyphus mirabilis*. Whether it is to be regarded as parasitically connected with the sponge, or whether the two are only accidentally associated, it is at present impossible to say. At all events, in no instance did I find the Stephanoscyphus unaccompanied by the sponge.

Stephanoscyphus may then be regarded as a compound hydrozoon, whose zooids are included in cup-like receptacles resembling the hydrothecæ of the calyptoblastic hydroids; but these zooids, instead of being constructed like the hydranths of a hydroid, are formed on the plan of a medusa. It has plainly very decided affinities with the Hydroida, but is nevertheless removed from these by a distance at least as great as that which separates from them the Siphonophora. It thus becomes the type of a new hydrozoal order, for which I propose the name of THECOMEDUSÆ. GEO. J. ALLMAN

* See Haeckel's "Kalkschwämme."

ANOTHER NEW COMET.

THE following letter from Mr. J. R. Hind, dated Mr. Bishop's Observatory, Twickenham, July 27, appeared in Tuesday's *Times*:—

"M. Stephan, Director of the Observatory at Marseilles, notified to us by telegram yesterday the discovery of a comet on the previous night by M. Borrelly, a colleague of M. Coggia (to whom is due the first detection of the bright comet which we have just lost), at that Observatory. The position at 2 A.M. on the 26th inst. appears to have been close to the star Theta, in the constellation Draco, in right ascension 238 deg. 4 min., and polar distance 30 deg. 28 min. The comet is pretty bright, and its motion towards the west. Clouds have prevented any observation at Twickenham during the past night.

"A communication from Berlin this morning mentions —contrary to what I should yet have expected from my own calculations relating to the orbit—that Dr. Tietjen, of the Imperial Observatory, has found indications of a sensible deviation from parabolic motion in the recent bright comet between April 19 and July 14. The curve is elliptical, but the inferred period of revolution is of such length as to be open at present to uncertainty, which can only be removed by observations in the other hemisphere. The semi-axis major is found to be rather more than 430 times the earth's mean distance from the sun, and the corresponding length of revolution is nearly 9,000 years.

"The tail of the late comet increased very quickly and considerably in length, as frequently happens soon after perihelion passage. Assuming it to have proceeded from the nucleus very nearly in the direction opposite to that of the sun, its actual length had increased from 4,000,000 miles on July 3 to 16,000,000 on the 13th, and on the 19th, the last night it was visible in this hemisphere, to something over 25,000,000 miles. The increase of apparent length in this interval was from 4 deg. to 43½ deg."

NOTES

THE Priestley Centenary is to be celebrated, not only at Birmingham, as we have before announced, but at Leeds, by two meetings, to be held in the hall of the Philosophical Society. The chair will be occupied at the two meetings by Dr. Clifford Allbutt and Mr. Sykes Ward, F.C.S., and addresses are to be given by the Rev. J. C. Odgers, who is to read a paper On the personal history of Priestley; Mr. T. Fairley, F.C.S., On the phlogiston theory; and Mr. S. Jefferson, F.C.S., On the discovery of oxygen.

DR. ACLAND, Regius Professor of Medicine in the University of Oxford, has been appointed president of the Medical Council, in succession to Dr. Paget, of Cambridge. We believe the appointment is a five-yearly one.

AT a general meeting of the Council of the Yorkshire College of Science, held last Friday, Dr. T. E. Thorpe was elected Professor of Chemistry. Dr. Thorpe has for the last four years had the direction of large classes in theoretical and practical chemistry at the Andersonian University, Glasgow. He is the author of "A Manual of Inorganic Chemistry" and "A Text Book of Quantitative Chemical Analysis," and has made many original contributions to chemical literature.

THE death is announced of Father Paul Rosa, the colleague of Father Secchi at the Roman Observatory.

THE Select Committee of the Legislative Assembly of New South Wales, which was appointed to inquire into the management of the Sydney Museum, has furnished its report, in which the appointment of a Curator, with complete charge of the property of the Museum, subject to the Minister of Public Instruction, is proposed; at the same time an extension of the building at present holding the collection is suggested.

MR. C. A. BOWDLER's apparatus for steering balloons was tested on Saturday last at Woolwich, in the presence of several officers of the scientific branches of the army. The balloon to which the apparatus was attached was the new large one, 80 ft. high, belonging to Mr. Coxwell, which was considered by Mr. Bowdler too large for the size of his machine. His apparatus is very simple, consisting of fans like the screw propeller of a ship, 3 ft. in diameter, and making 12 or 14 revolutions per second, worked by band. When the balloon was exactly balanced the vertical fan caused it to rise and fall, but the horizontal fan was found to have no effect whatever in guiding the direction.

THE French National Assembly has adopted the proposal to award to M. Pasteur a pension of 12,000 francs, one half of which reverts to his wife should she survive him.

WE view with great pleasure the advance of the Birkbeck Institution within the last few years in its scientific department. Quite recently a scientific society has been established in connection therewith, the object of which is to inculcate and develop a taste for scientific pursuits among its members, by the reading of original papers upon scientific subjects and by debates, and particularly for the encouragement of the application of scientific principles to the arts and manufactures. In immediate connection with this society we find a Naturalists' Field Club, the aim of which is to organise excursions to the various districts possessing scientific interest, for the purpose of studying practically and under the direction of practical men, those sciences, such as geology, mineralogy, botany, &c., a real and sound knowledge of which can only be obtained by the actual study of Nature. We wish this new undertaking all possible success. As a proof of the high character of the work performed by this institution and the excellence of the instruction provided, we need only call attention to the fact that this year its students have been awarded one half of the total number of prizes offered for public competition by the Society of Arts at its annual examinations.

THE Royal Academy of Belgium proposes the following subjects for prizes to be awarded in 1875:—1. To examine and discuss, on the basis of new experiments, the perturbing causes which influence the determination of the electro-motive force and the interior resistance of an element of the electric pile; to find out the number of these two quantities for some of the principal piles. 2. To give an exposition of the knowledge attained on the relations of heat to the development of phanerogamous plants, particularly in reference to the periodic phenomena of vegetation; and, in this connection, to discuss the value of the dynamical influence of solar heat on the evolution of plants. 3. To make new researches on the embryonic development of the *Tunicata*. 4. To make new researches to establish the compositon and mutual relations of albumenoid substances. 5. To describe the coal-system of the basin ot Liége. A gold medal of the value of 1,000 francs is the prize in subjects 4 and 5: one of 600 francs for subjects 1, 2, and 3. The memoirs ought to reach the Secretary of the Academy before August 1, 1875. They must be written either in La'in, French, or Flemish.

THE destruction of vineyards by *Phylloxera*, which has lately so much engaged the attention of entomologists and botanists, was recently the subject of a bill in the French Assembly. Many prefects, on the plea of public welfare, have issued orders for the uprooting and burning of diseased plants, and opposing the introduction of foreign stocks; but to make this desperate course effectual, a special law putting the *Phylloxera* on a level with the rinderpest is necessary. M. Destreaux has submitted a bill to make this possible, and the Academy of Sciences gives it its support. Notwithstanding the investigations that have made, no reliable specific against *Phylloxera* seems to have been yet discovered. The bill before the Assembly is received as "urgent."

MR. NEWBIGGING, in his "Handbook for Gas Engineers and Managers," London, 1870, p. 159, gives a "Chronology of Gas Lighting." By this author's statement the first public exhibition of gas in London was in 1807, by Mr. Winsor, who lighted Pall Mall at that time. But Prof. B. Silliman, writing to the *American Gas Light Journal*, gives an extract from the elder Prof. Silliman's "Journal of Travels in England, Holland, and Scotland," containing a description of a public exhibition of illuminating gas from coal in July 1805, by "an ingenious apothecary" in Piccadilly, near Albany House. "The inflammable gas," the journal states, "is extricated simply by heating common fossil coal in a furnace, with a proper apparatus to prevent the escape of the gas, and to conduct it into a large vessel of water, which condenses the bituminous matter resembling tar, and several other products of the distillation that are foreign to the principal object. The gas, being thus washed and purified, is allowed to ascend through a main tube, and is then distributed by means of other tubes concealed in the structure of the room, and branching off in every desired direction, till, at last, they communicate with sconces along the walls, and with chandeliers depending from the roof, in such a manner that the gas issues in streams from orifices situated where the candles are commonly placed. Then it is set on fire, and forms very beautiful jets of flame, of great brilliancy; and from their being numerous, long, and pointed, and waving with every breath of air, they have an effect almost magical, and seem as if endowed with a kind of animation. The gas is sometimes made to escape in revolving jets, when it forms circles of flame—and, in short, there is no end to the variety of forms which ingenuity and fancy may give to this brilliant invention. The expense of the apparatus, and its liability to accidents, forms an obstacle of magnitude, and, on the whole, it is probable it will not be generally adopted." This is curious reading in 1874! Mr. Murdock had employed gas illumination in 1792, and gas was used in Paris in 1802. But London was in the dark until 1805.

DR. MELLICHAMP, of Bluffton, South Carolina, has been prosecuting researches on the pitchers of *Sarracenia variolaris* and the way in which insects are caught in them. The species abounds in this district, and even early in May many pitchers were developed. He has confirmed the presence of the sugary secretion within the rim. He finds that it bedews the throat all the way round the rim, and extends downwards from $\frac{1}{4}$ in. to $\frac{3}{4}$ in. Dr. Mellichamp also finds—and this is his most curious discovery—that this sweet secretion is continued externally in a line along the edge of the wing of the pitchers down to the petiole or to the ground, forming a honeyed trail or pathway up which some insects, and especially ants, travel to the more copious feeding ground above, whence they are precipitated into the well beneath. Ants are largely accumulated in these pitchers. As to the supposed intoxicating qualities of this secretion, Dr. Mellichamp was unable to find any evidence of it. On cutting off the summit of the pitchers and exposing them freely to flies in his house, he found that the insects which came to them, and fed upon the sweet matter with avidity, flew away after sipping their fill, to all appearance unharmed. On the other hand, he thinks that the watery liquid in which the insects are drowned and macerated possesses anæsthetic properties; that house-flies, after brief immersion in it, and when permitted to walk about in a thin layer of it, "were invariably killed—as at first supposed—or at any rate stupefied or paralysed in from half a minute to three or five minutes," but most of them would revive very gradually in the course of an hour or so.

IT is probable that a scheme for the establishment of another Medical School at Dacca, on the same footing as those of Calcutta and Patna, will shortly be sanctioned by Government.

THE success which has attended the ostrich-breeding farms in South Africa has induced some French gentlemen to endeavour to imitate the system in Algeria, and African birds have also been sent to La Plata and other countries in South America, where it is hoped they may take the place of the native birds, which are inferior in quality to the African ostrich. Generally speaking, the system on which ostrich farms are conducted is as follows. The birds kept for breeding purposes, about three years old, are placed in separate paddocks, in pairs, and their eggs are either hatched in the natural way or placed in incubators prepared for the purpose. By this means a larger proportion of eggs is hatched. The young birds are fed on grass, lucerne, and other vegetable matters, and are sheltered at night. Each pair of birds will produce about twenty chickens, which may be plucked when they are about eighteen months old, before which time the feathers are not of much value. The price of good ostrich feathers, wholesale, is about 40*l*. per pound weight. If the birds are well kept, and have plenty of exercise and food, their feathers are of good quality; but the plumage of wild birds is considered superior to that of inferior tame ones. The value of each year's plucking from the young birds is about 7*l*., and of the birds themselves at six months old is 30*l*. to 35*l*. The breeding birds are worth 125*l*. per pair.

THE new screw steamship *Durham* sailed from Plymouth on Sunday, bound for Melbourne, having on board several members of the Imperial German Astronomical Expedition. They carry with them a large number of instruments with which to observe from Port Ross, one of the Auckland Islands, the coming transit of Venus.

WE have received, reprinted from the excellent Indian ornithological journal *Stray Feathers*, a copy of a lengthy paper by Mr. V. Ball, on the Avifauna of the Chota Nagpur division of Bengal, which, besides giving an account of the birds found in the district, contains an instructive description of its geology, flora, and mammalian fauna; the author laying great stress, as is but too seldom done, on the interdependence between these mutually related phenomena.

THE tenacity of life of popular errors is well exhibited in the following extract from the *Californian Horticulturist*:— "The influence of forests in drawing moisture from the heavens may be seen from the experience of San Diego, California. Previous to 1863 there was yearly a rainy season, which made the soil nourishing and productive. In 1863 a destructive fire swept over the greater part of the country, destroying the forest and blackening the hills. Since then there has been no rainy season at San Diego." When will public writers learn that forests influence the climate by drawing water, not from the air, but from the soil?

AN addition is in preparation to the Colonial Floras published under the authority of our Colonial Government, in the form of a "Flora of Mauritius." It will be edited by Mr. J. G. Baker, assistant-curator to the Kew Herbarium.

PROF. SCHIMPER, of Strassburg, in a paper read before the Botanical Congress at Florence, claims to have discovered a fossil plant in "protogine," a rock hitherto considered of igneous origin, which occurs in the form of erratic blocks on the sides of Mont Blanc and in the plains of Piedmont. The specimen, which was collected by M. Sismonda, and is preserved in the Museum of the Turin University, has been identified by Prof. Schimper as *Annularia sphenophylloides*, a plant, perhaps aquatic, widely distributed in the coal-strata of Mont Blanc.

A DRAWING-ROOM meeting in aid of the Palestine Exploration Fund was held on the 24th inst. at the residence of the Duke of Westminster, Grosvenor House. Capt. Warren, before

giving an account of his experiences, made an appeal to the meeting for increased support to carry on the work of exploration, which was at present flagging for want of funds. He urged the subscribers to the Fund to complete the work of surveying the country as soon as possible, as the land, being so fertile, was constantly being taken by the Greeks and other foreign cultivators of the soil for farming purposes. As a consequence, the old names of the towns and villages were fast disappearing, and the whole country was assuming a different aspect. This meeting was the first of a series that is to be held, information as to which can be obtained of the secretary at the office of the Fund, 9, Pall Mall East.

ACCORDING to the State geologist of Minnesota, the cretaceous lignite beds of Minnesota Valley are likely to afford valuable coal mines.

IN the report to the Admiralty of Capt. G. S. Nares, of H.M.S. *Challenger*, dated Melbourne, March 25, 1874, Capt. Nares, speaking of the temperature of the ocean, especially near the pack edge of the ice, says:—"At a short distance from the pack, the surface water rose to 32°, but at a depth of 40 fathoms we always found the temperature to be 29°; this continued to 300 fathoms, the depth in which most of the icebergs float, after which there is a stratum of slightly warmer water of 33° or 34°. As the thermometers had to pass through these two belts of water before reaching the bottom, the indices registered those temperatures, and it was impossible to obtain the exact temperature of the bottom whilst near the ice, but the observations made in lower latitudes show that it is about 31°. More exact results could not have been obtained even had Mr. Siemens' apparatus been on board." It seems to us that the difficulty mentioned is one which would certainly have been surmounted by Messrs. Negretti and Zambra's new recording thermometers, a description of which appeared in NATURE, vol. ix. p. 387; this being exactly one of the cases to which this instrument is peculiarly adapted. We believe the inventors and makers have greatly improved their thermometer since our description appeared, and no doubt means will be taken by the Admiralty to transmit one to the *Challenger*.

MR. PILLISCHER, optician and scientific instrument maker, of New Bond Street, W., has been decorated by the Emperor of Austria with the golden Cross and Crown of Merit, as are cognition of his Majesty's approval of the superior quality and precision of his scientific instruments shown at the late Vienna Exhibition.

THE following is a list of candidates successful in the competition for the Whitworth Scholarships (Science and Art Department), 1874:—William Martin, metal turner, Wolverton; Robert A. Sloan, engineer's apprentice, Birkenhead; William Sisson, engineer, Gateshead; Frederick Stubbs, engineer's apprentice, Derby; Thomas L. Daltry, draughtsman's apprentice, Newcastle-on-Tyne; Frederick H. Livens, engineer's apprentice, Gainsborough.

THE additions to the Zoological Society's Gardens during the past week include two Tigers (*Felis tigris*) from Calcutta; two Yellow-billed Sheathbills (*Chionis alba*) from the Southern Ocean, presented by Mr. H. Roberts; a Wanderoo Monkey (*Macacus silenus*) from the Malabar Coast, presented by Lieut. Vipan; a Rose-crested Cockatoo (*Cacatua moluccensis*) from the Moluccas, presented by Mr. John Elms; three Grey-breasted Parakeets (*Bolborhyncus monachus*) from Monte Video, presented by Mr. C. Purnchard; a King Vulture (*Gyparchus papa*) from Tropical America; a Red-backed Buzzard (*Buteo erythronotus*) from South America, purchased; a Philantomba Antelope (*Cephalophus maxwellii*) born in the Gardens.

ON SPECTRUM PHOTOGRAPHY *

II.

I NEXT come to a very beautiful reflex action of spectroscopy on photography; and now I must take you back to America. I am nearly certain that everyone in this room is perfectly familiar with the name of Rutherfurd in connection with celestial photography: if you will allow me I will point my reference to him by throwing on the screen one of his magnificent photographs of the moon, which he was good enough to give me some little time ago. Unfortunately, I am not able to throw on the screen a photograph of the solar spectrum which we owe to him, the most magnificent photograph—and I say it with the intensest envy—which I think it is possible to obtain. However, I have a copy of it on the wall, and it is well worth inspection. Rutherfurd, whose name is associated with that of Delarue in the matter of celestial photography, was not content with reflectors. He lives in the centre of New York, and I suppose New York is as bad as London for tarnishing everything that the smoke and atmosphere can get at; and he came to the conclusion that he must abstain from celestial photography altogether, or else make a lens—and a lens with Mr. Rutherfurd means something over 12 in. diameter—which should give him as perfect an image in New York with 15 in. of glass, as a perfect reflector of 15 in. aperture would give him as far away from a city as you please. Mr. Rutherfurd, who never minces matters, knowing that it was absolutely impossible to get such a lens as this from an optician, who of course neglects almost entirely the violet rays—the very rays which he wanted—in constructing an ordinary telescope, determined to make such an one himself. He thought about the matter, and he came to the conclusion that in any attempt to correct a lens of this magnitude for the chemical rays, the use of the spectroscope would be invaluable. He therefore had a large spectroscope made, in order to make a large telescope, and then we have just as distinct an improvement upon the instruments which we owe to the skill of those who first adopted the suggestion of Sir John Herschel and brought together the chemical and the visual rays, as the improvement we owe to Herschel was upon the instruments which dealt simply with the visible rays. Mr. Rutherfurd simply discards the visual rays, and brings together the chemical rays; the result of his work being a telescope through which it is impossible to see anything, but through which the minutest star, down I believe to the tenth magnitude, can be photographed with the most perfect sharpness. This is the instrument of the future, so far as stellar astronomy is concerned. Having thus achieved what he wished in the construction of this instrument, and having the spectroscope, Mr. Rutherfurd commenced a research, which, I am sorry to say, he has never published, for it would be of the greatest value to any photographer or any astronomer amongst us, upon various kinds of collodion and upon the best arrangement of lenses for photographing the spectrum. Mr. Rutherfurd found that some collodions which he got were so local in their action as to be almost useless for that reason, and that others were so general in their action that they were also almost useless for the exactly opposite reason. I will now throw on the screen the line G and the lines in the green, or rather the lines approaching to the green near F; with ordinary collodions, such as one generally gets, that is to say, collodions not absolutely good, but free from both the extremes referred to by Mr. Rutherfurd, we want something like five seconds for the part near the line G. Well, when you go a little way along the spectrum in the less refrangible direction, you have to put minutes for seconds—in other words, the exposure has to be sixty times as long. I have another photograph of the spectrum, which will show you the part of the spectrum less refrangible than the line F to which I have referred. This photograph which you see on the screen required an exposure of very nearly half an hour.

Those of you who are most familiar with the solar spectrum will recognise the extreme importance of Mr. Rutherfurd's contribution to photographic spectroscopy, when I tell you that his photograph of the solar spectrum is quite as admirable and excellent as is the photograph of the moon which I have just shown you on the screen. During the last year this question of the solar spectrum has again been considerably advanced by photography in America. Mr. Rutherfurd's photographs, admirable although they are, are refraction photographs, that is to say prisms were

* Continued from p. 112.

used, and, more than this, prisms of glass. You will, therefore, quite understand that the photograph extends only a very little distance beyond the lines H. But America was not satisfied with this, and in the person of Dr. Draper, the son of the Professor Draper whose name is so honourably associated with the commencement of work done in photography thirty years ago, has just now photographed the solar spectrum far beyond H. A copy of his photograph is on the wall, but unfortunately I have not a copy which I can throw on the screen.

I have already referred to the extreme importance of photography in astronomy, and the point that I wish to urge to-night, after what I have stated regarding all the work which has been done up to the present time, is this—That what photography has been in the past to astronomy—what it will be in the future no one can say—such can photography, and such must photography, be to chemists and physicists. Of course, in the way of photographic application, it is scarcely fair to say that a daily photographic record of the prominences around the sun is a question either of physics or of chemistry. But still the method which enables us, or which, I hope, will enable us shortly, to obtain a daily photograph of every prominence which bursts out—although absolutely invisible to our eyes—on the sun, is a method which depends on physical laws, and has nothing to do with astronomy in the ordinary sense. If you will allow me, I will show you now on the screen a photograph of a drawing which was made by an eminent Italian observer in India during the last eclipse. It is a drawing made by Prof. Respighi, of the sun's corona, as seen by the spectroscope; and I hope in the next eclipse we shall not any longer have merely drawings to refer to, but that we shall have a photograph which can be brought here, and which will let us know exactly how the matter stood. You see there on the screen three rings—a red ring, a green ring, and a blue ring. They are red, green, and blue, because the element in that part of the sun's atmosphere—hydrogen—gives us lines in the red, green, and blue; and they are rings because the hydrogen atmosphere extends in the most admirably regular way all round the sun. In fact, we may say that, in observations of this kind, we use the corona instead of the slit, and if that is good for the corona it is perfectly obvious to you it is good for the chromosphere—for the brighter regions lying closer to the sun than the corona does—as we know that it gives a line of intense blue, exactly where photography, as it is generally carried on, has its strongest *point d'appui* in the spectrum; and it is quite clear to you that we ought to be able to get a photograph of this every day, just as easily as we saw it in India during the eclipse.

We will next consider the application of photography, no longer to the mere solar spectrum, but to the physics of the sun. What is the solar spectrum? It is the continuous spectrum of the sun, minus certain portions where the light of the continuous spectrum has been absorbed. What have been the absorbers? The gases and vapours, generally speaking, in an excessively limited zone of the sun's atmosphere, lying close to the bright sun we see; close, I say, to the photosphere. This zone is called the reversing layer. Then if the solar spectrum is the result of the absorption of this reversing layer, what will happen to the solar spectrum if the constitution of the layer changes? Obviously a change in the solar spectrum. Now, recent researches carried on by means of photography show us that if you take any particular vapour in the reversing layer, which you may call A, for instance, and then assume that the quantity of A in the layer is reduced, the absorption of that particular vapour will be reduced; what then will be the result on the photograph of the solar spectrum? Some of the lines will disappear. Suppose that this particular vapour which we call A, instead of being assumed to decrease in quantity, increases in quantity, what will happen to the solar spectrum? The same researches have told us that as its quantity increases its absorption will increase, and that its increased absorption will be indicated by an increase in the number and in the breadth of the lines absorbed. What, then, will happen to the solar spectrum if any change of this kind is going on? The photograph of a solar spectrum taken, say, today, may be different from the photograph of the same part of the spectrum taken at some distant period. What is the distant period we do not yet know—whether three months, six months, six years, or eleven years; but, at all events, there is reason to think already that if we had a series of photographs of the solar spectrum, taken year by year, we should see great changes in the spectrum. Allow me to show you a photograph of a very limited portion of the solar question, and I will prove my case; and let me tell you I could not prove my case if photography had not been called in, because if the existence of any particular metal, or of the increase of any particular metal, depends on such a small matter as one line among 10,000, what will happen if a man neglects to observe this change? People will say, "Oh! in a research of that kind it is altogether excusable if he has made a mistake." But if you have a series of phenomena recorded by means of a camera on "a retina which never forgets," as Mr. Delarue has beautifully put it, and if you compare those pictures day by day, and year by year, the thing is put beyond all question when you get one line disappearing, or another line appearing.

Now we have before us a part of the solar spectrum near the line H, and I wish to call your particular attention to one line. We have admirable drawings of the solar spectrum taken about the year 1860. If the draughtsman was recording by means of his eye the lines in the spectrum, he would not be very likely to overlook a line darker than some he inserts, but he might easily overlook finer lines. Now, it is a fact that in the most careful map that we have—a map drawn with a most wonderful honesty and splendid skill—a line is absent in the region indicated, which line is now darker than some that were then drawn, and that line indicates the presence of an additional element in the sun—strontium. I do not make this assertion thinking that subsequent facts will show the drawing to be wrong, but because I see reason to believe that what we know already of the sun teaches us that it is one of the most likely things in the world that strontium was not present in such great quantity in the reversing layer when the drawing was made; but, however that may be, I think you will see how important it is that this photograph, which I have just thrown on the screen, should be compared with photographs made five, ten, fifteen, a hundred, or two hundred, or as many years as you like ahead, and it is in this possible continuity of observation of the solar spectrum, carried on for centuries, that I do think we have in photography not only a tremendous ally of the spectroscope, but a part of the spectroscope itself. Spectroscopy, I think, has already arrived at such a point, at all events in connection with the heavenly bodies, that it is almost useless unless the record is a photographic one. I am glad to say that only to-day I have had a letter from Dr. Draper, who tells me he has at last succeeded in getting an admirable photograph of the spectrum of a star. Now that is of the very highest importance, because the sun is nothing but a star, and the stars are nothing but distant suns; and as long as we merely investigate the sun, however diligently or admirably we do it, and neglect all the others, it is as if a man who might have the whole realm of literature to work at should confine himself to one book, and that book probably not a good representative of the literature of the country he was examining into.

So much for the application of photography to what may be called the celestial side of spectroscopy; but let me tell you that this, so far as spectroscopy is concerned, does not exist. To the spectroscope all nature is one, and it is absolutely impossible to make a single observation, either on a sun, or a star, or a comet, without bringing chemical and physical considerations into play; and it will be a regrettable circumstance if chemists employ the spectroscope in terrestrial chemistry—they have not done much in that way yet—without taking the sun and all the various stars of heaven into counsel, because the spectroscope is absolutely regardless of space, and shows us that the elements which are most familiar to us here, or at all events a good many of them, are present in the most distant stars, and the spectroscope shows us those elements existing under conditions which are absolutely impossible here.

There is another point, too—spectroscopy is, above all things, molecular. We are dealing with the ultimate atoms, or molecules, or whatever you like to call them, when, by means of the spark, we drive a substance into vapour. And if chemists, for instance, will simply ask themselves which substances have their lines reversed in the solar spectrum, I think, before they have thought that problem out—that very simple problem, as it seems—there will be such a flood of light thrown upon terrestrial chemistry, that the only wonder will be that it has not been seen before, years and years ago. These, you will say, are theoretical applications. It is perfectly true; and there are a great many other theoretical applications that it would be my duty, as it would be my pleasure, to bring before you, if time permitted. But that is not all. I have to refer to the application of the spectroscope in what are considered by some people more practical directions. The more you deal with the most abstruse considerations of Science, the more likely you are to get practical applications out of them.

You have already seen how exceedingly important it was to use a slit instead of a round hole in these experiments. It was the verdict of Wollaston, and it was the verdict of Becquerel and Draper, as I have shown you to-night with regard to photography. You have also seen that we can use the circular corona as a slit equally well.

Now if we take a long slit and divide it into as many portions as we choose, we see at once the improvement that we introduce into spectroscopic photography. All we have to do is to divide that slit into portions, as it were, by letting a window run down the slit, and when the window has arrived at the second part of the slit, let in light from a new source. This principle has been carried out practically in the following manner:—A rectangular brass plate 71 mm. long, and 35 mm. broad, slides in grooves in front of the slit of the spectroscope, and a window 4 mm. high, cut out of this plate, leaves a portion of the slit of this length exposed. A small pin presses firmly against the face of one of the sliding plates, and a row of small shallow holes or notches is drilled in the plate so as to intercept it in its upward or downward movement at those points where the pin falls into a notch. The distance between the notches is precisely the same as the height of the opening cut in the sliding plate, so that the movement of this plate from one notch to another corresponds to a distance equal to the height of the exposed part of the slit, and the spectra compared are confronted, so to speak, absolutely; the upper edge of one spectrum abuts against the lower edge of the other, and the coincidence, or want of coincidence, between lines in the two spectra can thus be determined with the greatest precision. The spectroscope employed contains three prisms of 45° and one of 60°; its observing telescope is replaced by a camera with a 3-in. lens by Dallmeyer of about 23 in. focal length for the use of which I am indebted to Lord Lindsay. With this arrangement—the spectrum being received upon a sensitised $\frac{1}{4}$ plate—the portion between the wave-lengths, 3,900 and 4,500, can be obtained at once in good focus. A ray of sunlight, reflected from a heliostat mirror so as to fall upon the slit-plate, is brought to a focus by means of a double convex lens just between the carbon poles of an electric lamp, while a second convex lens placed between the lamp and the collimator tube, serves to cast an image of the sun or of the electric arc upon the slit-plate. Supposing, now, we wished to compare the iron spectrum with that of the sun: the sun's image in sharp focus on the slit-plate is first allowed to imprint its spectrum on the prepared plate. The ray of sunlight is then cut off, the sliding plate moved up or down till the pin catches in the next notch, and the image of the arc, passing between an upper pole of carbon and a lower pole consisting of a carbon crucible containing a fragment of iron, is allowed to fall on the portion of the slit thus exposed.

Let me show you some photographs illustrating this description. Here is a single photographic plate on which the new method has enabled us to register no less than four different spectra; those of you who are familiar with photographic processes will immediately see how it is that the number is not forty instead of four. Having a slit of a certain length, if I open all the length of that slit at once I should get a spectrum the breadth of which would depend upon the length of the slit; but if I commence operations by allowing the light first to come through one small portion of the slit, then we shall get the light from the particular metal which I employ in the electric arc falling on one part of the plate, and registering itself on the photographic plate. Then, if I close up that part of the slit, and open another one, I shall be able, through that newly opened part of the slit, all the rest being closed, to photograph on the plate the spectrum of another substance, say iron. Then, having used up that part of the plate, I can close that portion of the slit, I can bring my window lower down, and there we have the spectrum of cobalt. The window has been brought farther down, and there we have the spectrum of nickel, so that we have, as the work of some eight or nine minutes at the outside, a photograph—not a perfect one in this case, but this was the first one taken on this method—which will register with the most absolute and complete accuracy and certainty not less than 1,000 lines. Now a careful student of those lines, working as hard as he can, thinks himself very fortunate if he can lay down ten an hour. Therefore, as ten an hour are to 1,000 in seven minutes, so is the eye to photography in these matters.

I have a photograph of a somewhat similar nature, which I am anxious to place before you. We have here an absolute comparison rendered possible, by means of photography, between the lines of the spectrum of iron and the lines of the spectrum of the sun. You see that in the case of most of the thick lines, you get a thick line in the solar spectrum corresponding with the lines of the iron. And, more than this, you see, I hope, all of you, that these lines of iron are of different lengths. The reason of that is that I have been careful to photograph on the plate the lines due to the various strata of iron vapour, from the rarest vapour, which is obtained at the outside of the electric arc, to the densest, which occupies the centre of the core, and you will see the most beautiful gradation as we pass from the outside part of the spectrum to the inside. This inside part represents the complete spectrum of the core, and the outside the incomplete and almost mono-chromatic spectrum of the vapour which surrounds the denser core in the middle of the spark; thus we have practically reduced the spectrum of iron to one line, instead of 460. That is the first photograph of the kind which has been taken; I say that, not because I am proud of it, but because you all know how enormously photographic processes are likely to be developed the moment, not one individual, but a great many, try their hands upon them, so that an enormous improvement upon what you now see may be anticipated. Not only have we developed, in the application of photography to spectroscopy, a valuable ally to Science, as we have in the application of photography to astronomy—and you know what that has done, and what it is going to do—but we have, I believe, what we may almost call a new chemistry, some day to be revealed to us by means of photographic records of the behaviour of molecules. Recollect that the difference between the iron spectrum of one line and the iron spectrum of between 400 and 500 lines is simply due to the difference in the arrangements of the molecules or atoms of iron in the centre of the electric arc and its exterior. There is one question which all lovers of the spectroscope may ask of photographers, and that is this, why should we any longer be confined, in registering spectra, to the more refrangible end of the spectrum, when one of the very first spectra of the sun that was ever taken was a complete photograph of the spectrum, including not only the blue, the green, and the yellow, but the red, and the extreme red? I think that if photographers will study the action of light on molecules, and read that extraordinary paper of Becquerel's, and will give those who are familiar with the spectroscope, and those who are anxious to promote the progress of spectroscopic research, a means of extending photographic registration, not only into the green part of the spectrum, which they do already with difficulty, but to the extreme red, then the use of the eye will almost entirely be abolished in these inquiries. And although no one has a higher estimate than myself of the extreme importance of the eye, I think that the more it is replaced by permanent natural records in these inquiries, the better it will be for the progress of Science.

J. NORMAN LOCKYER

SCIENTIFIC SERIALS

THE current number of the *Quarterly Journal of Microscopic Science* contains several papers of interest. Dr. Michael Foster commences with an article On the term Endothelium, in which he proves that the word is etymologically pure nonsense, Ruysch's word epithelium signifying that it covers papillæ. His endothelium must be understood to mean *that it is inside a papilla*. It is also valueless for other reasons: for if it is defined as that epithelium developed from the germinal mesoblast, the epithelium of the Wolffian ducts, of the ureters, and of Muller's ducts would have to be included. Therefore the term is insignificant and must be abolished. *Monoderic* and *polyderic* are proposed as terms to indicate that the cells form one or several layers.—The second part of Prof. Haeckel's interesting Gastræa theory follows, in English. In it the systematic and the phylogenetic signification of the Gastræa theory and the ontogenetic succession of the system of organs are discussed, as well as the bearing of the whole on the theory of types. The author is so prolific in his introduction of new words, the definitions of many of which are to be found in other publications, that a Haeckel Glossary in the next number of the *Journal* would not be out of place, to assist readers in the full appreciation of that illustrious biologist's very suggestive theory.—Mr. J. W. Groves explains his method of arranging and cataloguing microscopic specimens.—A paper follows by Mr. E. C. Baber On picro-carminate of ammonia as a microscopic staining fluid, in which he explains M. Ranvier's method. The great advantage of this reagent is shown to consist in its staining tissues in a series of colours varying from red

to yellow: it also acts rapidly and can be kept in a dry form.—The Rev. E. O'Meara describes a collection of Diatomaceæ from Spitzbergen, including many species not enumerated by Cleve's Diatoms of the Arctic Sea.—Mr. Buck describes and figures a new Polyzoon belonging to the family *Halcyonelleæ*, named by him *Clavopora hystricis*, from a single specimen obtained in the expedition of the *Porcupine* in the Mediterranean.—An article from the *Indian Medical Gazette*, On the etiology of Madura foot, is discussed, the vegetable origin of that disease being severely handled. A note by the Rev. M. J. Berkeley is appended, strongly supporting Dr. V. Carter's original observations.—Dr. W. G. Farlow, of Harvard University, writes On a sexual growth from the prothallus of *Pteris cretica*, in which he shows that whilst in some of the prothalli archegonia and antheridia were developed, others gave rise to young fern-plantlets by a direct budding of the cells, without any sexual intervention. The paper is illustrated with two plates.—Mr. E. R. Lankester has two papers, one on *Torquatella typica*, a new type of Infusoria, allied to the Ciliata, from Naples; peculiar in not possessing cilia, not even round the oral region and capitular prominence, but in their place a bell-like prolongation of the body-wall like a ring of united cilia. The second paper is on the heart of *Appendicularia furcata*, in which that organ is shown to consist of two nucleated cells connected by fourteen or so slender vibratile fibrillæ, whose mutual connection by a membrane is uncertain. This organ is thus nothing more than a "most vigorous churn, beating and stirring up the fluid in the great perivisceral hæmolymph space without propelling it in any particular direction." The paper ends with some suggestive remarks on the reduction of the structure of organs in diminutive elaborate types generally.

Justus Liebig's Annalen der Chemie und Pharmacie.—Band 172, Heft 2.—The following papers are published in this part:—On the salts of parabanic acid, by N. Menshutkin. The formula of the ammonium salt is $C_3H_2N_2O_3.NH_3$; by the action of water on the salt the ammonium salt of oxaluric acid is produced, and by the action of heat alone oxaluramide. The potassium and sodium salts have likewise been examined and two silver salts obtained, of which the formulæ are $C_3HAgN_2O_3.H_2O$ and $C_3Ag_2N_2O_3.H_2O$.—The same author contributes a paper entitled, "Notice on potassium oxalurate and the determination of the alkaline metals in the salts of the acids belonging to the uric acid group."—On the oxidation products of colophony and oil of turpentine, by Dr. Josef Schreder. By digesting colophony with dilute sulphuric acid, isophthalic acid ($C_8H_6O_4$) and trimellithic acid ($C_9H_6O_6$) are obtained. Turpentine oil oxidised by dilute nitric acid, gives terebinic and terephthalic acids.—On the conversion of cinchonidine into an oxy-base, by Dr. J. Skalivert. Cinchonidine is mixed with carbon disulphide and bromine dropped into the mixture. A brominated compound of the formula $C_{20}H_{22}Br_2N_2O$ is thus obtained, which on treatment with potassium hydrate yields the new oxy-base $C_{20}H_{24}N_2O_3$. Analyses of the sulphate and of the double Pt salt are given.—On ferrous anhydrosulphate, by T. Bolas, already noticed in the Journal of the Chemical Society.—The following are communications from the Tübingen laboratory:—(1) On the cyan- and carboxyl derivatives of diphenyl, by Oscar Doebner.—(2) On normal phenyl propyl alcohol and allylbenzene, by Leopold Rügheimer.—(3) Researches on the synthesis of allylbenzene, by Rudolf Fittig.—(4) Researches on the constitution of piperine and its decomposition products piperic acid and piperidine, by R. Fittig and W. H. Mielck. This is the fourth notice on the subject, and the authors now touch upon the constitution of piperic acid. By the action of bromine a tetra-brominated acid $C_{12}H_{10}Br_4O_4$ is obtained which by the action of sodium carbonate is converted into the dibrominated compound $C_{12}H_8Br_2O_4$. This last substance boiled with soda solution and precipitated by an acid yields a monobrominated body of the formula $C_{12}H_8BrO_5$. The authors next proceed to the consideration of a new acid which they have obtained by acting upon monobrompiperonal with bases, and then decomposing the salt produced by means of hydrochloric acid. The new acid has the formula $C_{12}H_{10}Br_4O_5$, and must be regarded as the substitution product of the acid $C_{12}H_{14}O_5$. By the action of soda on the sodium salt of the new acid an intermediate compound having the formula $C_{12}H_8Br_2O_5$ has been produced. Bromine dropped into a solution of hydropiperic acid in carbon disulphide, gives rise to the formation of the compound $C_{12}H_{12}Br_2O_4$. In the concluding section the decomposition of hydropiperic acid by means of fused potassium hydrate is treated of. The chief product of the reaction is protocatechuic acid, $C_7H_6O_4$, H_2O. The authors finally assign the constitutional formula

$$C_6H_3\left\{\begin{array}{l}\left.\begin{array}{l}O\\ O\end{array}\right\rangle CH_2\\ CH = CH - CH = CH - CO - OH\end{array}\right.$$

to piperic acid.—The part concludes with papers by Peter Greiss On the sulphurisation of sulphurobenzoic acid or dicarboxylsulphocarbanilide, and by M. G. Gustavson On tetra-iodide of carbon. This substance has been obtained by the action of aluminic iodide on CCl_4 according to the equation—

$$3CCl_4 + 2Al_2I_6 = 2Al_2Cl_6 + 3CI_4.$$

The substances are made to react in carbon disulphide solutions.

Gazzetta Chimica Italiana, Fascicolo V., 1874. This part contains the following papers:—On the extraction of sulphur, by F. Sestini.—On the action of sulphur on earthy carbonates, particularly on neutral calcium carbonate, with regard to geology and agriculture, by Prof. Egidio Pollacci. This paper was communicated in April to the Reale Istituto Lombardo di Scienze e Lettere. The author's principal object is to prove that a mixture of sulphur and calcium carbonate acted upon by water with free access of air gives rise to the formation of calcium sulphate. The chemical changes are thus expressed—

$$2S + 3O_2 + 2H_2O = 2H_2SO_4$$
$$2H_2SO_4 + 2CaCO_3 = 2CaSO_4 + 2CO_2 + 2H_2O.$$

The author is of opinion that the oxidation of the sulphur is effected *directly* by atmospheric oxygen in presence of $CaCO_3$ and water.—The concluding paper is entitled Chemical Research on Turkey Red, by Prof. Abelardo Romegialli. The remainder of the part is devoted to abstracts from foreign periodicals.

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, July 1.—This number contains an article by Dr. J. Hann On the diminution of atmospheric vapour with increase of elevation. Experiment and mathematical theory both deny the existence of an independent vapour atmosphere, which according to Dalton's law would decrease much less rapidly with elevation than atmospheric vapour really does. Hence Mr. Strachey (Proceedings of the Royal Society, March 1861) would not deduct the vapour pressure from the height of the barometer to obtain the pressure of dry air. From a table showing the actual decrease of vapour tension with increase of height, observed in various ascents of mountains and in balloons, is derived a formula to express this decrease. Thus where p and p_0 stand for the pressures at the height h and at the surface of the earth, h being measured in units of 1,000 English feet,

$$(1)\ p = p_0\,(1 - 0{\cdot}075\,h + 0{\cdot}00146h^2)$$

and where e is the bases of natural logarithms, and h in units of 1,000 metres,

$$(2)\ p = p_0\,10^{-\frac{h}{6517}} = p_0 e^{-\frac{h}{2830}}$$

If atmospheric vapour obeyed the law of Dalton, its weight over any place would be four and a half times greater than the real weight. Dr. Hann calculates the weight of vapour at 1,962 metres to be only half, at 6,500 metres one-tenth, of the weight at the surface of the earth. With respect to this rapid decrease of moisture, Strachey remarked that mountain chains, even of moderate altitude, must have great influence upon the hygrometric state of the atmosphere. The above formula can only be used safely for calculating the *mean* pressure of vapour at a given height. It may be useful for barometric measurements of altitudes, since it frequently happens that the vapour pressure of only one of two stations, of which the difference in height is required, is known. Observed values, up to 1,884 metres, have been actually found to agree well with those calculated by the formula. This formula may be only another expression for the opinion of Strachey, that the mean degree of saturation at different heights remains nearly uniform, and therefore the vapour tension depends merely on decrease of temperature. But the calculation of the mean vapour pressure of one level from that of another level with so great accuracy appears not to have been hitherto accomplished.

Annali di Chimica applicata alla Medicina, t. lviii., No. 5.—In dietetics there is a paper by Dr. F. Turbacco On cheese and its alimentary use.—Beaumertz furnishes a contribution on farinaceous substances as food for children.—In pathology there is a paper by Dr. L. Ledeganck (translated from *La Presse Médicale Belge*) On the action of parasitic organisms in the production of necrosis.—In therapeutics we have the following papers:—On the anæsthesia produced in man by the injection of

chloral into the veins, by Oré.—Under the heading "Varieties" there is a paper by Prof. Fausto Sestini On the chemical composition of mulberry leaves; one On a new method of extracting logwood for vines and inks, from the agricultural chemical laboratory of Bologna, directed by Prof. A. Casali and Francesco Marconi; and, finally, a contribution by Melsens On the use of solutions of sulphurous acid, of neutral acid and sulphites, and of hyposulphites.

SOCIETIES AND ACADEMIES

London

Royal Society, June 11.—Researches in Spectrum Analysis in connection with the spectrum of the sun.—No. IV., by J. Norman Lockyer, F.R.S.

Maps of the spectra of calcium, barium, and strontium have been constructed from photographs taken by the method described in a former communication (the third of this series). The maps comprise the portion of the spectrum extending from wave-length 3900 to wave-length 4509, and are laid before the Society as a specimen of the results obtainable by the photographic method, in the hope of securing the co-operation of other observers. The method of mapping is described in detail, and tables of wave-lengths accompany the maps. The wave-lengths assigned to the new lines must be considered only as approximations to the truth. Many of the coincidences between lines in distinct spectra recorded by former observers have been shown by the photographic method to be caused by the presence of one substance as an impurity in the other; but a certain number of coincidences still remain undetermined. The question of the reversal of the new lines in the solar spectrum is reserved till better photographs can be obtained.

Royal Horticultural Society, July 1.—Scientific Committee. Dr. Hooker, P.R.S., in the chair.—Dr. Gilbert described the results of some investigations made by Mr. Lawes and himself on the conditions of the development of fairy rings. The mycelium of the fungus which produced the rings accumulated nitrogen in the superficial layers of the soil with the result of stimulating the growth of the grass and giving it the dark green colour which is characteristic of vegetation richly supplied with nitrogenous nutriment. When this luxuriant growth was grazed off, the soil was left relatively poor in nitrogen, and it was accordingly found that the superficial soil inside the rings was poorer in nitrogen than that outside it.—Dr. Hooker stated that seeds of the Kerguelen's Island cabbage (*Pringlea antiscorbutica*) sent to Edinburgh in a sealed bottle had germinated, while those sent to Kew in boxes had altogether failed. The following communication from Mr. Darwin was read:—"The leaves of *Pinguicula vulgaris* possess a power of digesting animal matter similar to that shown by the sundews (*Drosera*). Albumen, fibrin, meat or cartilage induce a secretion from the glands of the upper surface of the leaf, and their secretion becomes feebly acid (but not so much so as that of *Drosera*). Their secretion is reabsorbed, and causes an aggregation of the protoplasm in the cells of the glands, such as had been observed in other similar cases. Before excitement the glands were seen to be filled with a homogeneous pale greenish fluid; after the aggregation of the protoplasm it can be seen to move. When a row of insects or of cabbage seeds are placed near the margin of a leaf (or when a single insect is placed at one point), the whole margin (or one point) becomes curled considerably over in two or three hours; the apex of the leaf will not turn over towards the base. Small fragments of glass also cause a similar movement, but to a much less degree. The inflexed margin pours forth a secretion which envelops the flies or seeds, but pieces of glass cause no, or hardly any, increase of secretion. But here comes a puzzle: if the flies or fly be removed, the margin of the leaf turns back in less than twenty-four hours; but it does so also when a row of flies and cabbage seeds are left adhering; so that the use or meaning of the inflexion is at present quite a puzzle."—Mr. W. G. Smith showed engraved wood blocks of lignum vitæ, which he found more brittle than box.

Vienna

Imperial Academy of Sciences, Feb. 26.—Dr. Urba communicated a paper on some rocks of South Greenland, collected by Prof. Lanbe, from the second German Polar Expedition.—M. Pelz presented a memoir on determination of the axes of conical surfaces of the second order.—Dr. Adolph Meyer gave an account of new and little-known birds of New Guinea.—Dr. Exner read a paper on the employment of the ice-calorimeter for determining the intensity of the solar radiation; describing an apparatus by which the intensity may be measured directly in calorics, without (as in the Pouillet pyrheliometer) a change of temperature in the instrument, rendering correction necessary.—Dr. Brauer communicated a note on the development and mode of life of *Lepidurus productus* Bosc.—MM. Schulhof and Holetschek communicated the elements and ephemerides of a comet discovered on Feb. 20 by Prof. Winnecke at Strassburg.

Paris

Academy of Sciences, July 20.—M. Bertrand in the chair.—The following papers were read:—Note on the action of two current elements, by M. Bertrand. The assertion that two elements of the same direction attract one another is shown to be inexact, even for parallel elements, and does not agree even with Ampère's law. The author has solved the following problem:—A current element being given, to find in a point of space M the direction that must be assigned to another element, that their mutual action may be attractive, repulsive, or *nil*.—Extract from the Report of the Commission of the Agricultural Society of Chalon-sur-Saône, in the department of Saône-et-Loire, on Phylloxera, by M. Boully.—Reply to a criticism by M. Garrigou, contained in a recent note entitled "Carboniferous Limestone of the Pyrenees; Marbles of Saint-Béat and of Mont," by M. A. Leymerie.—On the efficacy of the method of submersion as a means of improving the vine in the Crimea: extract from a letter from M. Boutin to M. Dumas.—Employment of the *résidues d'enfer* of the oil-mills against *Phylloxera*, by M. Rousseau.—Third note on the electric conductivity of ligneous bodies, by M. Th. du Moncel.—On the stratification of the electric light, by M. Neyreneuf.—On the passivity of iron, by M. A. Renard. The author described several experiments illustrative of methods by which iron can be made passive in ordinary nitric acid.—Action of chloroform on sodic acetatic ether, by MM. A. Oppenheim and S. Pfaff. The product of the reaction was saponified by soda and then acidulated with HCl. A new acid of the formula $C_9H_8O_5$ is thus obtained. This acid is dibasic and belongs to the aromatic series, the authors considering it an isomer of uvitic acid, the substituted groups occupying the positions 1 : 2 : 4.—On the isomeric compounds C_2H_4IBr, by M. C. Friedel. The author has repeated the experiments recently published on this subject by M. Lagermarck, and concludes therefrom that no third isomer of this formula exists.—On a development of heat produced by the contact of sodium sulphate with water at temperatures when the known hydrates of sodium sulphate cannot exist, and when the saturated solution of the salt deposits it only in the anhydrous state, by M. de Coppet.—Ethers of normal propylglycol, by M. E. Reboul.—Experiments on the generation of proto-organisms in media protected from aërial germs, by M. Onimus.—Indifference in the direction of the adventitious roots of a cactus, by M. D. Clos.—Observation of a bolide on the evening of July 18, at Versailles, by M. Martin de Brettes.—On the composition of potassium permanganate, by M. E. J. Maumené. The author concludes that the formula of the salt is Mn_2O_7KO.—New method of determining metals or oxides, by the same author.

CONTENTS

THURSDAY, AUGUST 6, 1874

HITZIG v. FERRIER.

IN a German contemporary, *Das Ausland*, for July 6, the editor has a note on the comparative value of the researches of Drs. Hitzig and Ferrier, in which he animadverts severely on English journals, specially mentioning NATURE, because they have not taken up the subject, and shown that all the credit of the discovery of the localisation of the cerebral functions is due to Fritsch and Hitzig, and that Ferrier has only followed up their line of investigation without giving them due credit for their work.

It is evident that the editor of *Das Ausland* is not a constant reader of this journal, for if he were he would not have stated that we have taken no notice of the work of Fritsch and Hitzig. We believe that we were the first, or, if not the very first, among the first in this country to draw attention to the researches of the able German physiologists, when we gave an abstract (NATURE, vol. viii. p. 467) of an excellent report by Dr. Neftel in Dr. Brown-Séquard's Archives of Scientific and Practical Medicine (New York), upon some of the recent researches in Neuropathology, including an account of the investigations of Fritsch and Hitzig, Gudden, Nothnagel, and others Our object in publishing that abstract was to enable our readers to form their own opinion on the subject.

The facts, as far as they affect the question at issue, are these :—It had until quite recently been thought that the cortical substance of the cerebral hemispheres was devoid of irritability, being the seat of mental phenomena. Hitzig in 1870* found that contraction of the eye-muscles in man can be produced by galvanic excitation of the hemispheres. This discovery led Hitzig, and with him Fritsch, to commence a series of investigations on the lower animals, with very feeble galvanic currents ; and as the results of their experiments they were able to state that the excitation of distinct and limited portions of the anterior convex portion of the brain produces movements of certain groups of muscles on the opposite side of the body, the following new facts being established.†

1. The indication of the points for the irritation o almost all the muscles.

2. The proof that after the irritation with the induced current, secondary movements appear.

3. The proof that epileptiform fits may follow the application of this current.

4. The proof that the loss of blood destroys the excitability of the brain.

In the " West Riding Lunatic Asylum Medical Reports for 1873 " (vol. iii.), Dr. Ferrier published a paper containing the results of experiments on various animals, in which the cerebral surface was excited by the interrupted current. This physiologist also localises the seat for the stimulation of different sets of muscles, in many cases going more into detail than do Fritsch and Hitzig ; the method of stimulation which he adopts—the interrupted current—being one which the German authors had rejected as unsuitable.

What Dr. Hitzig complains of is, that in the original paper above referred to Dr. Ferrier only mentions his name and that of Fritsch in connection with the first of the four above-stated propositions, thereby retaining for himself the whole credit for the other three. In a review of Hitzig's recent work, published in the *London Medical Record*, Dr. Ferrier—writing in a spirit which we hardly think suitable to the occasion, and regretting that he has not indicated some *minor* coincidences between his observations and those of Fritsch and Hitzig, " on account of the construction which Hitzig puts upon them "—acknowledges, we are glad to see, that there are several points which the two German physiologists recorded, and which he had previously failed to credit them with. Nevertheless, he still seems to fail to realise that his true relationship to the original discoverers of the method he employs is that of disciple to master, and not that of an equal, as far as the subject itself is concerned.

To show that due credit has not been given in the right direction, it may be mentioned that in this country the localisation of the cerebral functions has thus become associated with the name of Dr. Ferrier, so much so that in his recent work on " Mental Physiology," Dr. Carpenter, in an appendix, has a chapter on the subject, in which the names of Fritsch and of Hitzig are not even mentioned, the title being " Dr. Ferrier on the Brain." Now, Dr. Carpenter, in this chapter, gives a kind of abstract of Dr. Ferrier's paper above referred to, and it is impossible that an author of so much experience could have omitted even the mention of the true workers-out of the method and facts he recounts, unless these facts and methods had been brought before his notice in a manner which does but very insufficient justice to their originators.

The same cause has probably led most Englishmen to associate the name of Dr. Ferrier so intimately with the doctrine. The question is, Has this author given due credit to Hitzig and to Fritsch, whose careful series of experiments—called into existence by the logical working-out of an opportunity which many less competent observers would have let pass unheeded—gives them full reason to expect all the honour due to the discoverers of the localisation of the cerebral functions ?

Dr. Ferrier may remark that the work of Fritsch and Hitzig was public property for three years before he published his investigations, and that in his paper he assumes that the reader was acquainted with the foreign literature on the subject. Other physiologists have acted on that assumption, and have received credit for a depth of thought and power of observation which they have not deserved ; and this experience should make all authors more than ordinarily careful, when continuing the investigations of other than their own countrymen, to state clearly and fully all that has been previously done by foreigners in their particular line.

Dr. Hitzig seems much aggrieved at the little credit given him by Englishmen in comparison with that which has been bestowed on Dr. Ferrier ; but he may rest assured that all working physiologists fully appreciate the value of his methods and his facts, and that their conviction that his position is impregnable is the only reason why they have not thought it necessary publicly to state in print what time will prove to all, namely, that he was the undoubted discoverer of the important doctrine with which his name is so intimately associated.

* Du Bois-Reymond's *Archiv.*
† See *London Medical Record*, vol ii., p. 448.

A MARINE AQUARIUM FOR INLAND STUDENTS

A COMMITTEE of the British Association was last year appointed to make some inquiries into the best mode of preserving delicate marine organisms during life, the question being whether the injection of a fine stream of air into the tank in which they are living would be as efficient as, or better for this purpose than, a jet of running water. Dr. Hubrecht, of the Hague, has furnished Mr. Ray Lankester with the following account of a contrivance worked with great success by Prof. Selenka, who has recently given up his chair at Leyden, on account of malaria, and taken a similar post at Erlangen.

A point of the greatest importance for those who study marine animals and who want to keep them alive for a certain time, is the way to keep a limited supply of sea-water fresh and in good condition so as to sustain life in the objects of their researches. Even in those vast institutions on the coast at Brighton, Naples, &c., where the inhabitants of the ocean exhibit their splendours to the eyes of the public, and where there would seem to be no difficulty at all in changing and refreshing the sea-water at any given moment, this point requires more attention and care than is ordinarily supposed, and the success of an aquarium often depends upon the more or less ingenious method by which the refreshing of the water is brought about. Especially important is a free access of atmospheric air, which must enter into solution and sustain the respiration of the different inmates.

To attain this end on a small scale in a laboratory situated at a distance from the sea-coast, with glass vessels of various sizes instead of tanks, and a small barrel of sea-water, which must suffice for a considerable time, the following system, adopted by Prof. Selenka, first in Leyden and at present in Erlangen, gives the most satisfactory results.

A receptacle for fresh water of about 2 cubic ft. or larger is placed in some spare corner, two stories higher than the room in which the aquarium is situated. By means of a siphon reaching to the bottom, the water can be put into communication with a tube leading to the lower floor. A tap enables one to regulate the quantity of water flowing through the siphon. Immediately behind the bend of this and fastened to the side of the receptacle, a so-called Bunsen's aspirator effects the distribution of air-bubbles in the water streaming down. This instrument simply consists of a tube in glass or gutta percha, with an opening as large as a pin's head. The water now continues its way downward through a series of glass tubes of no great width, fastened to nails in the walls by strings.

This system of tubes, to be had at a very small cost and labour, leads the water into a second receptacle in the same room with the improvised aquaria. It consists of a cylinder in zinc of about three feet by one in diameter placed upon a wooden stool; a large tap at the bottom permits its being emptied into a pail. In the lid three small tubes form a communication with the exterior, each of them, as well as the whole apparatus, being closed by taps as hermetically as possible. One of these is put into communication with the above system of tubes which descend to the bottom of the receptacle. The second, to which no interior tube is fastened, is in communication with a pair of bellows which permit the creation of an initial atmospheric pressure in the reservoir. Instead of the bellows a simple tube, half india-rubber, half glass, may do as well, the pressure then being obtained by simple blowing with the mouth. The function of the above apparatus is clearly that of compressing the atmospheric air in the zinc receptacle by means of water descending from a certain height. This compressed air is now used for the refreshing and providing with oxygen of the sea-water in the different smaller vessels.

A third tap in the lid of the zinc reservoir permits the air to escape into a glass bell, where a small mercury manometer indicates the amount of pressure, a detail which may, however, be omitted. In the perforated stop of this bottle from six to twelve hermetically sealed glass tubes—shellac is best for sealing them, india-rubber for the stop itself—are ready to provide the different vessels with a supply of air. With this view india-rubber tubes, which can be shut up by glass staves, form the continuation of the glass ones. When made ready for use, a spring screw applied to this india-rubber tube, regulates the quantity of air flowing out, while a special end-piece conducting the air-bubbles into the vessel with sea-water is pushed into the open end of the tube.

Those end pieces form an important part of the apparatus and may give rise to a great economy of the force required, when by some well-adapted combination their effect is multiplied.

In order to obtain the greatest advantage from the air-bubble which, when the apparatus is put into working order, rises through the sea-water in the vessel into which one of the tubes is brought, it is desirable that it should present as large a surface as possible to the water; making the contact more perfect and the dissolving process easier.

A so-called vulcanised rose, with numerous fine pores, is for this purpose fixed to the extremity of the tube on the bottom of the vessel. This may be replaced by a simple india-rubber stop which has been applied to the extremity of the tube, and into which extremely fine glass tubes—easily got by pulling out a thicker one before the blowpipe and cutting it to the required lengths—have been inserted. Or we may take two flat circular pieces of vulcanised india-rubber connected together, and fix into the border of the lower one a series of such fine glass tubes disposed like the spikes of a wheel, care being at the same time taken that the communication be maintained between the hollow part of this india-rubber disc to which the hair tubes correspond and the glass tube providing the air.

To make the effect in the water still more complete, a small water wheel (the paddles of which are made of thin half-spheres of glass, the axis of a vulcanised tube revolving round a glass stave) may be placed above the rising stream of air-bubbles, which put the wheel in a slow rotation, and cause in this way a constant movement of the particles in the sea-water, a circumstance which cannot but be favourable.

Nearly the whole of the apparatus described above may be made at home, and can be had at very little cost. It is of great efficiency and keeps the sea-water in the

smaller vessels in a wonderful condition of purity, if care be taken to remove dying specimens and if no feeding be going on. Development of eggs and larvæ may be studied without the necessity of changing the sea-water excepting at considerable intervals of time, and marine animals of the most varied types can be kept alive very long indeed at a very small expenditure.

If put into practice by any private zoologist or laboratory in Britain, the results will most probably be no less gratifying than they have been in the above-named places where the system has only as yet been carried out.

A little more costly but still more efficient is a zinc gasometer, which can contain about half a million cubic centimetres of air, with a diameter of about 60 centims. This may be placed as it is in Erlangen without difficulty in the corner of any laboratory. It is wound up every morning by means of a simple capstan, and the pressure is effected by stones put on the top. The quantity of air escaping can be accurately regulated by hermetic taps in the conducting tube.

The great advantage which it has in common with the apparatus described above is that it remains active without further interference for a space of twenty-four hours.

FOSTER'S "PHYSIOLOGY"

Physiology. (Science Primers). By M. Foster, M.A., M.D., F.R.S. (Macmillan and Co., 1874.)

IT is extremely seldom that a fairly informed reader can lay down any text-book, after having read it from end to end, and feel that it has completely fulfilled the purpose for which it was written. Either the method of explanation is imperfect and involved, the facts that are given being correctly stated, or the language may be excellent at the same time that there is a want of attention to accuracy. We believe, however, that all will agree with us in thinking that in this short "Science Primer" Dr. Michael Foster has succeeded in producing an introductory manual which is perfect in itself, and quite a type for future authors of similar productions.

Many who devote themselves to the higher branches of scientific inquiry seem to have an inborn fear of putting the arguments and facts of their favourite subject in any but the most uninteresting and unintelligible language. They write on the assumption that their readers are all as well informed, or nearly so, as themselves on the literature of the science of which they treat; consequently, to the majority their works are of comparatively little value. This imperfection is manifest in many text-books, the utility of which is thereby reduced below that of many otherwise less worthy productions to the commencing student.

In the work before us, however, we think that Dr. Foster has succeeded, beyond any author with which we are acquainted, in placing himself on a level with his intended readers, and in putting the fuudamental principles of physiology before the commencing student in a language, and by means of a consecutive argument, which possesses quite sufficient intrinsic attraction to tempt anyone with the least predilection in that direction, to study, reason out, and attempt to verify his statements. Dr. Foster's similes are peculiarly to the point, and are at the same time drawn from such well-known sources, that no one will have the least difficulty in perceiving their applicability, at the same time that he will be able to realise the full importance of their bearing. The following is one of the best of these, and will well repay the reading.—

"When you look down upon a great city from a high place, as upon London from St. Paul's, you see stretched below you a network of streets, the meshes of which are filled with blocks of houses. You can watch the crowds of men and carts jostling through the streets, but the work within the houses is hidden from your view. Yet you know that, busy as seems the street, the turmoil and press which you see there are but tokens of the real business which is being carried on in the house. So it is with any piece of the body upon which you look through the microscope. You can watch the red blood jostling through the network of capillary streets. But each mesh bounded by red lines is filled with living flesh, is a block of tiny houses, built of muscle, or of skin, or of brain, as the case may be. You cannot see much going on there, however strong your microscope; yet that is where the chief work goes on. In the city the raw material is carried through the street to the factory, and the manufactured article may be brought out again into the street, but the din of the labour is within the factory gates. In the body the blood within the capillary is a stream of raw material about to be made muscle, or bone, or brain, and of stuff which, having been muscle, or bone, or brain, is no longer of any use, and is on its way to be cast out. The actual making of muscle, or of bone, or of brain, is carried on, and the work of each is done, outside the blood, in the little plots of tissue into which no red corpuscle comes."

Notwithstanding the simplification of the argument to its extreme degree, no attempt is made to arrive at this simplification at the expense of truth. We are not informed, as is often said, that venous blood contains carbonic anhydride dissolved in it, whilst in arterial blood this is replaced by oxygen; but more accurately, though less simply, that "both contain, dissolved in them, oxygen, nitrogen, and carbonic acid; venous blood contains less oxygen and more carbonic acid than arterial blood."

Some will think that many of the straightforward facts of the circulation should not be studied until they can be appreciated, unassisted, in their logical sequence; but we think that the following quotation will give a reality to the peregrinations of a blood-corpuscle which comes home to even very young minds. "Suppose you were a little red corpuscle, all by yourself, in the quite empty blood-vessels of a dead body, squeezed in the narrow pathway of a capillary, say of the biceps muscle of the arm, able to walk about, and anxious to explore the country in which you found yourself. There would be two ways in which you might go. Let us first imagine that you set out in the way which we will call backwards. Squeezing your way along the narrow passage of the capillary in which you had hardly room to move, you would at every few steps pass, on your right hand and on your left, the openings into other capillary channels as small as the one in which you were. Passing by these you would presently find the passage widening, you would have more room to move, and the more openings you

passed the wider and higher would grow the tunnel in which you were groping your way. The walls of the tunnel would grow thicker at every step, and their thickness and stoutness would tell you that you were already in an artery, but the inside would be delightfully smooth. As you went on you would keep passing the openings into similar tunnels, but the further you went on the fewer they would be. Sometimes the tunnels into which these openings led would be smaller, sometimes bigger, sometimes of the same size as the one in which you were. Sometimes one would be so much bigger that it would seem absurd to say that it opened into your tunnel. On the contrary, it would appear to you that you were passing out of a narrow side passage into a great wide thoroughfare. I dare say you would notice that every time one passage opened into another the way suddenly grew wider, and then kept about the same size until it joined the next. Travelling onwards in this way you would, after a while, find yourself in a great wide tunnel, so big that you, poor little corpuscle, would seem quite lost in it. Had you anyone to ask, they would tell you that it was the main artery of the arm. Toiling onward through this, and passing a few, but, for the most part, large openings, you would suddenly tumble into a space so vast that at first you would hardly be able to realise that it was the tunnel of an artery like those in which you had been journeying. This you would learn to be the *aorta*, the great artery of all; and a little further on you would be in the heart."

In conclusion, we are sure that there is no book which could be more profitably placed in the hands of the youth of both sexes, as a means of intellectual training and general culture, than this small work of Dr. Foster's. It possesses the advantage of combining precise reasoning with information on a subject which is all-important in every-day life; a subject which, if more universally understood, would lead to the adoption, by all, of means for the healthy maintenance of life which are now as systematically ignored as they are misunderstood. The reader is referred to Prof. Huxley's "Elementary Physiology" for the discussion of many subjects which the space allowed and the age of the pupils make it necessary to omit in the work before us.

OUR BOOK SHELF

Exposition Géométrique des propriétés générales des Courbes. Par Charles Ruchonnet (de Lausanne). Troisième édition, augmentée et en partie refondue. (Paris, 1874.)

Eléments de Calcul approximatif. Par Charles Ruchonnet. Seconde édition augmentée. (Paris, 1874.)

We have read these works with interest and somewhat of surprise: with interest because the subjects are fairly interesting and are treated in the well-marked style which distinguishes the writings of French mathematicians; with somewhat of surprise that the subjects treated at such length should have met with such a large circle of readers as is indicated by the number of editions that have been called for. The first work on our list establishes many general properties of curves by means of first principles and by the use of infinitesimals. This mode of treatment, so far as we know, is confined in our own text-books to a chapter or two in Dr. Salmon's works, and it would be hard to find more than he has given in any other work. The author himself states that this elementary knowledge will carry the student through the book with the sole exception that a more extended acquaintance with mathematics is required for an article devoted to the finding the distance between a curve and its osculating sphere in the neighbourhood of the point of contact. The author, too, claims the major part of the demonstrations as his own, though in some cases he has generalised results previously given, and in some cases has established known properties in a novel way.

The work is divided into two parts; the first treating of the tangency, curvature, and osculating circle of plane curves: the second part treats of the analogous properties for non-plane curves, and deals also with the polar surface, the osculating sphere, ruled surfaces, developables, and the osculating helix. There are five pages of plates containing eighty clearly drawn figures.

The "Calcul approximatif" is concerned with numbers only. M. Ruchonnet considers that he has improved upon the processes given by previous writers as regards their generality and precision as well as the facility with which they are effected. There are six articles and two notes. In the preliminary observations, the writer's aim is concisely stated to be the turning of an expression composed of incommensurable numbers (incommensurables avec l'unité) into a decimal to any given degree of exactness. He here treats of *absolute* and *relative* error, and then proceeds to summation. In the third article, in applying his methods to multiplication and involution, he sketches out the contracted process of multiplication employed by Oughtred; then follow contracted division (reference made to Serret's "Arithmétique"), evolution, and functions of a single variable. Amongst the important additions in this edition, is a complete solution of the problem "Combien de chiffres exacts faut-il calculer d'un nombre pour pouvoir en extraire la racine $m^{\text{ième}}$ avec n chiffres exacts?"

Many illustrative selections might be made, but as these would not be of general interest, we content ourselves with recommending those who take an interest in either of the subjects discussed by M. Ruchonnet to taste and judge for themselves.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Flight of Birds

In Nature, vol. x. p. 147, I observe a letter signed "J Guthrie," and dated from the Cape, on the subject of the Flight of Birds, and particularly on the "hovering" of birds. It appears that one of your correspondents had referred to my chapter on this subject in the "Reign of Law" as giving a satisfactory explanation of this phenomenon. Mr. Guthrie thinks, on the contrary, that what I have there said "requires no refutation;" which is not wonderful considering the entire misconception which he evinces of the explanation I have given. He quotes me as affirming that "by a proper arrangement of its wings and tail and the position of its body, a bird can, *without muscular exertion*, remain suspended in a horizontal air-current, provided the latter be of sufficient velocity." If I had said this I should have talked nonsense. But I have not said it, as your readers may see by referring to the page (170, first edition) to which Mr. Guthrie himself refers. What I have said is, that under certain conditions of strength of air-current a kestrel can maintain the hovering position "with no *visible* muscular motion whatever." Mr. Guthrie omits the word "visible," and probably has no idea of its force and meaning in the sentence referred to. The maintenance of the wings and tail in the proper position, and of the body at the proper angle, does in itself, of course, involve continuous and difficult muscular action, although it is not visible, just as a rope-dancer standing still in some tiptoe attitude may require immense muscular effort although no motion be visible, and although the whole aim, object, and effect of that exertion be to produce stillness, and not motion.

So far is it from being true that I have represented hovering as an accomplishment of wingmanship which requires little exertion, that I have asserted with emphasis the exactly opposite doctrine—that it is a specially difficult operation, requiring very often great exertion, and always requiring special muscular effort.

It is evident, however, that Mr. Guthrie is still ignorant of the facts which have to be explained. In the passage which he misquotes I am not stating any theory; I am stating a fact which I have seen over and over again. It is a fact beyond all question that a kestrel can maintain itself hovering in a strong horizontal air-current, with no other muscular exertion than that which is required to keep its wings and body at th right angle. I have seen it done a hundred times in level countries, when by no possibility could any upward deflection of the wind have arisen from the configuration of the ground.

One of the first and most fundamental facts to be admitted and accounted for in the flight of birds is, that perfectly horizontal air-currents have a powerfully sustaining effect upon vane surfaces, which are presented to them as birds' wings are presented. "Hovering" and "soaring" are only to be explained when this fact is seen and admitted. ARGYLL

Inverary, Argyllshire, July 30

Exhibition of Specimens and Apparatus at British Association Meetings

I AM anxious to draw the attention of the readers of NATURE to the arrangements to be made this year at the British Association meeting (for the first time) for the reception of specimens and apparatus illustrating papers or short communications made to the sections. The provision of a room for this purpose—a kind of temporary museum—has during the last four years been recommended by the committees of Sections C and D, several times, and this year the experiment is to be made. Those who have promoted this plan are naturally anxious that it should be a success. I would therefore appeal to the secretaries of the various sections to assist in initiating this new feature of the meeting, by endeavouring, as far as possible, to secure from the authors of papers objects which illustrate their communications; such objects to be deposited during the week of meeting in the room provided by the Council. This room will be open to inspection under the same regulations as the sectional meeting rooms, and the objects deposited will be carefully ticketed and arranged, and, where necessary, placed under glass cases.

From Section A we may expect physical and astronomical apparatus and models; from B, new chemical products and specimens of apparatus illustrating new processes; from C, geological specimens of rarity or new to science; from D, zoological and botanical specimens, anatomical preparations, for the exhibition of which microscopes will be provided, and also ethnological specimens; from E, maps and geographical models; from F and G, models or machinery not too large for a room.

It is necessary to mention that objects exhibited must be in illustration of some communication (however short) to one of the sections, in order that they may thus be sanctioned by the committee of such section.

By the co-operation of the sectional secretaries with the members of the committee appointed to superintend the arrangements of this room or repository, we ought to succeed in adding an important and valuable feature to the scientific interest of the meetings of the Association. E. RAY LANKESTER

A Waterspout at Milford Haven

THE enclosed account of a waterspout which was sent to me by one of our telegraphic reporters may perhaps be of interest to your readers. ROBERT H. SCOTT

Aug. 1

"St. Ann's Head, Milford Haven, July 28

"Sir,—The waterspout mentioned in this morning's report was observed yesterday at 4.50 P.M., about a mile outside the port, following in the wake of a squall. Its course lay about N.E., and the progressive movement was judged to be between twenty-five and thirty knots per hour. Its diameter at the base was about 40 ft., and the direction of the whirl from left to right, or with the hands of a watch. The lower portion was well defined, but the middle and upper portions were not so distinct; in fact, the connection with the clouds above, although undoubtedly existing, could not be discerned from our point of view. The sea immediately under it was greatly agitated and white with foam, the spray ascending in a spiral form. Thunder was heard with the squall that preceded it, and the wind veered from S. to S.S.W., although it backed to S. again afterwards. (Signed) JOHN C. WALKER

"R. H. Scott, Esq."

Periodicity of Rainfall

MY attention has been recalled to the letter (vol. viii. p. 547) of my old friend Mr. Meldrum, dated Sept. 15 last, upon the above subject, by its recent republication in a Barbados newspaper. I had intended at the time to examine whether his objections to my statements were valid, but absence from the island and other occupations interfered. On reperusing his letter, I perceive that he notices a disagreement between my figures and those given by Mr. Symons, which requires to be explained, and I take the opportunity of endeavouring to remove his doubts with regard to the correctness of my results. Mr. Symons's annual averages for 1843–61 were drawn from one station, or rather from two; from Fairfield for the years 1843–46, and from Halton, a station nearly three miles distant, and having twice the elevation, for the rest of the period. My averages were taken for the first four years from the same single station, the only record then in existence, and from a varying number of stations during the other years.

Mr. Meldrum thinks that, with certain alterations which he suggests, my calculations will support his theory. I should be very glad if they did. My object in pursuing my inquiries into the rainfall of Barbados has been to assist the planters in forecasting the coming seasons, so as to guide them in their agricultural operations; and I would gladly welcome every contribution to this end, whether it be Mr. Meldrum's sun-spots or Prof. Chase's lunar influences. I was therefore disappointed when I found that the experience of this island did not coincide with that of Mauritius, and I am sorry that a further comparison of the data, which is not open to any objection of discordance of elements, confirms my first calculations.

If I take Fairfield and Halton alone, for the thirty-one years 1843–73, I obtain the following results:—

	Maximum years.	Minimum years.
1843–45 ...	... —	163·7
1847–49 ...	... 158·3	—
1855–57 ...	... —	170·7
1859–61 ...	... 186·6	—
1866–68 ...	... —	177·8
1870–72 ...	... 157·1	—
Total ...	502·0	512·2

This calculation shows an annual average excess in *minimum* years of 3·4 inches. But the rainfall at Fairfield during the last three years, for which alone I have the means of comparison, is 13·33 per cent. below that of Halton. Therefore 21·7 inches have to be added to the minimum average of 1843–45, which would increase the above excess to 10·6 inches. If Halton alone be taken for the five periods, the average of the maxima is 167·3, and that of the minima 174·2, yielding an excess of *minima* of 6·9 inches.

A comparison of three stations for 19 years, 1855–73, being the longest comparable period, exhibits the same results. These three stations, Halton, Binfield, and Husbands, are situated in opposite parts of the island, and furnish a fair average of the whole:—

	Maximum years.	Minimum years.
1855–57 ...	... —	192·7
1859–61 ...	... 193·6	—
1866–68 ...	... —	182·6
1870–72 ...	... 162·7	—
Total ...	356·3	375·3

This calculation shows an annual average excess of 9·5 inches in *minimum* years, which differs only by 1·1 inch from the above corrected calculations founded on the returns of a single station.

Mr. Meldrum, in his letter of September, writes, that I have "taken 1846 and 1871 as middle maxima years [in my first paper I also took 1848], whereas 1849–72 are probably more correct." Mr. Meldrum is in error as to my having taken 1846 as

a middle maximum, as a reference to my former letter (NATURE, vol. viii. p. 245) will show; and I do not find any reference to 1846 as a maximum in Prof. Tyndall's letter, or in that of Mr. Symons, which alone I had seen when I last wrote. In both of these 1848 is named, and I demur to the changes to 1849 and 1872; to the first because, apparently without any sufficient reason, a dry year (48·10 inches) is discarded, and a wet year (67·88 inches) is added, and to the second, not because it affects my calculations, but because no reason is given. The change appears to favour Mr. Meldrum's views, but it scarcely does so, because the estimated quantity of 65 inches in 1873 resulted in an actual average of only 51·26 inches, which would make a difference of 13·74 inches in that year, and would change the trifling excess of 2·64 inches on the maximum side into a larger excess of 11·10 inches on the minimum side.

It is unnecessary, however, to go beyond the calculation which I have above submitted to show that Barbados does not bear out Mr. Meldrum's theory. I am quite prepared to agree with him that, if the preponderance of evidence drawn from a wider area and from longer periods does support it, the opposite results obtained in Barbados, although it is most favourably situated for observations of this nature, being fully exposed to the trade winds blowing over the Atlantic during the greater part of the year, and not apparently subject to any disturbing influences, only show that no particular locality can draw a safe inference as to the manner in which the presence or absence of sun-spots is likely to affect it.

A further consequence presents itself to my mind. It appears to me that the atmospheric influences entering into this question —chiefly evaporation and rainfall—must balance one another pretty equally over the face of the globe, either contemporaneously or by seasons; that the excess of rain received by some places has been drawn from others, which have consequently experienced the opposite effects of evaporation and drought. If therefore certain solar influences, whose presence is indicated by the appearance of sun-spots, have the effect of causing an excess of rain in certain years over so wide an area as Mr. Meldrum supposes, whence does this excess come? If from some atmospheric reservoir, independent of the globe, the excess would be general; the alternations of rain and drought might vary by years or by seasons, more or less long, but not contemporaneously by, or in, localities. If, however, they be drawn from the earth, or from atmospheric strata near the earth, there must be evaporation and drought in those parts whence the excess is drawn. Barbados, as I have pointed out, is singularly free from local influences which would affect its rainfall differently from the rest of the globe. When therefore I find the experience of Barbados differing from that of Mauritius, and of many other parts of the world, I am driven to the conclusion that the influences indicated by the existence of sun-spots are not universal, although they may possibly operate on, and intensify, other influences already existing from other causes; and that the absence of those influences and the existence of different effects in Barbados is not an exceptional result, but a necessary consequence, to be expected in other parts of the globe also, and to be anticipated from the ordinary operation of known physical laws. I shall not, however, be dogmatic on the point, and shall hail further proof of the correctness of Mr. Meldrum's theory as a welcome contribution to the "Meteorology of the future."

RAWSON W. RAWSON

Care of Rabbits for their Dead

SEVERAL months ago you published, among others, a letter of mine, on the "care of monkeys for their dead." Since then I have been making observations upon a similar attention displayed by rabbits, although the considerations which lead to its exercise are apparently much more practical than in the case of monkeys.

Most people are aware that if a rabbit is shot near the mouth of its burrow, the animal will employ the last remnant of its life in struggling into it. Having several times observed that wounded rabbits which had thus escaped appeared again several days afterwards above-ground, lying dead a few feet from the mouth of the burrow, I wished to ascertain whether the wounded animals had themselves come out before dying—possibly for air, —or had been taken out after death by their companions. I therefore shot numerous rabbits while they were sitting near their burrows, taking care that the distance between the gun and the animal should be such as to ensure a speedy, though not an immediate, death. Having marked the burrows at which I shot rabbits in this manner, I returned to them at intervals for a fortnight or more, and found that about one half of the bodies appeared again on the surface in the way described. That this reappearance above-ground is not due to the victim's own exertions, I am now quite satisfied; for not only did two or three days generally elapse before the body thus showed itself—a period much too long for a severely wounded rabbit to survive,—but in a number of cases decomposition had set in. Indeed, on one occasion scarcely anything of the animal was left, save the skin and bones. This was in a large warren.

It is a curious thing that I have hitherto been unable to get any bodies returned to the surface, of rabbits which I *inserted* into their burrows *after death*. I account for this by supposing that the stench of the decomposing carcase is not so intolerable to the other occupants of the burrow, when it is near the orifice, as it is when further in. Similarly, I find that there is not so good a chance of bodies being returned from an extensive warren of intercommunicating holes, as there is from smaller warrens or blind holes; the reason probably being, that in the one case the living inhabitants are free to vacate the offensive locality, while in the other case they are not so. Anyhow, there can be no reasonable doubt that the instinct of removing their dead has arisen in rabbits, from the necessity of keeping their confined domiciles in a pure condition. GEORGE J. ROMANES

Dunskaith, Ross-shire, July 26

THE NEWFOUNDLAND SEAL FISHERY*

THE vessels employed in this fishery are generally built for the purpose at Aberdeen, Greenock, or Dundee; but some obsolete men-of-war have been bought and strengthened to meet the requirements of the trade. Those steamers built for the purpose range from 170 to 470 tons register, and have screw propellers. The *Bear*, in which I went, belonging to Messrs. Walter Green and Co., and commanded by Captain Alexander Graham, a sealing master of thirty years' experience, was a new vessel of the largest class, built by Messrs. Stephens, of Dundee, was barquentine rigged, and had compound engines of 110 H.P.

The smallest rod in the latter was $2\frac{1}{2}$ inches in diameter, the minimum that has been found to stand the shock of concussion with the ice. Propellers are made in one piece of cast-iron; metal having been tried was found to twist, and those made with separate blades to screw in inevitably broke in the thread of the screw. They are about 7 in. in thickness near the boss and about 2 in. at the point, and should be made without a sling hole, two propellers of the *Bear* having broken at that place. Over the banjo frame are the "slip boards," pieces of hard wood about 3 in. thick, that slide down the screw well on each side of the Sampson posts to prevent ice getting in above the propeller. They should be made to hoist up in one piece with the banjo, otherwise considerable time is lost in unbolting them. The brine from salt-meat casks is kept and poured down boiling to loosen the gear set fast by frost and ice. The propeller may be known to be broken by the great increase in vibration that inevitably follows when in the ice. After watching for a long time I found the effect produced on the engines by the ship striking the ice was scarcely perceptible, and the stoppage of the propeller by ice even at full speed only caused the connecting rod to vibrate slightly.

The bows for about 20 ft. from the stem are built nearly solid with the numerous beams, timbers, and diagonals; this space is called "the fortification." The bows are sharply built with a raking gripe, the advantage of which is that the vessel does not strike the ice on all the stem at once, but gradually meets the pan, and by the force of the way runs on it as up an inclined plane, and thus adds weight to momentum in breaking a passage. The stern should be

* The following notes from personal experience were made in the present year by Navigating Lieutenant Wm. Maxwell, R.N., and communicated to the Hydrographer of the Admiralty.

full, to carry the ice clear of the propeller, a fine run having a tendency to guide the ice into the screw well.

The vessels are surrounded completely with iron-wood bark about three inches thick; the stern has an iron plate down it, the rudder is sheathed on both sides and abaft, and from the stem about ten feet aft iron plating about half an inch in thickness is bolted. The rudder hole is unusually large to admit a rapid change, and chains are used for steering with.

The "sheer poles," two long spars, are crossed and lashed at one end and suspended from the bows with heavy chains that cross from the bowsprit-cap and one of the other ends on each side from the cat-head. They are intended for men to jump on from the ice when coming on board, or as a temporary resting-place when breaking the ice from the bows or guiding the vessel, and for those purposes man-ropes are slung and a ladder led from the bulwarks to them and the ice. "Pokers," long poles with iron spikes, are used as levers to move the ice, and occasionally as tracking poles. The "crows' nest" is a barrel lashed to the mast-head, fitted with a seat and rest for a telescope and a trap-door, to prevent cold air rising. The hold is divided into spaces called "pounds" by strong partitions, to prevent the cargo shifting with the lurch of the vessel. A tank fitted with a steam-pipe from the boilers, to convert ice into water, completes the list of exceptional fittings in these vessels. The water so made tastes like condensed water at first, but acquires the aëration more rapidly.

Twenty-three similarly fitted steamers went to the fishery this year. The crew, 273 in all, consisted of captain, masters of watches, engineers, firemen, cooks, stewards, and seamen. All share alike, except the captain, in the proceeds of the voyage; but the masters of watches, engineers, and firemen have their pay in addition. The captain has 6*d.* currency for each young pelt brought in, and 1*s.* 3*d.* to 1*s.* 6*d.* currency for each hundredweight of old seal blubber.

The men ship in one of three capacities, viz., "gunner," "gunner without gun," and "batsman." If there is much shooting, the gunners get each 10*s.* for the hire of their guns; those with no gun are supplied with them from the ship's stores.

The only necessaries for the men's outfit, besides woollen clothing, are a pair of sealskin boots with thick soles, a lacing at the top to tie them close round the calf of the leg and prevent water getting in, and large pyramidal nails, "frosters," or "sparrowbills," to avoid slipping on smooth ice. A sheath-knife, a small steel, and eye-preservers of glass with wire gauze surroundings, complete the list. The men are furnished from the ship's stores with bats, straight poles $4\frac{1}{2}$ ft. long and $1\frac{1}{2}$ in. diameter, and "starts," iron hooks and spikes, with a small piece bent at right angles to the butt to stick into the bat. A groove is cut in the latter, and the start is seized in the whole, constituting a "gaff," and combining the uses of boat-hook and alpenstock. A hauling rope, about three fathoms of $1\frac{1}{2}$ in. cordage, to lace up and drag on board the seals, is also supplied.

The men are divided into three watches under masters of watches, who choose their men in turn, one at a time, and each watch is again subdivided under quarter-masters, who are responsible for their men on the ice and are furnished with two numbered flags bearing the ship's name. These numbers are entered against the names of those to whom they are given in a book kept for the purpose, enabling the captain to tell at a glance what men are away by the absence of flags. They are also divided into boats' crews, consisting of "bow" and "after" gunners and two oarsmen, chosen in a similar manner to the watches by the bow-gunners, who take charge of the punts, rough-built country boats, that are numbered to distinguish them. The *Bear* carried twenty-five of these punts.

The men in steamers divide amongst them one-third of the gross catch; the remainder goes to the owners for expenses of outfit and share of the profits. In sailing vessels the men share a half between them, but have to pay 1*l.* to 2*l.* currency berth money for their chance. Nearly 8,500 men were engaged in the fishery during the spring of this year.

When young seals are met with, the men are sent on to the ice, equipped as described. If the seals are not numerous, the ship is kept as close as possible to them; each man secures as many as he can, and drags them to the ship, the first tow being the property of that man who sees the seals first. They are killed by blows on the nose with the gaff, and are then scalped, by drawing a line with the knife through the skin and blubber from chin to tail, and skinning until the ribs on the left side are reached. The knife is then stuck in the heart, to make a hole through which a finger can be thrust to grasp a rib, and the carcase is held in that way till the pelt is removed. The scudders, or hinder flippers, are cut off, and when "panning," one of the foremost paws is taken out to make a hole through which to pass the slings for hoisting on board; but when towed to the ship both are left in to be eaten afterwards. The fore-paws (or "flippers" in the vernacular) when roasted are esteemed great delicacies, and much attention is paid to the cook to obtain permission to cook them.

As soon as a sufficient number are collected for a "tow" (six average-sized young ones being considered enough), the first is laced from the head through one or two holes cut close to the edges of the pelt, so that the hair is on the ice; the second skin is then laid half-way along the first, and the hauling-ropes passed for two turns through both, then for one turn through the second only. The third is then placed on the second, and so on to the last, when the end is made fast. The other end of the hauling-rope is passed through a hole cut in the nose of the first pelt, and a loop is made for one hand to grasp while the other grasps the end over one of the shoulders. The gaff is pushed through the tow-butt behind, and forms a tail to the whole. When the pelts are brought to the ship, they are hoisted thus on board, and each man unlaces his own to secure the hauling-rope and gaff belonging to him.

When the vessel cannot get near the seals or they are extended over a large area, they are "panned" or collected in heaps, each marked with a flag by the different sub-divisions. When taken to the pan the pelts are unlaced and stowed flat, with the hair on the ice, to prevent the sun burning them. If night comes on before the pan is picked up by the ship, a lantern is sent and is watched by a man till the vessel arrives. With the prospect before them of a whole night to be so passed, the men take axes to make ice-houses, and light a fire of the carcases to keep themselves warm. Often, however, the only chance of the men being picked up is to remain by the pan until the ship arrives, without any material to shelter or keep themselves warm.

The pelts are kept on deck at least one night to cool, and are then stowed in the pounds as soon as time permits; otherwise they are a most unsafe deck cargo, threatening to lurch with each motion of the vessel. "Sish," or broken up ice, is sometimes placed between the layers of skins; they are counted when stowed, and the account is kept by the senior "master of watch."

The system of capture is the same with the old seals, but one is considered enough for a tow, and shooting is often resorted to when the ice is at all open, and becomes a necessity in the case of the male "Hood," who fights desperately.

When the vessels are fast in the ice and no seals are near, the gunners are sent away "swatching," or waiting an opportunity to shoot any that may show themselves in the lakes of water near. When sent away for long distances, the men carry a board to rest on, and build ice-

houses to protect them from the wind; but at the best it is bitterly cold work. They also take a few biscuits with them, and eat, in addition, the hearts of the young seals, uncooked. The signals for recall are the ensign at the mast-head in clear, and the steam whistle in foggy weather.

The seals taken generally are of two kinds, "Harps," or Saddle-back, and "Hoods," or Bladder-nose Seal.

The "Harps" are distinguished by the sealers as "White Coats" when young, from their colour; "Dippers" after the white coat has fallen off and the spotted skin shows; "Bedlemers" till the saddle or harp is formed; and "Saddle Harps" when they arrive at maturity. "Jennies" or "Tuckers" are the females in the first year of whelping, and "Lords" or "Noggerheads" those deformed from the want of proper nourishment consequent on the mother being driven away or killed. Harps have black claws.

The "White Coat" remains perfectly passive to be killed, and the "Dipper" may be attracted by whistling or singing, and approached till within striking distance; but the mothers take to the water and desert their pups at the slightest alarm. The males are never with their families, but are always to be found on the south-west edge of the whelping ice. This generally consists of ice made on the coast of Labrador with small hummocks on it, that give shelter to the young from the north-easterly winds, the approach of which may be known by the incessant crying of the young Harps. The "harp" or saddle begins to form at the age of one year, is perceptible at the second, and perfect at the third. After that it is difficult to judge the age, but the teeth generally give evidence of extreme age.

The "Hood" is much the finer kind in size and appearance, and is so called from an air-bag covering the head of the full-grown male, that can be inflated at will, and is so when danger is apprehended. It resists completely the blows from a gaff, and the slugs used in sealing do not penetrate it except at close quarters. They can, however, be killed by a blow under and along the line of the jaw, but considerable dexterity is required to effect this, and they can be shot dead by hitting them behind the air-bag or hood. They live in "families," male, female, and pup. Unlike the "Harps," the female rarely deserts her young, but makes a feeble and ineffectual defence in its behalf, and is killed by its side; and in most cases the male offers a desperate resistance, making it unsafe for one man to attack it. They have white claws, and the male attains a length of 7 ft., and has a beautiful dark spotted skin. The young are white with a black stripe down the back, and rarely cry, nor have either sex any sign of the hood. The ice on which they whelp is heavy Arctic ice, rafted into large hummocks, and is generally to the north-eastward of the "Harps." The young of this species come to maturity and take to the water earlier than the "White Coats."

The females of both species are ready for fishing as soon as the young are born, and beat inshore to the shoal fishing-grounds, returning with unerring certainty to the pan on which they had left their young, notwithstanding wheel or drift of ice in the interval. The inference on seeing old seals is that the young are outside; they are never to be seen northward of their whelps. Both species have the power of protruding and withdrawing the teat, so that after the young have suckled, no danger may accrue from crawling over the ice.

When the vessels have secured a large cargo, or at the latest by April 10, they return to St. John's to prevent the loss of the blubber by running from excess of heat. On the south side of the harbour large vats have been constructed, and machines erected for preparing and refining the oil from the blubber. The pelts are taken from the hold and passed through the hands of "skinners," who separate blubber from the skin, take out the flippers, cut off the noses, &c. The blubber is then weighed and the quantity recorded as the catch, less 1½lbs. for each pelt to balance the flesh left on in scalping. The skins are counted and a deduction of sixpence currency made from their value for every hole found in addition to those necessary for lacing, &c. "Cats" are pelts that weigh less than 25 lbs., and are not included with the other seals, but have a specially low market value of their own, that helps to prevent the animals being taken while too young.

The blubber is thrown into a trough and conveyed thence into tearing machines, two cylinders with rough teeth that grind the blubber and tear the vesicles; thence to tanks, where it is converted by steam into oil and conveyed to other receptacles. A further process of bleaching takes place in reservoirs covered with glass roofs, and sometimes lined with tin, that in a few days makes the oil as clear as water. The refuse is subjected to great pressure to take off the last and worst kind of oil, and is then sold for manure. Seal blubber is valuable in the following order, viz.: that of (1) Young Harp; (2) Young Hood; (3) Bedlemers; (4) Old Harps; (5) Male or "Dog" Hood; (6) Female Hood. The blubber of the last is of much the least value as the small amount of oil contained tints with a yellow colour oil from the other species, and the vesicles are so tough as occasionally to break the teeth of the tearing machines. The skins are salted and exported to England, where they are converted into fine leather and used in the manufacture of ladies' boots.

If the vessels are cleared before April 15, they make a second voyage and hunt the Dippers and old Harps, principally the latter. The Hoods, both old and young, have by that time entirely disappeared. In rare successful cases a third trip is sometimes made, and the vessels do not return till the middle of May. The catch of 1874 has been very poor, from a great number of very young seals having been taken, but in former years as many as 33,000 have been brought in by a steamer from the first voyage.

The ice encountered in the course of the voyage is of various kinds. In mild winters large areas of "sish," or frozen snow and salt water, are met with. This is most difficult to walk on, and the men rarely escape a ducking during a day's tramp. Harp ice is the next in point of thickness, and is generally rafted ice made on the Labrador shore, while the heaviest, or true Arctic ice, large hummocks and heavy pans, is the favourite place of resort for Hoods. Though all icebergs travel from the north, those predominating this year were large, low, and flat; one was seen from twenty to forty feet in height, that was quite two miles measured diagonally. It is dangerous to try to cross their track, because the ice is packed by the pressure of the berg, so that not even a powerful steamer can force her way through. Ice navigation is very uncertain from many causes, but principally from tides, currents, and "wheel" of the ice. When near the land the two former have to be specially guarded against, as the surrounding ice remains the same and gives no evidence of the change of position. In one case a drift of twenty-five miles was experienced in two days; ship, icebergs, and field ice remaining in exactly the same relative positions.

The "wheel" of the ice is caused by pressure of heavier ice on one corner of the field, causing the latter to turn as on a pivot in the direction of the pressure. This is quite uncertain in direction and speed, and no experience can foresee either. Running ice is also a source of danger to vessels fast in it, as they are propelled with irresistible force against any obstacles to their progress—icebergs, rocks, &c. In the spring of 1872 a steamer (*Wolf*) was crushed in an instant by that means, and the vessel went down before the men had time to secure their clothes. Often before a breeze of wind comes the ice rafts or squeezes, layer on layer, with a creaking sound. This also occurs in heavy squalls, and is a source of great danger to vessels fast in heavy ice.

In foggy or stormy weather, the vessel is kept under command, if possible, to clear any icebergs seen, but if not able to move, should be placed broadside to the wind or before it; the danger of being head to wind is, that if the ice anchors carry away and a crack forms under the stern, the force of concussion with the ice may damage the rudder fittings irreparably.

When crossing the water at night and approaching ice, the vessel is always stopped to take the shock gently, and because icebergs loom much like field ice. The whereabouts of water is inevitably shown by a dark horizon, and that of ice by the blink or "glinny."

There are no laws regulating the prosecution of the seal fishery except one passed in 1873, forbidding the departure of sailing vessels before the 5th, and steamers before the 10th of March.

Little Placentia, Newfoundland, June 22

THE INTERNATIONAL GEOGRAPHICAL CONGRESS

THE Organising Committee of the Geographical Congress to be held in Paris in the spring of 1875 have issued a programme of subjects to be discussed during the meeting. The "Commissaire Général" of the Congress is M. le Baron Reille, to whom, at 10, Boulevard Latour-Maubourg, all communications ought to be addressed. The Congress will last eight days, the first of which will be devoted to a general meeting for the purpose of inaugurating the work of the Congress. The members will be divided into sections, each of which will meet separately on the following forenoons to discuss the subjects connected with the section; the afternoons will be devoted to general *séances*. During the meeting of the Congress there will be an exhibition of objects relating to the study of geography, and on the last day prizes will be awarded to exhibitors. The transactions of the Congress will be ultimately published. The conditions of subscription are much the same as those of the French Association for the Advancement of Science.

The sectional sub-committees have provisionally prepared a series of questions for discussion under each section; proposed additions to or modifications of these should be addressed to M. le Baron Reille as above. The sections are as follows:—

I. *Mathematical Section*, including Mathematical Geography, Geodesy, and Topography. The following are some of the questions to be discussed in this section:—Substitution of the centesimal division of the quadrant for the division called sexagesimal; consequences relative to the division of time in astronomy.—Choice of a zero for a general level.—Measure of the differences of longitude; utilisation of telegraphic lines for the purpose of determining longitudes; advantages to geography by the electric telegraph.—Employment of chronometers.—Measure of an arc of the meridian in the southern hemisphere, and particularly in the Argentine Republic.—The most simple instruments and the quickest methods for determining magnetic declination.

II. *Hydrographical Section*, including Hydrography and Maritime Geography.—Among the questions to be discussed in this section are the following:—Choice of a simple and uniform method for reckoning the points of the compass.—Researches concerning the depth to which the agitation of the surface of the sea penetrates.—Study of marine currents; question of the currents in straits.—Determination of the temperature of the sea at different depths; instruments used; selection of the special points where these observations ought to be made.—Causes of the temperature of the Gulf Stream.—Programme of international instructions relative to observations which could usefully be made at once.

III. *Physical Section*, including Physical Geography, General Meteorology, General Geology, Botanical and Zoological Geography, General Anthropology. Among the subjects proposed for discussion in this section are:—New and well-established facts relative to the mobility of the crust of the earth during historical times.—Various theories as to the origin of mountains.—Lithology of the bed of the ocean.—Actual results of recent researches on the influences exercised by astronomical phenomena, such as solar spots, meteoric showers, &c.—To investigate new facts relative to the circulation of the atmosphere and the ocean, the movements of aërial and maritime currents, and their influence upon climates.—To discover the origin and general progress of great atmospheric whirlwinds or cyclones, as well as their periods; to determine their duration, their force, and the extent of the countries exposed to their effects.—Means to be adopted in order to extend more widely the establishment and the discussion of simultaneous meteorological observations, recommended by the International Congress at Vienna.—Geographical distribution of animal and vegetable species during tertiary times; consequences which flow therefrom relative to the climatology of the globe during that period; geographical relation between the quaternary and the existing fauna and flora; extinctions and migrations; distribution of land and water during that period.—Species, genera, and families of plants which are characteristic of the great natural regions.—Also many questions relative to the geology, zoology, botany, anthropology, &c., of the various great divisions of the globe—Europe, Asia, America, Oceania.

IV. *Historical Section*, including Historical Geography and the History of Geography, Ethnography, and Philology.—This section includes questions as to the condition of man both in prehistoric and historical times, comprehending the discussion of many particular points of history and ethnography.

V. *Economical Section.*—This section is concerned with subjects connected wirh Economical, Commercial, and Statistical Geography.

VI. *The Didactic Section* will discuss questions connected with Geographical Education and the diffusion of Geographical Knowledge.

VII. *Section of Voyages*, including explorations and voyages, scientific, commercial, and picturesque. In this section such points as the following are proposed for discussion:—How could a permanent bureau be constituted to indicate to travellers, by land and sea, the *desiderata* of geographical science?—Questions as to the undiscovered portion of Africa, as to the equipment of voyagers and travellers, instruments for various purposes, the bearing of explorers towards natives, narratives of travel, &c., &c.

There are proposed for discussion in the seven sections in all 123 questions, of which the above are a sample; and it will be seen, we think, that if the right men are induced to attend the Congress, and if the discussions are conducted in a truly scientific and candid spirit, great good must be the result to the many branches of science which are more or less connected with the subject of geography.

THE LAST NEW COMET

MR. J. R. HIND, F.R.S., writes as follows to the *Times* from Mr. Bishop's Observatory, Twickenham, August 1:—"From three consecutive nights' observations of the new comet of Marseilles, received from M. Stephan, I have calculated a first approximation to the orbit. It appears the comet will not reach its perihelion till about the 25th inst., but is already slowly receding from the earth, being distant from us at the time of discovery about 55,000,000 miles. Though it may continue visible in good telescopes for several weeks, it is not likely to become an object of any general interest, like the comet which has just left this hemisphere. The elements bear no resemblance to those of any comet previously computed."

THE FORM OF COMETS*

III.

WE are now arriving at a conclusion, for the conditions mentioned are very narrow. In order that a force exerted by the sun may present at any point whatever of the trajectory of a moving body these two radial and tangential components, it is sufficient, and it seems to me absolutely necessary, that this force should not be propagated instantaneously like attraction, but successively, *i.e.* at a definite rate. In order that it may drive to a distance the rarest materials of comets, at the same time exerting only an extremely weak action upon their much more dense and more compact nuclei, it is necessary, and it is sufficient, that this force should be one of surface and not of mass, like attraction. If the light of the sun were due, as was long believed, to the emission of innumerable atoms moving at the rate of 77,000 leagues a second, the force exerted by these atoms would fully satisfy these conditions. Unfortunately, the emission hypothesis has been shown to be false, and is now replaced by that of the undulations of an imponderable fluid on which attraction has no hold. If statical electricity, in order to produce attractions and repulsions, had no need of a particular material medium, such as our atmosphere, we might perhaps be able to call in the aid of that force; but it would still be necessary to prove that the sun is electrical, and that it is able to develop a very marked electric state in comets without acting similarly upon

Fig. 8.

other bodies. As to magnetism, which appears independent of any medium, we know very well that it is not a surface-action, but an entirely specific force, capable of attracting or repelling the densest materials; and besides, the phenomena of terrestrial magnetism scarcely leave room for attributing to the sun a magnetic power sensible at such distances. Finally, electricity and magnetism are polar forces which impart to bodies opposite powers of attraction and repulsion, while cometary phenomena argue only a simple repulsive force.

There remains the repulsive force of solar heat. In all bodies heat gives rise to a force among the molecules which tends to separate them more and more; it is this which enables our steam-engines to work, and which forces projectiles from our guns. It is evidently a surface-action, and not one of mass; and at least, in maintaining that it is sensible only between the molecules of bodies, *i.e.* that its sphere of action is infinitely small, it is natural to think that the surface of a heated body exerts its repelling action all round it, as well as towards the interior. Moreover, there is nothing opposed to the supposition that this force is propagated successively, since its cause, heat, is itself propagated in planetary space with a definite speed, that of light.

Here is our hypothesis formulated. By introducing this repulsive force, acting by successive propagation, into the differential equations of the movement of comets, along with that of attraction, we see that there springs from them the established phenomenon of their acceleration with its most delicate characteristics.* The analysis which I made has been latterly revised and verified by an illustrious Italian geometer, M. Plana, with developments which leave nothing to be desired in point of mathematical rigour, while the hypothesis of a resisting medium starts, as I have said, with conditions incompatible with the principles of mechanics. It only now remains for us to see whether the same force will also account for the highly complicated phenomena of the figure of comets.

Let us set out from this distinctive characteristic:— The repulsive force exercised at a distance by the incandescent surface of the sun is a surface-action, the more capable of driving off a body, the smaller the density of the body is. According to an estimate deduced from the observed acceleration of Encke's comet, it will be sufficient to reduce, in the proportion of 1,000,000 to 1, the density of the nucleus of that comet to represent the excess of this repulsive force over attraction. The question, then, is, to discover if such great variations of density are exhibited by the various appendages of comets, of which the most compact parts have already so small a mass under so enormous a volume. But this is precisely what facts establish in the most exact and striking manner. The figure of Donati's comet, which I am about to bring before you, shows that the nucleus, in proportion as it is subjected to the heating action of the sun, emits vapours which go on dilating more and more, so as to form around the nucleus envelopes having a radius ten or even a hundred times greater. But if the matter of a sphere with a radius equal to 1 expands into a sphere having a radius equal to 100, it is sufficient to make the density become one million times less. In fact, all the matter of the nucleus is not thus disseminated in the head of the comet; this dilatation affects only a very small portion of the primitive mass, and we see how the density of the extreme layers of the head may fall much below the figure given by the above calculation.

Fig. 9.

* Continued from p. 248.

* The progressive change of two elements alone, to wit, mean motion and eccentricity; nothing on the position of the plane of the orbit; for the rest, simple periodic inequalities scarcely sensible, but differing, however, from those which the resistance of a medium would give.

We shall understand better what precedes by examining for a little in detail some phenomena presented by the head of the comet of 1858, at the time when the already formed tail was continually fed by materials emitted by the nucleus, and carried away by solar repulsion. (See Fig. 8.)

The concentric zones of a decreasing brightness, which are noticed around the nucleus, on the side next to the sun, are due to an intermittent emission of matter. This matter is seen to dilate more and more with a very moderate initial speed of about 19 metres per second, and finally to reach the limits of the head of the comet; a second, a third, &c. emission closely follow the first, and are developed in the same manner. The brightness, at first very marked, of these successive envelopes of the nucleus grows rapidly weaker in proportion as their density diminishes. Finally, in the exterior layers, the more and more rarefied materials become the prey of the solar repulsion, which makes them turn back, driving them towards the tail at a rate incomparably greater than the former, for in twenty-five days the tail of Donati's comet

FIG 10.

had reached a length of 14,000,000 leagues; it increased in length at the rate, not of 19 metres, but of 8 leagues per second. I showed, at the outset, to what excessive rarefaction the materials of these immense appendages attain.

You see that upon such materials a surface-action like the repulsive force must have beautiful play, while the solar attraction, independent of the surface and density, continues to act in the same manner upon all these molecules. The struggle, then, between these two forces will turn in favour of the former as soon as the progressive dilatation of the cometary matter, gradually spreading itself in surrounding space, will have brought it to a certain degree of diffusion, and there is nothing to hinder the repulsive action thus becoming twice, three times, even ten times more powerful than attraction.

From the fact that this force, or rather that the radial component of this force, acts in the direction of the radius vector, from the fact that the expelled molecules preserve very nearly the tangential speed which the comet possessed, it necessarily results, as we shall see, that the tails, from the first, must be opposite to the sun and bent in a backward direction.

Fig. 9 represents the successive positions of a series of molecules emitted by the nucleus of a comet so as to constitute the axis of the tail. In this figure, we suppose for the molecules a density such that the repulsive force exactly counterbalances the solar attraction: thus their motion, solely due to the tangential velocity of the comet, takes place in a straight line. To simplify matters, this

FIG. 11.

rate has even been supposed constant, as if the orbit were a circle.

On the first day, the comet being at C^1, a molecule m^1 is detached and subsequently follows the line $m^1\ m^1\ m^1$.... On the second day, a molecule m^2, likewise leaves the nucleus at C^2, and subsequently describes the tangent $m^2\ m^2\ m^2$....Similarly, on the third day, for a molecule m^3, and so on. If we join by a continuous line the series of positions occupied at the same time, the fifth day, by all these molecules m^5, m^4, m^3, m^2, m^1, we shall

FIG. 12.

have the curvilinear axis of the tail; this will be, in this particular case, the involute of a circle. This construction accounts for the three laws which have been ascertained as the result of observation:—1. The tail, at its origin, is sensibly opposed to the sun, S;* 2. The tail is curved backwards on its path; 3. The axis of the tail is a plane curve situated in the plane of the orbit.

If the density of these molecules were still smaller, the repulsive force would prevail over the solar attraction, and these molecules would describe no longer straight lines,

FIG. 13.

but sections of an hyperbola whose convexity would be turned towards their common focus, S. (See Fig. 10.)

The series of points m^1, m^2, m^3, m^4, emitted at C^1, C^2, C^3, C^4, by the comet, gives yet another curve like the former, but with a curvature much less pronounced and nearer to the radius vector.

There results from this theory a consequence to which

* In reality the axis of the tail is not rigorously tangential at C^5 to the radius vector; it makes with this radius a small angle for which the theory accounts, but which I think may be neglected here for the sake of brevity and simplicity.

I must call your earnest attention, for it is verified in nature in the most striking way and upon the largest scale. All molecules of the same density must naturally group themselves together in the vicinity of the curvilinear axis of the tail $m^5\ m^4\ m^3$. . . . and thus form the open plume to which we have referred ; but if the comet emit molecules of very unequal densities, on which the repulsive force acts with different energies, there ought to be several distinct tails, more or less curved, all situated behind the radius vector. This is precisely the case with Donati's comet. Fig. 11 proves the truth of this ; it shows the comet with three distinct tails. The two smaller tails were almost straight, but always in rear of the radius vector ; they presented their less marked convexity in the same direction as the bright tail.

The great comet of 1861 had also two tails. When we saw it for the first time, on June 30, it appeared to have only one, 118° long and perfectly straight, except a singular irregularity for which we could not at first account (see Fig. 12). But soon the two tails separated, and it became evident that we had been deceived by a simple play of perspective. The earth, in fact, on June 30 was in the plane of the orbit of this comet, and as the curvilinear axes of the tails are always situated in this plane, they were united, from our point of view, into one and the same straight line, or at least into one and the same arc of the great circle of the celestial vault. The sketch of the same comet (Fig. 13) seen a fortnight previously by observers in the southern hemisphere, shows clearly the disposition of this double tail, the most curved half of which almost touched the earth with its extremity.

FIG. 14.

These singular effects of the repulsive force are easily explained by a comparison which will appear at first to be far removed from our subject, but the fundamental analogy of which is palpable : I refer to the winnowing of corn. In fact, we cannot better compare the entire surface-action of the repulsive force than to that of a puff of air which repels light bodies and has no sensible action upon denser bodies. When we wish to separate the grain from the chaff by means of the winnowing fan, we allow both to fall gradually into a current of air ; the grain escapes from its action and falls at the feet of the winnower, while the chaff, much lighter, is carried to a distance, and forms upon the ground a separate heap (see Fig. 14). If a third material, still lighter than the chaff, is found mixed with the grains placed upon the fan, it will be drawn away still farther, and will form a third heap beyond the second. Evidently the fall into space, under the sole influence of terrestrial attraction, would not operate with such discrimination, for all matters placed upon the fan would fall at the same rate and along the same curve, whatever might be their density.

Well, the repulsive force of the sun—a surface-action, and not one of mass, like attraction—winnows, so to speak, the materials which are separated from the cometary nucleus by being rarefied ; it picks them out and distributes them, according to their density, into tails of different curvatures. The lightest form the straightest tails, and those nearest to the prolonged radius vector, while the nucleus, escaping the repulsive action on account of its relatively enormous density, continues to obey, almost rigorously, the Keplerian laws of attraction.

We need not believe that the phenomenon of muliple tails is rare ; without speaking of the horrible dragon depicted in Fig. 2, many comets have had several tails. The facility with which the almost straight but very feebly luminous tails of Donati's comet escaped observers in France, leads us to believe that the phenomenon may be general, and that by careful inspection several tails may almost always be found to each comet. And according to theory, a perfect homogeneity of materials, the necessary condition for a single tail, must be, for any celestial body, rather the exception than the rule.

But then, it may be said, if very dense matters are drawn away by nucleal emission on the side next the sun, ought these materials escaping the repulsive action not to take the lead of the nucleus and form a sort of tail on the side next to the sun ? Yes, without doubt ; and this case is effectually fulfilled, for some rare comets have presented it, such as those of 1823, 1845, and 1851. I would not insist upon these exceptional but not abnormal tails, situated on the side nearest to the sun, almost lying upon the orbit, or at least forming an obtuse angle with the initial direction of the ordinary tails.

(To be continued.)

DR. BHAU DAJEE

THIS very remarkable native of India, the true friend of his fellow-countrymen as well as of science and learning, died on May 31 at the comparatively early age of 51 years. As many of our readers may be ignorant of the claims of Dr. Bhau Dajee to notice, we give a brief sketch of his career, for which we are indebted to the *Times of India*.

He was born in 1823 in the village of Manjeren, near Sawunt Warree. His parents were in poor circumstances, and when he was about seven years of age they came to Bombay, bringing him with them. He was first placed in the native Education Society's Schools in Bombay, and afterwards went to the Elphinstone College. There he took a foremost place amongst the scholars, and was noted for his ability and unremitting application to his studies. The highest scholarships were taken by him, and he was specially rewarded with a gold medal. When his studies were concluded he was appointed assistant professor of chemistry and natural philosophy at the college. About this time (1842) a prize of 600 rupees was offered by Government for the best essay in English and Guzerathi on Female Infanticide. This prize Bhau Dajee gained, and the essay, which has since been published, has always been looked upon as one of the best contributions on that subject. He commenced his studies at the Grant Medical College, under Dr. Morehead, in 1845. The college had only then been established for a short time. His success here was again most marked, and gained for him the lasting friendship of many distinguished members of the medical profession. He received his diploma in 1851. He soon created a name for himself as a clever and rising medical practitioner, and quickly found himself in possession of an extensive practice amongst all classes. His time was divided between his medical duties and his historical and philological researches. From the first he took a great interest in all public questions, especially those which affected the interests of his fellow-countrymen. He, with Dr. Birdwood, was instrumental in the establishment of the Gardens and Victoria and Albert Museum, Bombay. The Bombay Association too may be said to owe its existence to his energy ; he was the first secretary, and always took a deep interest in the discussions of the society on Indian affairs and measures. A considerable portion of his income was expended in procuring rare and valuable MSS. from Cashmere, Orissa, Benares, and Southern India

These he carefully translated and annotated, and numbers of the translations and remarks appeared in the scientific journals of the day both in India and in Europe. He was president of the Bombay branch of the East India Association, and up to the time of his illness constantly took part in the discussions of that body. His exertions in the cause of native female education procured for him the respect and gratitude of his more advanced fellow-countrymen. He established the Literary and Scientific Society, Bombay, and became its first president. His exertions to procure a recognised system of female education amongst the Hindoos were rewarded by a collection made by his admirers of some 12,000 rupees, which, at his request, was expended in establishing a school which has ever since been known by the name of "Bhau Dajee's Girls' School." He was elected a member of the Bombay Board of Education in 1852. He also filled the presidential chair of the Grant Medical College Society. As vice-president of the Bombay branch of the Royal Asiatic Society, he devoted a considerable portion of his spare time to furthering the interests of the society, and to the museum he presented many valuable contributions. With all the leading public questions of his time Bhau Dajee was familiar, and invariably took part in their discussion. Although he was in possession of a large practice he never accumulated a fortune, as he always willingly and readily gave money for the relief of distress. One of his latest and most important discoveries in medical science was the cure for leprosy, which he was on the point of perfecting when seized with paralysis. While ill he was most anxious that his manuscripts should be collected and got ready for publication. This duty will, we understand, be performed by his brother, Dr. Narayen Dajee, himself an accomplished scholar and well-known medical practitioner. Dr. Bhau visited many parts of India, but never went to England, though we believe he had a strong inclination to do so. Numberless instances of his public spirit and generosity might be cited did our space permit.

The public services of Dr. Bhau Dajee have been so numerous and important that it is but right that steps should be taken to commemorate them by means of a memorial, and we hope that but a short period will be allowed to elapse before some definite proposal will be laid before the public.

The deceased doctor was a member of numerous scientific societies both in India, in Europe, and in America.

OUR SULPHUR SUPPLIES

SIGNOR PARODI has addressed a report to the Italian Government, in which he gives his estimates that the sulphur of Sicily will be exhausted in fifty or sixty years. At present it is on Sicily we depend almost entirely for the supply of our sulphur—that "mainstay of present industrial chemistry"—which is so largely used in our arts and manufactures. Our demand, too, has been a steadily increasing one. In 1842 we imported 16,686 tons, and in 1862 the demand had risen to 75,000 tons. In the production of nearly every textile fabric sulphuric acid is used; it is more or less directly employed in soap and glass-making, metal refining, and the preparation of artificial manures requires large quantities. Our consumption seems to be limited only by the supply.

Recently a correspondent in the *Journal of the Society of Arts* stated, from his own experience of Sicily, that "with few exceptions, the ore is carried to the surface on the backs of boys. . . . The produce of a mine in Sicily is chiefly determined by the difficulty of getting boys . . . and the mines soon reach a depth at which they cease to be profitably worked. All the sulphur in the island, therefore, below 400 feet is untouched." He consequently doubts the correctness of Signor Parodi's estimate.

Still this report of Signor Parodi's is likely to cause some uneasiness, and the prospects of our obtaining a large supply at a cheap rate from Iceland must not be forgotten. The island is but two days' journey from Scotland, and from recent reports on the harbours there seems no reason why a continual intercourse might not be kept up. Many travellers have borne testimony to the immense fields of unworked sulphur there, and the fresh deposition in worked districts is stated to take place at a wonderfully rapid rate. In the celebrated solfatara of Puzzuoli, near Naples, after the mixture of gravel and sulphur has been submitted to the distillation of the sulphur,* the gravel is returned, and in thirty years is again so rich in sulphur as to admit of the same process. In Iceland this renewal of sulphur in the gravel is said to occupy but three years; the supply is therefore practically inexhaustible. Estimates show that while Sicilian sulphur is 5*l.* 17*s.* a ton in Britain, Icelandic would be about 2*l.* 18*s.* a ton.

According to a pamphlet by Dr. Carter Blake, recently issued, we learn that a lease for working some of the mines in the northern and eastern provinces of Iceland has been granted to Mr. Lock, of London.

A GREAT TELESCOPE

WE have already referred to the series of splendid gifts from Mr. James Lick, from San Francisco, to the State of California, the whole amounting to 2,000,000 dols. The most remarkable of these donations is one of 700,000 dols. for the purpose of erecting and endowing an astronomical observatory, and equipping it with "a powerful telescope, superior to, and more powerful than, any telescope ever yet made." The author of this magnificent bequest (the *New York Times* states) is in every sense of the word a self-made man, and has followed the wise example of the founders of our Cooper Institute and Lennox Library in securing the proper fulfilment of his trust by providing for its organisation in his lifetime. The United States already possess in the telescope of the Naval Observatory at Washington an instrument of the same gigantic proportions as that erected by Mr. Newall in this country; and we may add that this was the first instrument constructed after Mr. Newall had shown by his costly experiment that such dimensions were possible. The glass for the lenses of both these instruments was furnished by Chance and Co., of Birmingham, England. Under Mr. Lick's gift, Messrs. Alvan Clark and Sons are designated as the final judges of the most appropriate site for the proposed great telescope of California and of the world. How amply endowed will be the Lick Observatory, on the summit of the Sierra, may be conjectured from the fact that the great Washington telescope cost but 44,000 dols. The trustees who have the spending of the 700,000 dols. will be limited simply by the ability of the glass-makers to turn out a lens of sufficient size. We assume (continues the above paper) that the proposed telescope will be a refractor, since the great reflectors, of which the best known are Herschel's and Rosse's, have been found comparatively useless for accurate observations. The great speculum or object-mirror of the former was 49½ in. diameter, and the latter had two specula of 6 ft. diameter. Both were among the marvels of the generations that saw them constructed; but the latter, albeit only thirty years old, is nearly as much out of date as the former, which was constructed eighty-five years ago. It is just possible that the existence of a bequest large enough to yield six times the price which has ever been paid for a telescope may be the means of giving birth to lenses of what would now be reckoned impossible size and perfection. The 26-in. object lens of the Washington telescope has been duplicated in the one ordered by Mr. M'Cormick, of Chicago, for the Washington and Lee University of Lexington; but, though larger lenses have been talked of, their successful production is still problematical. Many costly

* Ure's Dict. of Arts, &c., vol. iii., p. 830.

failures have preceded the attainment of the 26-in. diameter, and Chance and Co. are said to be the only firm in the world who will undertake the manufacture of a disc of that size. Science knows no country, and Mr. Lick's munificent bequest in the cause of astronomy will be hailed by *savans* all over the world.

MENTAL POTENTIALITY IN CHILDREN OF DIFFERENT RACES

MONS. J. C. HOUZEAU, the author of the "Études sur les facultés mentales des animaux comparées a celles de l'homme," has lately concluded, in Jamaica, a series of laborious experimental investigations on the relative or comparative intellectual capacity and development of the children of different races inhabiting that island. The conclusions arrived at by such an observer are worthy of the highest consideration in Europe: while the subject is one that has an important bearing on various popular educational, ethnological, and social questions of the day—such as the unity of mankind, and the possibility or probability of civilising savage races A recent letter addressed to me by M. Houzeau, contains the following brief account of his experiments and conclusions; an account that cannot fail, I think, to be interesting to the readers of NATURE.

"I have been busy, meanwhile, on a curious study about the comparative development of intelligence of children belonging to different races. I had an opportunity here to submit to the test black, brown, and white children. Fifteen of them were sent to me every day for two hours by their parents, my country neighbours: three of them white, seven coloured cf various shades, and five black. For a whole year I gave them myself common instruction, and carefully watched their proceedings and their rate of improvement. I do not expect to publish anything about that experiment, at least at this time. But I will state here the conclusions to which it has led me.

"1. There is in each child a different degree of intellectual proficiency, which could be called, in mathematical language, his or her 'personal coefficient.' However, these individual differences are much less than I had anticipated, and are not the striking feature in the unequal rate or speed of improvement.

"2. In this unequal speed, I see nothing—at least nothing clearly and unmistakably discernible—that can be referred to the differences of race. This will probably appear strange after all that has been said of 'inferior races.' Should other facts show that my experiment was not properly conducted, and that the trial was not conclusive, I am ready to give up. Still, it is at least my 'provisional conclusion.'

"3. The rate of improvement is due almost entirely to the relative elevation of the parental circle in which children live—the home influence. Those whose parents are restricted to the narrowest gauge of intellectual exercise, live in such a material and coarse *milieu*, that their mental faculties remain slumbering and gradually become atrophied; while those who hear at home of many things, and are brought up to intellectual life, show a corresponding proficiency in their learning.

"The question of course would require more space and development. I rather mention it as a subject for study than anything else. I had in my life some rare opportunities to study 'inferior races,' including Indians of America, and 'half-breed Indians' of the mixed race of Mexico. I believe most of the *savans* of Europe have but a very incomplete idea of the mental, and still more of the moral, status of 'inferior societies.' Much remains to be said about it."

My present object being briefly to introduce to English readers M. Houzeau's views as to the relative intellectuality of the children of different races in Jamaica, I will not here explain in what respects I differ from his conclusions—how far I regard his experiments inconclusive. I would only remind him, as well as the reader, of the impossibility of duly estimating the direction or amount of future or adult mental development by the study of mental phenomena in the young. It has been, I think, proved, for instance, that—

1. At or up to a certain age girls are as sharp as, or sharper than, boys at lesson-learning and repeating. Cases are constantly being recorded—perhaps paraded—in the newspapers of girls or young women beating boys or young men of equal age in competitive examinations. And yet it is not to be inferred that the female mind is either superior or equal to the male, that is, in a comparison of averages. For the fact is, that throughout the animal series, including Man, the female mind is, in some respects, different from, and inferior to, that of the male. We know, moreover, that female superiority, when it exists, is usually at least confined to school life. In subsequent intellectual development proper, man, as a rule, far surpasses woman. Again—

2. Up to a certain point there is the closest possible parallelism between the mental endowments of the human child and of the young of sundry other animals. At certain stages of development, and in certain animals, the comparison is not even in favour of the child. And yet, though we are still far from knowing what is the range of the mental potentialities of other animals than man, we have no reason for supposing that in any of them will the maximum intellectual or moral development attain to the average in cultured and civilised man.

W. LAUDER LINDSAY

NOTES

AT a recent meeting of the Trustees of the "Gilchrist Educational Trust," they decided to appropriate a sum not exceeding 1,000*l*. to the promotion of scientific research, with the prospect of repeating this grant annually if it should bear adequate fruit. The plan proposed is to ask the Council of the Royal Society to make recommendations to the Trustees, stating in each case the object of the research, the qualifications of the individual by whom it is to be conducted, and the sum they propose to be assigned to him; the purpose of the grant being to assist men of science who have shown themselves capable of advancing science, and who may feel themselves precluded from devoting their time to *unremunerated* work, by freeing them from the necessity of giving up investigations of great promise for the sake of mere bread-earning. We believe that this important movement is due to the representations of Dr. Carpenter, the Secretary, to the Trustees, that they would be in this mode worthily applying about a fourth part of their income in meeting a great national want, and in promoting the second of the objects as to which they have an uncontrolled discretion under the will of the founder—"The benefit, *advancement*, and propagation of learning in every part of the world." The Council of the Royal Society has, we understand, appointed a Committee to consider the conditions under which the Council may most fittingly undertake the responsibility of advising the Gilchrist Trustees as to the appropriation of their grants.

THE matter in dispute between the President and Council of the Linnean Society and a certain section of the Fellows, which caused so much excitement in the Society some months ago, and led to the premature retirement of Mr. Bentham from the chair, was referred to Lord Hatherley as arbitrator, and has just been decided entirely in favour of the President and Council; so that no further action will be taken in the matter.

WE regret to record the death, on July 31, of Dr. Charles T. Beke, whose name is so well known in connection with geography, ethnology, and philology.

We have reason to believe that it is the intention of Dr. J. E. Gray to send in his resignation of the Curatorship of the Zoological Department of the British Museum at the close of the present year. Such being the case, he would retire from office towards the middle of 1875, within six months of his resignation being accepted.

An interesting experiment was recently made by MM. Bertrand and Mortillet, directors of the St. Germains Museum, in the Champ de Manœuvre: the war implements constructed from designs of Trajan's Column were tested, when it was found that the catapult threw arrows a distance of 300 yards. The mark was hit regularly each time up to 180 yards. The same can be said of the *onager*, which sends stones to a distance of 180 yards with astonishing precision, although weighing 1½lbs. The initial velocity was calculated to be more than fifty metres per second, as the time taken to reach the mark is not more than seven seconds and sometimes less than five. All these apparatus are to be tried at a public exhibition to be given in the beginning of next October.

On Saturday last, the "capping day" of the graduates of Edinburgh, the occasion was celebrated by the customary dinner of the Edinburgh University Club, at St. James's Hall; Dr. Cobbold, F.R.S., in the chair. Amongst the distinguished visitors present was the Right Hon. Sir Bartle Frere, K.C.B., who, on replying to the toast of "The Visitors," remarked on the high state of efficiency of the men who entered on Foreign Service, having previously studied at the northern University. During the afternoon a telegram was received from Prof. Balfour announcing that upwards of 100 new graduates were enrolled amongst the alumni of the University.

At the last meeting of the Connecticut Academy of Arts and Sciences, Prof. Marsh made a communication on the size of brains of tertiary mammals, comparing the relative sizes of those of the Eocene, Miocene, and Pliocene. His facts appear to have a very important bearing on the history of the evolution of mammals, and indicate future interesting lines of research. In all the known examples of groups he has been able to compare, he finds those of the Eocene have remarkably small brains; those of the Miocene are larger, and the Pliocene still larger, while the existing species are again still larger.

Dr. G. B. Halford writes to the *Melbourne Argus* on the strength of the poison of Australian snakes as compared with those of India, and also of the efficacy of liquor ammoniæ in counteracting the poison. It is established that the poison of the Australian tiger snake is as deadly as that of the cobra, but Dr. Ewart of Calcutta concludes from experiments that the liquor ammoniæ as a counter-agent is inert. Dr. Halford gives the details of a case in which a greyhound which had been so badly bitten by a snake as to be totally "insensible either to sound or feeling, and never moved," was rapidly brought to life and strength by the injection of ammonia and water into the jugular vein. Dr. Halford thus concludes his letter:—"They have far more advantages in India for these inquiries than we have at present. They have their snake men, who handle the reptiles freely for them—a Government that has already given thousands of pounds for the purpose of experiment and publication. I feel myself a very poor and insignificant rival, and yet there is nothing I should like better than to pursue the subject to the end, if that be possible—not to publish an illustrated work on snakes, with details of all the failures in treatment that have ever occurred, but to discover the best remedy or remedies for the treatment of snake-poisoning. If the Government would assist, I would do the work; or if they would appoint anyone else I would help with every suggestion possible, for in the long interval that has elapsed since my first experiments I have not been idle. It is good in science, as in other things, occasionally to *reculer pour mieux sauter.*"

It is said on good authority that the introduction of sheep into the foot hills and higher portions of the Sierra Nevada, in California, is beginning to make havoc of its proper flora.

A Mathematical Society of Bohemia, with its headquarters at Prague, has announced its formation.

The last meeting for the year of the American Academy of Science and Arts was held in May, yet early in June the volume of Proceedings was issued, containing all the papers of the session.

Prof. Silvestri, who has made a special study of the phenomena of Mount Etna, announces that an eruption may be expected shortly.

The Hope Chemistry Prize in the University of Edinburgh, now converted into a travelling scholarship, has been awarded to Mr. R. M. Robertson.

A telegram from Melbourne, of Aug. 1, states that Coggia's comet is visible there and presents a brilliant appearance.

M. Sidoroff, says the *Eastern Budget*, member of the Geographical Society of St. Petersburg, has addressed a report to the Russian Admiralty with regard to the Austrian Polar Expedition, of which nothing has been heard since August 1872. M. Sidoroff says in his report that the *Tegetthoff* was last seen by Count Wiltczek in a gulf near Cape Nassau, whose outlet was then being choked up with ice. Since that time various seamen coming from Novaya Zemlya have reported that the quantity of drift ice in the Icy Sea had considerably increased, and that in the summer of 1873 it was extraordinarily abundant. Formerly the ice on the coast of the above island only extended to a distance of five versts in the month of June, while in midsummer 1873 the width of the icy zone amounted to about 100 versts. M. Sidoroff believes that if Cape Nassau had been free of ice, the *Tegetthoff* would certainly have gone round the north-eastern point of Novaya Zemlya, which is only a day's journey from Cape Nassau, and thus reached the gulf of Yeniseisk without difficulty. It is therefore probable that the expedition is frozen up and in want of provisions, and M. Sidoroff accordingly recommends the Russian Government to send food, &c., by land to Cape Nassau, adding that he will contribute 100*l*. to the expenses of the undertaking. The Admiralty has approved of this proposal, and is now taking the necessary steps for carrying it out.

With regard to the question of "Sounding and Sensitive Flames," Mr. A. K. Irvine, of Glasgow, writes—"About twelve years ago I first observed the 'sounding' flame as it occurs on the combustion of gas and air passing through a disc of wire gauze enclosed in a tube, and showed it to one or two scientific friends, but I published nothing on the subject till 1871, when I took patents in this and other countries for a miners' safety lamp, which indicates by a loud musical note the presence of an explosive atmosphere, by the ignition (at the ordinary flame of the lamp) and combustion of the gas and air entering through a disc of wire-gauze surrounding the wick tube."

The annual session of the British Archæological Association commenced on Tuesday morning in Bristol, under the presidency of Mr. Kirkman Hodgson, M.P., and will continue all the week and conclude next Monday at noon. The members of the Association, numbering about 100, and including archæologists from all parts of the country, assembled in the Guildhall, where they were welcomed by the Mayor and Corporation. The party then proceeded to the first point of interest on the day's programme, namely, St. Mary Redcliffe Church; here Mr. F.

Godard, F.S.A., read a short paper on the church. The members of the Association afterwards visited the Temple Church, which is noted for the fact of its tower being 4 ft. out of the perpendicular.

THE great work "On the Marine Mammals of the North Pacific," by Capt. C. M. Scammon, of the United States Revenue Service, has now been completed and is published by John H. Carmany & Co., San Francisco. It forms a stout quarto volume, with many plates, and contains an exhaustive history of the whales, porpoises, and other Cetaceans, together with that of the sea-elephant, sea-lion, sea-otter, the walrus, &c., all accurately figured and described. A specially important section of the volume is that upon the American whale-fishery, giving an account of its origin, extent, mode of prosecution, its progress and present condition, with a full description of all the apparatus used in the capture and utilisation of the Cetaceans, and the incidents of a whaling life. In an appendix is a systematic account and catalogue of the Cetaceans of the North Pacific, by Mr. Dall, a glossary of words and phrases used by whalemen, and a list of stores and outfits. As an exhaustive treatise, even of a limited field of the whale-fishery, this book will probably occupy the first rank in the literature of the subject.

THE Reports and Proceedings for 1873 of the Miners' Association of Cornwall and Devon contain a number of valuable papers on various subjects connected with mining. The Association, we regret to see, is somewhat cramped for want of funds, though we are glad to see from the lecturer's report that much good work is being done in the way of spreading scientific knowledge among the young men of the districts in the midst of which the Association is established.

THE sum of 22 guineas, subscribed by a few gentlemen, having been placed in the hands of the Council of the Leicester Literary and Philosophical Society to be distributed in prizes, in such a manner as to promote the study of natural science, the Committee appointed for carrying out the scheme have resolved to offer the prizes on a plan by which they hope that the interest and co-operation of a large number of persons will be secured, and the Town Museum at the same time greatly benefited. The prizes will be awarded for specimens of Leicestershire rocks, minerals, and fossils; Leicestershire insects and spiders; Leicestershire shells, land and water; Leicestershire plants, including cryptogams. Every specimen must have been collected within the borders of the county; and the other precautions are such as ought to produce a valuable local collection of specimens.

FEW persons are aware of the important exploration which has been going on for a year or two past in Costa Rica, under the direction of Prof. William M. Gabb, a geologist and explorer of Philadelphia, well known for his excellent scientific work, especially in connection with the geological survey of California, under Prof. Whitney. The special object is an investigation of an entirely unknown region of South-eastern Costa Rica, inhabited only by savages, but known to contain rich treasures of minerals, worked by the Spaniards in the early days of the Conquest; this knowledge being only by traditions. Although the party has consisted only of Prof. Gabb and four assistants, it has already gathered a great deal of important information and material in reference to the economical, scientific, and political history of the region investigated. In the course of his labours, Prof. Gabb found the people less savage than had been supposed, and he has already succeeded in winning their confidence to such an extent as to induce their chief to accompany him on a visit to San José. As might have been expected, the geological structure of the country has occupied a large share of Prof. Gabb's attention, and enough has been discovered to warrant the belief that the mineral resources are of great importance. The greatest interest attaches, however, to the discovery of two previously unknown volcanoes, not less than 7,000 ft. high, in the main cordillera just north-west of Pico Blanco. Of these he is about to make a thorough examination. The natural history collections made by the professor are of unusual magnitude and value, embracing all departments of zoology, and especially rich in mammals, birds, reptiles, and insects. Of fish there were but few species, but all that could be found were secured. The ethnology and philology of the country have been attended to very thoroughly. Material illustrating the manners and customs of the people was also gathered in great quantities, and important discoveries made of *Huacos*, or prehistoric graves. In addition to these, Prof. Gabb is on the track of an ancient buried city, of which no mention is made in any history of the country. The natural history and ethnological collections made have been sent to the National Museum, where they form a conspicuous feature in the Central American series. The material thus collected by Prof. Gabb will, on his return, be made the subject of an elaborate work, in which he hopes to present the whole subject of the physical and natural history of the country in its fullest detail. An important geological discovery made by him is that the appearance of dry land on the isthmus is of Tertiary date, and that it is coeval with the period of volcanic excitement in the Californian sierra.

MR. E. DUNKENFIELD JONES, of Pyroleira, near Jacareby, province of Saô Paulo, Brazil, writes us that on April 21 he witnessed a most glorious lunar rainbow just after a thunderstorm, at about 8.30 P.M. The arc was one of about 120°, and the secondary bow was just visible though not distinct; but the most remarkable part of the phenomenon was the increase of light over the *whole segment* of the circle. The clouds within the rainbow appeared much lighter than those outside. The bow was quite white, not the slightest trace of colour appearing. The moon was only five days old, and it seems strange that the rainbow should have been so bright with so young a moon. Our correspondent understands that lunar rainbows are very uncommon in that part of the world. This is natural, he states, for *showers* (during which alone the phenomenon can take place) generally occur before sunset and are rare at night.

THE exhibition intended to celebrate the fiftieth year of the Franklin Institute is to be held in Philadelphia from Oct. 6 to Oct. 31. All products of national industry may be sent for exhibition. In addition to three classes of premiums—a silver medal of the Franklin Institute, a bronze medal, and a diploma of honourable mention—cases of special merit may be referred to the Committee on Science and Arts, with a recommendation for the award of the Scott legacy premium or the Elliot Cresson gold medal. The Scott legacy premium—a bronze medal and 20 dols.—is vested in the City of Philadelphia by the provisions of the will of John Scott, of Edinburgh, made in 1816, and the city has confided the trust to the Franklin Institute. The Elliot Cresson gold medal is an honour which has rarely been awarded.

"REPORT on the Physical Character and Resources of Gippsland" (Melbourne, 1874) is the title of a pamphlet of upwards of 60 pp., containing a report of the Surveyor-General and the Secretary of Mines for Victoria of observations made on a recent tour through that part of the colony of Victoria. Gippsland includes that part of the colony between E. long. 145° 50′ and 150°, and contains an area of 13,898 square miles. The report contains many careful observations on the geology, natural history, and resources of the district, and is a valuable addition to our knowledge of the great southern continent. A good map and a geological section accompany the report.

LAST week two remarkably fine examples of the Smooth Hound or Skate-toothed Shark (*Mustelus vulgaris*) were taken in the fish weirs at Rhos Tynach, near Llandudno, and have been secured by Mr. W. Saville-Kent for the tanks of the Manchester Aquarium. The fish arrived in good condition, and have proved to be a pair, male and female. The latter, since its arrival, has presented the institution with six young ones; these are all doing well, already take food, and are now swimming about with the parents in the tank allotted them, 40 ft. long, presenting a most interesting spectacle. Some young herring have been introduced by way of experiment, and the result has been so satisfactory that it is sanguinely anticipated that the Manchester Aquarium will shortly possess as fine a shoal of herring as may be seen at Brighton. The inland position of the former station and the consequent difficulties to be overcome in transit will considerably enhance the value of such an exhibition. The attendance at the weekly lectures and the interest manifested in them continue to increase.

THE additions to the Zoological Society's Gardens during the past week include a Laughing Kingfisher (*Dacelo gigantea*) from Australia, presented by Mr. J. S. White; two Black-handed Spider Monkeys (*Ateles melanochir*) from Central America, presented by Mr. S. W. Rix; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Miss S. Hooper; a Tamandua Ant-eater (*Tamandua tetradactyla*) from South America, deposited; and three Blotched Genets (*Genetta tigrina*), born in the Gardens.

SCIENTIFIC SERIALS

THE *Journal of the Chemical Society* for July contains the following papers:—Note on a new mineral from New Caledonia, by Archibald Liversidge. This mineral is a hydrated silicate of nickel and magnesium allied to *alipite*.—Messrs. Gladstone and Tribe contribute the seventh part of their researches on the action of the copper-zinc couple on organic compounds. The substances now submitted to the action of the couple are the chlorides of ethylene and ethylidene. The dry chlorides are not acted on by the couple, even at a boiling heat, but in presence of water a feeble decomposition occurs. The decomposition is more energetic in the case of ethylidene chloride in the presence of alcohol, decomposition taking place according to the equations:—

$$C_2H_4Cl_2 + 2\left.\begin{matrix}C_2H_5O\\H\end{matrix}\right\} + 2Zn = C_2H_6 + 2\left.\begin{matrix}C_2H_5O\\Cl\end{matrix}\right\}Zn$$

$$C_2H_4Cl_2 + Zn = C_2H_4 + ZnCl_2.$$

Ethylene chloride only undergoes a small amount of decomposition when mixed with alcohol and heated with the couple.—Isomeric terpenes and their derivatives, Part IV., §1.—On cajeput oil, by Dr. C. R. A. Wright and T. Lambert. The oil was fractionally distilled, and the fraction boiling at 176°—179° (giving on analysis numbers agreeing with the formula $C_{10}H_{18}O$) was used for the experiments described. When treated with bromine the compound $C_{10}H_{18}Br_2O$ is produced, and this, on distillation, decomposes as follows:—

$$C_{10}H_{18}Br_2O = H_2O + 2HBr + C_{10}H_{14}.$$

The cymene thus obtained is identical with that obtainable from many other terpene derivatives, since it yields by oxidation a mixture of terephthalic and acetic acids.—§ 2. On the action of pentasulphide of phosphorus on terpenes and their derivatives, by Dr. C. R. A. Wright. The action of this substance appears to be the same in the case of citronellol and cajeputol, a terpene being first produced according to the reaction:—

$$C_{10}H_{18}O - H_2O = C_{10}H_{16}$$

and this terpene by the further action of the pentasulphide splitting up thus:—

$$C_{10}H_{16} + S = H_2S + C_{10}H_{14}$$

The cymene produced is identical with the preceding.—Action of ammonia on phenyl-chloracetamide and cresyl-chloracetamide, by Dr. D. Tommasi. When ammonia is dissolved in a mixture of alcohol and water, and the amides warmed with this solution, chlorine is exchanged for hydroxyl, according to the equation:—

$$\left.\begin{matrix}C_6H_5\\H\\CH_2ClCO\end{matrix}\right\}N + \left.\begin{matrix}NH_4\\H\end{matrix}\right\}O = \left.\begin{matrix}NH_4\\Cl\end{matrix}\right\} + \left.\begin{matrix}C_6H_3\\H\\CH_2HOCO\end{matrix}\right\}N$$

and similarly with the cresyl compound. This new compound, termed by its discoverer *phenyl-hydroxylacetamide*, is decomposed by boiling water, by potassic, sodic, and baric hydrates, this latter substance yielding aniline and some barium salt not examined. *Cresyl-hydroxylacetamide* is obtained by a similar process, and possesses very similar properties.—On Aqua Regia and the nitroxyl chlorides, by Dr. W. A. Tilden. The dried gases evolved from hot *aqua regia* when passed into concentrated sulphuric acid give rise to the deposition of a crystalline substance of the formula $NOHSO_4$, while free chlorine and hydrochloric acid gas escape. The acid nitroxyl sulphate heated with dry sodium chloride yields nitroxyl monochloride (NOCl) as an orange-yellow gas liquefying by a freezing mixture of ice and salt. The author's researches prove that this gas is the only compound of nitrogen, oxygen, and chlorine evolved from *aqua regia*, the reaction being:—

$$HNO_3 + 3HCl = NOCl + Cl_2 + 2H_2O.$$

The concluding paper is by Charles E. Groves, On the preparation of ethyl chloride and its homologues. The author passes hydrochloric acid gas into ethylic or methylic alcohol containing fused zinc chloride in solution. The present part contains its usual collection of valuable abstracts.

THE *American Journal of Science and Arts*, July.—Results derived from an examination of the United States weather maps 1872-3, by Elias Loomis; this we shall notice separately.—Prof. C. F. Himes describes a method of preparing photographic dry-plates by daylight, by desensitising and resensitising the silver compounds.—On a molecular change produced by the passage of electrical currents through iron and steel bars, by John Trowbridge. The conclusions are:—(1) The passage of an electric current through an iron or steel bar produces molecular change in it, which is apparent both at the closing and breaking of the circuit. (2) The rapid change of direction of a current through iron or steel bars produces a molecular disturbance which is greater than that imparted by a current sent in one direction alone. (3) Magnetisation of the iron or steel is sufficient to restore it to the normal magnetic state which is imparted by the magnetising helix. (4) The molecular action increases with the strength of the electric current.—The magnetism of soft iron, by David Sears. Mr. Sears follows up the investigations of M. Jamin given in the *Comptes Rendus* for Jan. 12 last. His results are:—(1). With poles of the same name opposed to each other the magnetisation of an iron bar forming the armature of the two poles is greater on a part of the armature beyond the two poles than it is when poles of opposite signs are opposed. (2) On points of the armature between the two poles the magnetisation is greatest when poles of the opposite names are opposed. A north and south pole attract an armature, therefore, with much greater force than two north or two south poles. (3) M. Jamin's conclusions from the experiments upon an iron bar forming a core to the enveloping helices are as follows:—(3°) "If the theory of solenoids is admitted, the action of parallel currents should be to increase the intensity of magnetisation; on the contrary, it is diminished. (4°) When the currents in the magnetising helices run in opposite directions, they should act opposed to each other on the currents circulating around the particles of the iron, and should diminish each other's action; on the contrary, it is increased. (5°) The action of the helices should be annulled at the middle of the bar. It is not." When the bar to be experimented on forms not the core, but the armature of two electro-magnets, the effects obtained are the reverse of those obtained by M. Jamin, and tend to confirm the theory of solenoids.—Mineralogical notes: Tellurium ores of Colorado; Geology of the Gold Hill Mining Region, with a map.—Notes on diffraction gratings, by John M. Blake, with woodcuts. After a long account Mr. Blake mentions that in many points he has been anticipated by Lord Rayleigh in the Phil. Mag. for February last. The explanation of the origination of the "bands" differs from Lord Rayleigh's.—On the spectrum of the Zodiacal Light, by A. W. Wright. A Duboscq spectroscope with a single prism was employed, the telescope and collimator of which have a clear aperture of 2·4 centimetres. The magnifying power of the former is nine diameters. Special

precautions were taken with the observations, and from them is drawn the following conclusions:—(1) The spectrum of the zodiacal light is continuous and is sensibly the same as that of faint sunlight or twilight. (2) No bright line or band can be recognised as belonging to this spectrum. (3) There is no evidence of any connection between the zodiacal light and the polar aurora. The deduction, drawn from the fact of its polarisation, that the zodiacal light is derived from the sun and is reflected from solid matter, is thus strengthened and confirmed by the identity of its spectrum with that of solar light. A discussion of the distribution of the reflecting matter in space is reserved for another article.—On the age of the copper-bearing rocks of Lake Superior; and on the westward continuation of the Lake Superior synclinal, by Roland Irving, with map and section.—On the parallelism of coal seams, by E. B. Andrews. This refers to the difference of opinion already expressed between Dr. Newberry and Mr. Andrews. Their question is whether the ancient shore lines with their coal marshes subsided in an even and uniform way, or very unevenly.

Journal of the Franklin Institute, May and June.—Section: Chemistry, Physics, Technology.—Prof. H. Wurtz's report On the water supply of the cities of Newark and Jersey City is continued, as is also Prof. Thurston's communication On investigations of the resistance of materials.—Dr. Lewis Feuchtwanger contributes a paper On baryta: its manifold uses in the arts. —Dr. C. Cooley describes a new connection thermoscope, by which the sensibility is increased, and its adaptation to a wider range of experiments secured.—Mr. Isherwood reports on Russian coals from the basin of the Don. He states they will doubtless soon be substituted for English coal along the shores of the Black and Mediterranean seas.

Neue Denkschriften der Allgemeinen Schweizerischen Gesellschaft für die Gesammten Naturwissenschaften, Band xxv. Zurich, 1873.—M. Mousson has made a general revision of the terrestrial malacological fauna of the Canary Islands, discussing and defining, as far as possible, all the species hitherto mentioned; and the results of this inquiry are here detailed in a comprehensive memoir on the subject. It appears that, according to the present state of our knowledge, the Canaries altogether contain 183 certain species of terrestrial and fluviatile molluscs; the largest numbers being presented by Teneriffe (90) and Palma (43); which may, in part, be explained by greater extent and richness of soil, and fuller exploration. The small proportion of fluviatile species is striking (there are only ten); it is probably due to the irregular character of most of the water courses, at times quite torrential, at others attenuated to a mere thread, or wholly dried up. Deposits of terrestrial shells are found at various points of the Canaries; and some lists which the author constructs from M. de Fritsch's inquiries on the subject appear to indicate three different degrees of antiquity in these remains. The deposits of Gomera and Fuerteventura, containing a series of species which have no present analogues, are older than those of Gran Canaria, which do present actual species though modified in the form of varieties; and the latter again are older than those of Teneriffe, the *débris* of which correspond entirely to extant forms. M. Mousson's observations in comparison of the Canarian fauna with those of neighbouring continents and islands are specially interesting. He concludes that the essential part of the malacological fauna of the Canaries is not reducible to any other fauna, and appears to have been developed in a manner perfectly autonomous. The particular features characterising the Canarian fauna consist of the predominance of certain sections of species, or of certain types, which elsewhere do not appear in the same manner, and the elimination of entire genera that occupy an important place in neighbouring fauna. "The only satisfactory explanation of this fact," says M. Mousson, "is that these islands, the objects in which, though often distinct from one another, yet range for the most part about common centres, have formed, since the origin of the present epoch (that is, since the great overturns which have separated the Tertiary epoch from the Quaternary, and opened the era which still continues), an independent whole separated by uncrossable barriers, by the sea, doubtless, from the African and European continents, as also rom the Madeira and Cape Verde Islands; which, themselves also, were independent." The differences between the old and recent fauna are attributable (on this view) rather to local overturns connected with the variable and volcanic nature of the ground than to geological and general climateric conditions; for most of the types have remained nearly the same, and have traversed the different sub-fossil fauna that are distinguishable. The diversity of neighbouring forms in the different islands denotes a separation of distant date, but proves nothing as regards the possibility of these islands having once formed a small compact continent, afterwards broken up.—The second and only remaining memoir in this volume is by Prof. Rütimeyer, and has for its subject the fossil tortoises of Solothurn and the rest of the Jura formation. The author's investigation is of a thorough and exhaustive character, and the paper (with its 17 beautifully executed lithograph plates), will be found a valuable contribution to this branch of palæontology.

Revue d'Anthropologie, t. iii. No. 1, 1874.—M. Gustave Lagneau, in the first paper, considers the grounds on which a purely Celtic origin may be ascribed to the primitive inhabitants of the Basin of the Saone and of the Rhone valley and its dependencies; and after sifting the evidence afforded by ancient and modern authorities he is led to ascribe a mixed origin to these peoples.—M. G. de Rialle devotes a long and very comprehensive paper to the history of the peoples of Central Asia.—M. F. Moreno's account of his discovery of some Prehistoric burying-grounds and *paredos*, or ancient Indian habitations, on the shores of the Rio Negro (Patagonia) forms a valuable contribution to our knowledge of the anthropological characters of the primitive inhabitants. M. Moreno's paper is enriched with a table of cranial measurements, comprising a series of results obtained from forty-five skulls.—M. T. Chudzinski gives the result of his observations on the muscular system of the negro, derived from the autopsy of three subjects at the Paris School of Anthropology, reserving for a future number the general considerations to which the facts observed seem to point.—The recent discovery in one of the Canaries of a Libyan inscription, such as has hitherto been found only in Numidia, has called forth some remarks from M. Faidherbe on the ethnology of the Canarian group. The writer believes that the population of the Canaries may be referred to Ouolofs, or West African blacks, to African Libyans, and probably to Phœnicians, besides a later intermingling with Europeans; and it is to the agency of Phœnician traders that he ascribes the knowledge of the Libyan characters and the practice—whose prevalence is amply proved—of embalming the dead, and reducing them to the state of mummies, in which condition they have been found among the natives of these islands.—In No. 2 of this year's series M. Topinard discusses at length the accuracy of Camper's facial angle, and the correctness and sufficiency of the data on which it was based. As the first attempt to establish a system of human craniometry, Camper's definition of the facial angle deserves the greatest respect, and M. Topinard shows that the subsequent depreciation of the value of his method is chiefly due to the vague and variable modes of its application, which originated with Geoffrey Saint-Hilaire and Cuvier. M. Topinard is of opinion that even when used with the greatest attention to the rules which Camper himself prescribed, his method can scarcely be employed with perfectly identical results by different observers, and hence he thinks it would be advisable to adopt some less variable process of determining the maxima and minima for the facial angle. The science of craniology is beginning to assume a more reliable character, and we may therefore hope that craniologists will soon find themselves in a position to adopt some definite and universally applicable method. This, however, can scarcely be attained till the fact is recognised that in craniometric measurements it is the means and not the extremes which we ought to aim at obtaining; the former are alone safe, the latter tend to error.—French geologists are still devoting a large amount of attention to that richest of all palæontological sources, the limestone districts of the Dordogne. In an additional note on the cave of the church at Excideuil, M. Parrot gives us the results of one of the most recent explorations of that region. A careful examination of this cave or crypt has revealed the fact that below the floor, at various depths, lie buried the *débris* of the Quaternary fauna intermingled with the remains of products of industry, belonging evidently to men contemporaneous with the animal deposits with which they are mixed. Reindeer, beavers, bears, are here all represented, and the industrial objects found are similar in character to those of the other caverns, but there are also numerous remains of jasper not met with elsewhere, and the bones have undergone a softening process hitherto unobserved. In other respects the cave of Excideuil offers no novel interest.—M. Hovelacque discusses the ethnological characters of seven genuine Tsigane skulls in the Paris Museum.

SOCIETIES AND ACADEMIES

London

Royal Horticultural Society, July 15.—Scientific Committee.—A. Smee, F.R.S., in the chair.—Mr. McLachlan showed damson leaves affected with a gall produced by *Volvulifex pruni*, a species commonly found on the sloe.—Dr. Hooker sent a note stating that since the last meeting a Ward's case had been received from Mr. Moseley of the *Challenger*, and though all the plants were dead, the soil, when spread out and watered, yielded numerous seedlings of *Pringlea* and *Azorella*.—Dr. Masters exhibited a branch of Privet, furnished with large woody spines.

General Meeting.—Dr. Masters, F.R.S., in the chair.—The Rev. M. J. Berkeley commented on the most important of the objects submitted to the Fruit and Floral Committees.

Philadelphia

Academy of Natural Sciences, Dec. 30, 1873.—Dr. Ruschenberger, president, in the chair.—The following paper was presented for publication:—Remarkable variations in coloration, ornamentation, &c., of certain larvæ of Nocturnal Lepidoptera, by Thos. G. Gentry.—On report of the committees, the following papers were ordered to be printed: Description of seven new species of *Unionidæ* of the United States, by Isaac Lea; Description of three new species of *Uniones* of the United States, by Isaac Lea.

Jan. 6.—Dr. Ruschenberger, president, in the chair.—Dr. J. G. Hunt remarked that the structure of the *Schizæa pusilla* differed widely from that of our other indigenous schizaceous ferns, viz, *Lygodium palmatum*, and its morphological elements are unlike those of our ferns in general. The barren frond of *Schizæa pusilla* is marked on its epidermal surface with a *double line* of stomata, and these organs extend the entire length of the frond. The cells which make up the interior of this delicate fern are cylindrical and vary in size, but their distinctive characters lie in minute projections or outgrowths from all sides of the cells, and these projections meet and are articulated with corresponding outgrowth from adjoining cells, so that the cells of *Schizæa* have penetrating between them in every direction intercellular spaces and channels of *remarkable regularity* and beauty, and so characteristic is this plan of cell-union that the botanist need find no difficulty in identifying the smallest fragment of the plant. This morphological peculiarity has not been noticed before.—Mr. Thomas Meehan exhibited some flowers of *Passiflora quadrangularis*, in which some of them had the pistils almost wanting, while the flowers were perfect in all other particulars. He said it was well known that in cultivation this plant never produced fruit unless by artificial cross-impregnation, but he thought the tendency to abort in the female flowers, and thus approach the classes which were in structure as well as practically uni-sexual, had not been noticed before. There was a species in New Zealand, however, known to be monœcious, and it might be just possible that the *Passifloraceæ*, with mostly hermaphrodite flowers, were following in the wake of the allied *Cucurbitaceæ*, in which a complete separation of the sexes was the rule.

Jan. 13.—Dr. Ruschenberger, president, in the chair.—Prof. Leidy remarked that two species of *Hydra* were common in the neighbourhood of Philadelphia. One is of a light brownish hue and is found on the under side of stones and on aquatic plants in the Delaware and Schuylkill rivers, and in ditches communicating with the same. Preserved in an aquarium, after some days the animals will often elongate the tentacula for several inches in length. The green *Hydra* is found in ponds and springs attached to aquatic plants. It has from six to eight tentacles, which never elongate to the extent they do in the brown *Hydra*. In winter the animal is frequently observed with the male organs developed just below the head as a mamma-like process on each side of the body. He had not been able to satisfy himself that these *Hydræ* were different from *H. fusca* and *H. viridis* of Europe. Prof. Agassiz had indicated similar coloured forms in Massachusetts and Connecticut, under the names of *H. carnea* and *H. gracilis*. Of the former he remarks that it has very short tentacles, and, if this is correct under all circumstances, it must be different from our brown *Hydra*, which can elongate its arms for 3 in. or more.

Jan. 20.—Dr. Ruschenberger, president, in the chair.—Prof. E. D. Cope described some species of extinct tortoises from certain formations of north-eastern Colorado, which had been previously found in the Fort Union or lignite beds of the Missouri river region by Dr. Hayden. He had in 1868 recognised the age of the latter as Cretaceous, contrary to the opinion expressed by some geologists, that the formation both in Dakota and Colorado is Tertiary.—Mr. Cope incidentally mentioned the recent discovery of remains of *Dinosaurs* in the lignite beds of Colorado, which were thus proved to belong to the Cretaceous period, and not Tertiary, as the evidence of the fossil plants had been interpreted by Mr. Lesquereux and others. Dr. LeConte expressed his great satisfaction at the complete confirmation, by his friend Mr. Cope, of the statements he made several years ago (Notes on the Geology of the Survey for the Extension of the Union Pacific Railway, Eastern Division: Philadelphia, Feb. 1867), concerning the Cretaceous age of the lignites at the eastern base of the Rocky Mountains, from near Denver southwards into New Mexico.

Jan. 27.—Dr. Ruschenberger, president, in the chair.—Prof. Cope made some observations on the age of the lignite and other corresponding formations of the West, and especially its supposed equivalent in Northern Colorado. He referred to his determination ot the Upper Missouri formation as Cretaceous in 1868; of the Wyoming Bitter Creek series as of the same age in 1872. He now added the Colorado strata to the same, on the evidence of vertebrate remains procured by himself during the past season, in connection with the United States Geological Survey under Dr. F. V. Hayden. These remains consisted of *Dinosauria* of three species, tortoises of five, and a single species of crocodile. Five of the genera were diagnostic. The *Dinosauria* were referred to the old genus *Hadrosaurus* and the new genera *Polyonax* and *Cionodon*. The *Cionodon arctatus* was a large herbivorous saurian, allied to *Hadrosaurus*, but with a most complex and singular type of dentition; the size that of a horse. The other two species are much larger.

Boston, U.S.

Society of Natural History, Feb. 18.—Dr. H. Hagen read a paper On amber in North America, calling attention to a forgotten paper by Dr. G. Troost, published in Silliman's *American Journal of Science*, 1821, entitled, "Description of a variety of Amber, and of a fossil substance supposed to be the nest of an insect, discovered at Cape Sable, Md." This paper contains much more than its title would indicate, giving an elaborate account of the geological formation of Cape Sable Dr. Hagen then described the different strata at Cape Sable, as given by Dr. Troost; comparing which with the profile of the coast of Samland in Eastern Prussia, where most of the amber was found, he showed there was little resemblance between the two, except the occurrence of amber in sandy strata and the agglutination of sand by iron oxide, although whether this sand has any similarity to the glauconite of the amber strata in Prussia he did not know. A striking difference between the amber strata in Eastern Prussia and in Maryland is the occurrence of lignite only below these strata in the latter and only above in the former locality. This fact perhaps indicates some similarity with the occurrence of amber in the so-called *striped sand* of the lignite layers of Prussia.—Dr. Hunt then read a paper on the deposition of clays. Having examined the water of the Mississippi near its mouth, he found it to contain about 1-2000 of suspended matter, chiefly clay, which required from ten to fourteen days to subside. He, however, observed that the addition of sea-water or of salt, sulphate of magnesia, alum, or sulphuric acid, rendered the turbid water clear in from twelve to eighteen hours. He thus explained the ready precipitation of the suspended clay when the river water comes in contact with the salt waters of the Gulf of Mexico, causing thus great deposits of fine mud and helping us to understand the origin of the accumulations of argillites and clay slates which are met with in various geological formations. An explanation of this phenomenon is to be found, Dr. Hunt thinks, in the researches of Guthrie on the formation of drops (Proc. Royal Soc., xiv., 1864). Studying the size of drops of water falling from a small sphere of ivory, he found that the cohesion of the water was diminished when it held saline matter in solution, as was shown by the smaller size of the drops. This was verified by experiments with solutions of various strengths, of nitre and chloride of calcium. It was found that the addition of eight parts of the latter salt to 1,000 parts of water reduced by one-ninth the size of the drops, which was determined by their diminished weight. These results show a diminished cohesion of the liquid to the ivory sphere, from which it was by the force of gravity made to fall. The cohesion in virtue of which extremely attenuated particles of clay are held

in suspension in water in opposition to gravity, is in this manner so far reduced by the addition of saline matters that gravity and cohesion rapidly assert themselves among the suspended particles, which collect together and subside, leaving the saline liquid clear. The precipitation of suspended clay is made very rapid when a strong solution of salt is employed.

Vienna

Imperial Academy of Sciences, March 12.—M. Puschl communicated a paper on heat of bodies and ether-density. To explain Dulong and Petit's law, he assumes that, in solid bodies, the *vis-viva* of atom-motion is small compared with the quantity of rays collected in the ether between the atoms, through reflection; that, at ordinary temperatures, bodies are nearly quite opaque for their own internal radiation; and that the chemical equivalent weights of bodies are no relative atomic weights, but weight quantities with equal amounts of atom surface. He thinks that possibly all chemical changes in bodies may be accounted for by heat radiation. The heat of bodies consisting mainly in motion of ether, a means is given of determining the lower limit of density of the latter; and M. Puschl considers it must be more than 26 billionths of that of water (regard being had to the specific heat of water).—A note from Prof. Maley stated that he had been able to make the urine of dogs alkaline through simple removal of the acid gastric juice from the body. —M. Oppolzer, from experiments on the velocity of propagation of the electric current, estimated it at 4,000 geographical miles in a second.—Prof. Böhm read a paper On formation of starch in the germinating leaves of cress, radish, and flax. He opposes Kundt's view that starch developed among the chlorophyll granules, on exposure to light, is an assimilation-product formed immediately from decomposed carbonic acid. He considers it rather a transformation-product of reserve nutriment already present in the cotyledons (adducing evidence of this from various experiments).—Dr. Streintz communicated a paper On deadening of torsion-oscillations of wires. Internal metal-deadening (as he calls that part of the deadening which has its cause in torsion of the wire), does not, he finds, follow the laws of air-deadening. One property they have in common; the logarithmic decrement for different amplitudes is the same. But the metal deadening remains unaltered when the moment of inertia is changed, or the wire lengthened or shortened, and so the time of vibration altered. It is independent of the diameter and tension of the wire; it grows quickly with the temperature. Annealed wires show a much less deadening than unannealed. These properties explain some peculiarities of musical instruments, and may be variously utilised.—M. Schrauf presented a note on the thermo-electric properties of various minerals.

March 19.—Prof. Mach communicated a third paper On the sense of equilibrium, giving a formula which applies to pressure of parts of the body on each other, muscular efforts, skin sensations, hydrostatic blood pressure, and the hypothetical functions of the labyrinth.—Dr. Boué gave an extract from his treatise on the constituent parts of mountain chains, on mountain systems, and comparison of the surfaces of the earth and moon. He criticises M. Elie de Beaumont's theory, regarding it as merely a fragment of a more general orogeny.

Göttingen

Royal Society of Sciences, Feb. 7.—M. Grisebach read a paper On a collection of plants made by Prof. Lorenz in the provinces of Cordova, Santiago del Estero, Tucuman, and Catamarca, in South America (between 26° and 31° S. lat.). The diligent labour of two years, and in widely different localities, furnished only 900 species, showing how little varied, comparatively, are the Argentine flora. Neither climate nor soil seems to account for this homogeneity. The author considers it explained by the fact of this part of South America having been raised out of the bed of the Atlantic later than the neighbouring regions of Brazil and Chili, long geological periods being necessary for the appearance of new organisms. As to the question whether there has been only immigration of species, or new species have arisen independently, it appears from comparison of Brazilian and Chilian flora that the latter is true; the number of endemic species is about 43 per cent., a proportion similar to that in flora regarded as independent. Among the immigrant species the relationship to Chili is most marked.—M. Kohlrausch communicated a paper On thermo-electricity, conduction of heat, and electricity. He sets out with the hypothesis that with a heat-current of certain amount dependent on the nature of the conductor, an electric current is connected; and explains by means of it the phenomena of thermo-electricity. To explain Peltier's observation of development of heat by an electric current at a point of junction, it is added, that heat is moved by an electric current; and the heat-moving force of the unit electric current in any body is proportional to the electromotive force of the unit heat-current in the same body. This suggestive paper also treats of the relations of the hypothesis to the principle of conservation of energy, displacement of the thermo-electric order of metals by temperature, heat conduction and work, &c.—M. Heymannrpresented a paper On an Indian drama, Bharata's Natyaçastram.—M. Enneper discussed some theorems relating to surfaces of the second order.

Paris

Academy of Sciences, July 27.—M. Bertrand in the chair —The following papers were read:—Action of differently refrangible rays on iodide and bromide of silver; influence of colouring matters, by M. Edm. Becquerel.—On the Algerian meteorological tracing, by M. Ch. Sainte-Claire Deville.—Objections to the method of uprooting vines for the destruction of *Phylloxera*; indication of another process; a letter from M. C. Naudin to M. Elie de Beaumont.—Report on M. Cauvy's memoir concerning the means of preserving vines from the invasion of *Phylloxera*, by the Commissioners.—Researches on explosive bodies: explosion of powder, by MM. Noble and F. A. Abel, first memoir.—Note on the quantity of water consumed by wheat during its growth, by M. Marié-Davy.—Actual state of the invasion of *Phylloxera* in the Charente provinces, extract from a letter from M. M. Girard to M. Dumas.—Indications given in 1845 of the existence of an ancient sea in Algeria, in the meridional portion of the Atlas, and on the possibility of re-establishing this sea, by M. Virlet d'Aoust, in a letter to the perpetual secretary.—On the production in the same medium and at the same temperature of the two varieties of sulphur, octahedral and prismatic, by M. D. Gernez.—On the action of ether on cupric oxide for transforming it into cuprous oxide and into metallic copper, by M. A. Guerout.—On isoterebenthene, by M. J. Riban.—On a division of the fibrin of blood from whence is derived a substance analogous to ordinary albumen, by M. A. Gautier.—On the anti-putrid property of the heavy oil of coal-tar, by M. L. Dusart.—New process for the manufacture of the so-called "*alummed*" stuccoes or plasters, by M. Ed. Landrin.—On decomposition of albuminoid matters *in vacuo*, by MM. N. Gréhaut and E. Modrzejewski.—Storm of May 26, at Vendôme (Loire et Cher); thunderbolt; scheme for a simplified lightning conductor, by M. E. Nouel.—On the metamorphoses of *Sacculina Carcini*, by M. A. Giard.—Note on the development of the spermatozoids of the brachyurous decapods, by M. P. Hallez. —On the origin of the hot winds of the Alps and the physical constitution of the Sahara, by M. Ch. Grad.—On a vitreous feldspathic orthose from the Isle of Rachgoun (Algeria, province of Oran), by M. Ch. Vélain.—Note on the geology and palæontology of the estuarine formations of the upper tertiary at the environs of Oran, by M. Bleicher.—On the phosphates of lime from Ciply, in Belgium, by M. Nivoit.

CONTENTS

Paga

THURSDAY, AUGUST 13, 1874

ICELAND'S MILLENARY

ANNIVERSARIES are nearly as old as history, and are of constant occurrence; centenaries are of comparatively modern date, but have been not infrequent during the past thirty years; a millenary, however, must not only necessarily occur with extreme rarity, but there are many chances that in a thousand years an event which was long held of the greatest moment may be looked back upon with comparative indifference, may have dwindled into comparative insignificance, as seen from a new point of view or in the shadow of some more stupendous occurrence; or the individuality, whether a nation or a widespread association, in whose career the event was held to be of prime importance, may have become either extinct or absorbed in some wider individuality, which may not be so impressed by the memory of the episode as to be moved to celebrate its millenary. The Icelanders then have reason to congratulate themselves that they have kept their individuality intact for so long, as to be now celebrating the 1,000th anniversary of their origin as a distinct and separate community.

It will be found on examination that men keep alive the memory, by festival or otherwise, of any event because that event marks the beginning or the renewal of life in an individual or a community. There are many events in the history of individual nations and of the world which might thus very appropriately be annually or centennially remembered; there are not a few occurrences in the history of our own country that well deserve such a commemoration on account of the new impulses they gave to our national life and our intellectual progress, as well as indirectly to the advancement of the world at large. We believe that, on the whole, this periodical celebration of the occurrence of events which mark certain stages in the progress of a community or of the world serves a good purpose and ought to be encouraged; it affords us an opportunity to take stock of our gains, to measure the extent of our progress, to see wherein we have erred and how we ought to mend our ways; and last, but not least, it gives the world an excuse for learning something about the important events which have marked its history.

This celebration of the 1,000th anniversary of the colonisation of Iceland ought to excite the interest of a wider circle than the few thousands who fondly cling to the bleak but picturesque Arctic outpost which has been the home of themselves or their ancestors for a thousand years, and where they have maintained stereotyped, as it were, the physiognomy, dress, and manners of a people that were at one time rulers of the sea and very nearly lords of all Europe. It would be an interesting task to investigate the causes which have brought it to pass that a people at one time so overflowing with energy as the old Norsemen, should for some centuries now have been justly regarded as the most peaceable, industrious, and most home-keeping people in Europe. As everyone knows, for about 200 years from about the middle of the eighth century A.D. the Norse rovers, the "vikings," the men of the viks, voes, or bays, were to be found on almost every sea of Europe, rousing to activity or over-mastering the exhausted southern nations. It was no doubt good for our own land that it should receive such a large infusion of this energetic northern life, as it did, first in the shape of Danish invaders and settlers, who have left a broad mark on the northern counties of England, the south and north-east and west of Scotland, and again in the shape of the Normans who shed themselves over the land under the leadership of Duke William. These Norsemen, one of the branches of the great Teutonic kin, seem to have taken kindly enough to the wild, roaming life of sea-rovers, and hardy indeed they must have been to weather the hazards of the sea in such craft as they then could command. But, after all, it should be remembered that even in the eighth and ninth centuries Europe had not quite subsided from the commotions which followed on the coming in from the east of the great Teutonic wave, and as the Scandinavian offshoot was probably one of the latest to reach its destination, the great northern peninsula, we need not be surprised that it was one of the latest to settle down to a quiet and home-keeping life; it did so only after sending out wavelets in all directions, east and west and south, which wavelets produced impressions that have continued for good even until now. As seen in the stories, historical and legendary, that come down to us, these hardy Norsemen of yore were a glorious race of men, half barbaric as they were, full of the greatest capabilities and a splendid energy, to the infusion among us of which we ourselves are no doubt indebted to a considerable extent for the capacity which has enabled us to attain such large intellectual and material achievements, and for that never-subdued love of liberty which in all directions has been so fruitful in results.

Even in Iceland, cut almost entirely off as it has been since its colonisation from the influences that have stirred and moulded the rest of Europe, the fine energy of its Norse Colonisers has by no means died out. Yet this old Norse Colony cannot be said to have advanced much beyond the standpoint it occupied a thousand years ago. The Icelanders have no doubt produced much literature that must be of permanent value both intrinsically and as an all-important aid to the scientific student of language and of the human race. Still they must, we fear, be looked upon as a thousand years behind the rest of Europe, and a study of their present condition will afford an excellent means of estimating the immense advances which the civilised world as a whole has made during the last thousand years. And to what is this advance owing? Is it not simply that in Europe generally, knowledge has been spreading in an increasing ratio, and that our knowledge has been becoming more and more scientific? Would not a survey of the nations of the world show us that those nations in which science is cultivated to the highest possible extent alongside of other fields of intellectual activity, are the nations which hold the front rank in the march of the world's progress? In short, it will be found, we believe, that the world's progress and science are almost convertible terms. But science to be of any practical utility requires something to work with, and that something in the case of our own nation is Coal. The student of history ought to bear this in mind, and thus he will see that in Iceland, however far theory might have

gone, geology would for ever have forbidden any great national advances as depending on science. Here is a tremendous thought for our statesmen and political economists. England without science would have been in the position of Iceland without coal!

The early visitors to Iceland are said to have found traces of former visitors in the shape of books, crosses, bells, &c., which it is supposed may have been left by monkish voyagers or fishers from Ireland, which at that time was pre-eminent in Europe for its learning. And this learning was the secret and the reason of Ireland's early pre-eminence; and it is only by the spread of education and by bringing the people under the influences which have done so much for the rest of Europe, that she can ever regain the position she once so proudly occupied. The Icelanders, on the other hand, seem to have improved as far as their opportunities have allowed them; but these opportunities have been comparatively few and unimportant. Now, however, that Denmark is handsomely to grant the island a reformed constitution, and that the eyes of the civilised world at large have been attracted to it, we hope Icelanders will be led to develop, by means of education and scientific knowledge, their own latent capacities as well as the capacities of their island home, which, like themselves, seems as if it were the "fragment of a former world." It is almost too trite to say that it is wonderful what human energy will accomplish under the most adverse circumstances when directed by scientific knowledge and stimulated by the encouragement and the hope of the approval of our fellows. And if the Icelanders generally had among them the opportunities of bringing themselves abreast of the rest of the world as far as education is concerned, and especially in respect to a knowledge of the methods and results of science, if even a very few of the permanent inhabitants became competent observers of nature, might we not rationally look for results that would shed considerable light on various important points in science—in geology, for example, and meteorology—that are waiting to be cleared up? Iceland, indeed, might very well become the world's polar observatory. Let us hope that this new episode in the history of Iceland may be productive of widespread and lasting benefit to the people themselves, and lead to an increase of the general sum of intellectual progress; and all peoples who can in any way claim to a Norse connection ought to sympathise with their old-fashioned brethren in their rejoicings, and lend them a helping hand to enable them to partake of the many good results which Norse energy has helped to achieve. Their quaint old Sagas, we are sure, would not give less pleasure during the dreary nights of their long winter, if told to an audience whose resources of rational enjoyment have been increased by a knowledge of "the fairy tales of science, and the long results of time."

The Icelanders themselves have good reason to remember the period of the colonisation of their wild island, for it was carefully planned and judiciously carried out a thousand years ago, and obtained effectually for its originators that freedom which they were in great danger of losing under the tyranny which then oppressed their native Norway. And here we may state, as a curious fact, that the millenary festival of the establishment of the kingdom of Norway itself took place only two years ago. That, and the festival of which we speak, are, so far as we know, the only celebrations of the kind that have hitherto been kept.

It was about the year 861 A.D. that Iceland was first seen by the Norsemen; the story being that in that year one Naddod, a vikingr, a leader of one of the then frequent plundering expeditions, was driven by a tempest on the eastern coast of this then unknown country, to which he very naturally gave the name of "Snjóland." No doubt Naddod would tell the story of his accidental discovery to his own folk when he returned home from his roving expedition, and it was possibly this story that instigated Gardar, the Swede, whose home was in Denmark, to visit the new-found land.* This Gardar seems to have found a good harbour near the present Austerhorn, where he wintered, and in the following year completed the circumnavigation of the island, which he renamed after himself "Gardarsholm." The next visitor to the yet uninhabited island is said to have been a "mickle" Norwegian vikingr, Floki "Volgertharson," who struck the east coast a few years after Gardar, and sailing south and west landed at Vatna Fjord in Bardestrand. Floki explored the country to some extent, and would have settled therein with his followers had not their cattle all died. He, however, appears to have passed a second winter at Hafna Fjord, returning home in spring full of information concerning the new land, which, the chronicles say, was at that time covered with wood, and otherwise more inviting than it is at the present day. Indeed, one of Floki's companions is said to have given quite a glowing account of the country; the very grass, he said, "dropped butter." From the large quantities of drift-ice which he found in the northern bays, Floki gave the island the name by which it has been ever since known—Iceland.

By this time the overbearing conduct of the Norwegian king, Harold Haarfager, had so galled his high-spirited nobles that to many their country had become intolerable, and they were quite ready to welcome any chance of escape from their monarch's oppressions. Love and murder, however, seem to have been the immediate causes of the first deliberate emigration from Norway of a band of colonists for Iceland. Ingolf and Leif, the story goes—and we believe its main features may be relied on as authentic—were two cousins, whose fathers had been obliged to fly from their native province for murder. Ingolf had a beautiful sister, Helga, whom Leif loved, but she was also loved by Holmstein, one of three sons of a powerful Norwegian noble, who were companions of Ingolf and Leif in their piratical excursions. Leif married Helga, and had therefore to meet Holmstein in mortal combat, when the latter was done to death. This and other occurrences made Norway too hot to hold the two cousins, who, indeed, had been condemned to banishment. After two piratical trips to Ireland, from which they returned with great booty, the cousins with their families and friends and Irish slaves, their goods and their chattels, bade farewell to their native land in the year 874 to found a republican colony in Iceland. Ingolf was first forced to land on a promontory on the south-east coast, which was hence named Ingolfshöfde, where he

* But according to the table in Rafn's "Antiquitates Americanæ," it was Gardar who discovered Iceland in 860.

remained three years, at the end of which time he removed to the site of the present capital, Reikjavik ("Reeky Bay"), where superstition apparently determined him to remain, notwithstanding the remonstrances of his servants, who had seen many more inviting spots along the coast. Meantime Leif, or Thorleif as he was now called, from a big sword he brought back with him from Ireland, had built his house at Thorleifshöfde, where, in the first spring after his arrival, he began to cultivate the ground. Having only one ox, however, the story goes, he compelled his Irish slaves to draw the plough; they thereon rebelled and murdered their master, they themselves being in turn pursued and nearly all killed by Ingolf, who then appropriated all the country between the river Olousa and Hval Fjord. The oppressions of Harold the Fair-haired soon sent many of the best of Norway's sons to become settlers in the new colony, and thus it was that Iceland was peopled, not by the scum of the mother country, as is too often the case, but by the best blood of old Norway. This influx of colonists continued for sixty years, when, the causes of emigration from Norway having ceased, and the best ground in Iceland having been fully occupied, immigration gradually came to an end.

From the first the colonists seem to have set themselves to make the best of their not very promising surroundings, and ere long to have settled down into a comparatively peaceful and contented community. One Ulfleet is said to have compiled a code of laws, and instituted the "Althing," or National Assembly, in 928, when for the first time it met at Thingvalla. Among other enactments pauperism was suppressed as a crime by the severest laws, one of which was intended effectually to prevent the procreation of a pauper class in a country where it was only by dint of the hardest labour that the sea and the land could be made to yield enough for all. The colonists were converted to Christianity about the year 1,000; in 1261, after many internal contests, the whole island swore allegiance to the Norwegian king, but about 1387 it was transferred to Denmark, attached to which kingdom it has ever since remained. The King of Denmark is now on the island —an event of the rarest occurrence—and, as we have said, is to grant to his Icelandic subjects a new and liberal constitution; we believe he is accompanied by Prof. Steenstrup.

This, deprived of detail and of much that is doubtful —though the Icelanders have less of the legendary in their early history than most other old countries—is the story of the colonisation of Iceland a thousand years ago. We have not space to enter into further detail concerning the physical aspect of the island, the character and customs of the people, their wonderful literature in all departments of intellectual activity, their discovery of and long intercourse with Greenland and North America. Greenland was seen by an Icelander, Gunnbjorn, so early as 877, and for centuries after some rocks between Iceland and Greenland were known as "Gunnbjorn's Skerries." Erik Rauda ("the Red") first visited Greenland in 983; three years afterwards he planted a colony on the south-west coast. We understand that a deputation from America is attending the millenary fêtes now being held in Iceland, and that some of the American scientific societies have shown their goodwill by sending valuable presents of books, &c. This is right and becoming on the part of the Americans, for, as we have just indicated, the Icelanders were the first European colonists of America, and had regular intercourse with the western continent for about 300 years; and it is curious to conjecture what might have been the history of that continent had the Norse attempts at colonisation not proved abortive. It is by no means improbable that Columbus himself, when he made that northern voyage in 1467, "a hundred leagues beyond Thule," may have heard some fragmentary traditions of the Greenland colony which he may have treasured in his heart as a confirmation of the idea which was subsequently to bear so rich fruit.

The history of this old Norse colony proves that the people have great capacity for work, and we again hope that this celebration of the courage and dauntless energy of their forefathers will be the means of rousing them to renewed activity, which will be beneficial both to themselves and to the world at large, which has increasing need of all the really good working power it can command.

RECENT RESEARCHES IN PHOTOGRAPHY

A SUBSTANTIAL contribution has been recently made to our knowledge of the action of light upon silver salts—a contribution which we cannot but consider as of the highest importance to photography, both as a science and as an art.

In the autumn of last year Dr. Herman Vogel announced * as the result of some experiments that he had been making, that "we are in a position to *render bromide of silver sensitive for any colour we choose*—that is to say, to heighten for particular colours the sensibility it was originally endowed with." This discovery is such a decided advance that it will be interesting to trace it from the beginning. Dr. Vogel, in the first instance, found to his astonishment that some dry bromide plates prepared by Col. Stuart Wortley in this country were more sensitive to the green than to the blue portions of the spectrum. This result was so totally opposed to the generally received notions that the subject was submitted to further examination. In the next experiments a comparison was instituted between dry bromide plates and the same plates when wet from the bath solution of silver nitrate. The results showed a decided difference in the behaviour of the plates. The sensibility of dry bromide plates appears to extend to a greater extent into the least refrangible end of the spectrum than is the case with *wet* plates. In Dr. Vogel's plates, in fact, which received the spectrum formed by the battery of prisms of a direct vision spectroscope from a ray of sunlight reflected from a heliostat and passing through a slit 0·25 mm. wide, the photographic impression of the spectrum, when developed by an *acid* developer, extended in the case of the dry plates into the orange, but with wet plates not quite into the yellow. The bromide plates prepared by Vogel, moreover, did not exhibit that increased sensitiveness for the green rays which characterised Col. Stuart Wortley's plates, and this led the German investigator to conjecture that the latter plates contained some substance which absorbed the green to a greater extent than the blue. To test this

* *Poggendorff's Annalen*, vol. cl., p. 453.

conclusion one of the plates was washed in alcohol and water in order to remove the yellow colouring matter with which the plate was coated, and it was then found to have lost, in accordance with Dr. Vogel's anticipations, its sensitiveness for the green rays. The peculiar action of the Wortley dry plates was thus shown to be due to the coating of colouring matter, and the next step made by Vogel was to seek some substance which especially absorbed in the yellow, and at the same time acted as a sensitiser by fixing the free bromine liberated by the action of light upon the silver bromide. Both these ends are fulfilled by the coal-tar colour known as *coralline*. A plate dyed with this substance and exposed to the spectrum exhibited two maxima of photographic action, one the ordinary maximum in the indigo (near G), and the other, almost as strong, in the yellow, thus affording complete confirmation of Dr. Vogel's views. Aniline green* was next tried. This dye is stated to absorb the red rays, and a corresponding increase of sensitiveness for the red rays was observed, the photograph again presenting two maxima of activity, the one in indigo and one in the red coinciding in position with the absorption band of the dye. Thus Dr. Vogel's results may be summarised by saying that a dyed film of silver bromide exhibits maxima of sensitiveness in those regions where the colouring matter exerts its maximum of absorptive power, but the precise conditions under which these results can be obtained must be considered at present as unknown, since many observers in repeating the experiments, among others Dr. Van Monckhoven,† have failed to obtain other than negative results.

In a communication made to the French Academy on the 27th of last month, however, the well-known physicist, M. Edm. Becquerel, stated that some experiments made at his instigation by M. Deshaies at the Conservatoire des Arts et Métiers had been productive of positive effects, and that some of Dr. Vogel's results with coralline and aniline green had been reproduced. M. Becquerel, however, does not confine himself to bromide films; similar results have been obtained by iodised collodion in which coralline was dissolved. A most remarkable action was observed also in the case of chlorophyll when this substance was used as a tinctorial agent. Although the collodion possessed only a faint green colour from the dissolved chlorophyll, the spectral image was of a much greater length than when plain collodion was used. Under these last circumstances the spectrum extended from the ultra-violet to between G and F, with the usual maximum of action near G, while with chlorophyll the region of strongest action extended from the ultra-violet to the line E in the green, and at the same time a weaker but yet distinct impression extended from E to beyond B in the red, with a strong band between C and D. By a close examination of the spectral image a second band of less intensity could be detected on the least refrangible side of the band between C and D, and other still weaker bands appeared in the green. The most striking confirmation of Vogel's results is to be found in the fact, observed by M. Becquerel, that the band between C and D *corresponds in position with the characteristic band of the absorption spectrum of chlorophyll dissolved in collodion.* The same results were obtained by M. Becquerel with every plate tried and with collodions containing different quantities of chlorophyll.

* The green referred to is probably that known as "aldehyde green." The so-called "iodine green," as I have frequently observed, *transmits* a band in the red

† *Photographic Journal*, No. 25, June 20, 1874.

It must be admitted, then, that a film exerting selective absorption in intimate contact with a sensitive film of silver bromide or iodide affects the latter in those parts of the spectrum where the selective action is taking place. Here surely is a wide field for investigation, and one the importance of which will be at once obvious to the physicist. Practically also, when the precise conditions of action are made known, valuable results may be anticipated from the application of this principle to science and to art. Since the year 1842, when M. Becquerel photographed the whole solar spectrum from the extreme violet to the extreme red, and when Dr. J. W. Draper photographed the violet, blue, and extreme red, no successful attempts have been made to imprint the least refrangible end of the spectrum; and this, when we consider the great importance that the study of the solar spectrum has assumed of late years and the painful or even dangerous character of prolonged eye observation, is to us a matter of wonder. M. Becquerel's result, it will be remembered, was obtained by a film of silver iodide, first insolated or exposed to diffused light and then to the action of the spectrum. Here again is another question—the precise action of *insolation* on sensitive plates—demanding explanation at the hands of the physicist. The practical aspect of Dr. Vogel's discovery need not here be discussed at length. Attention may be called to the well-known difficulty of getting reds or yellows to imprint themselves in portraiture, a difficulty which now bids fair to be overcome.

Then again, in what we must consider as a higher sphere of practical utility, great advantage to the study of solar physics is likely to accrue. In point of fact the photographic method of comparing spectra described in a recent communication to the Royal Society now becomes available for the whole extent of the solar spectrum, and our knowledge of the true composition of the sun will be thus in course of time recorded permanently on "that retina which never forgets."

Great results have already been achieved by photography, and greater may be looked for. It must not be forgotten that in this most interesting branch of chemical physics we are in a period either of provisional hypothesis, or, worse still, of no hypothesis at all, so that valuable additions to our knowledge of physical and chemical laws should be forthcoming. The changes wrought by a beam of light on sensitive surfaces are sometimes physical and sometimes chemical. We may appropriately recall here the fact that mechanical pressure upon a sensitised surface of a silver salt acts in the same manner as a ray of light, giving a dark stain under the action of reducing agents. The experiment of Grove also, in which an electric current is set up by the incidence of a beam of light upon a prepared Daguerreotype plate, should not be forgotten. The equivalence between light and the other form of force has not yet been established, and it may not be going too far to conjecture that thermodynamics may possibly in the future have to appeal to the action of light upon a photographic plate. In the meantime we look forward to the promised continuation of Dr. Vogel's researches with no little hope.

R. MELDOLA

LADY BARKER'S "LESSONS ON COOKING"

First Lessons in the Principles of Cooking. By Lady Barker (London: Macmillan and Co., 1874).

IN this little volume the authoress has proved beyond all manner of doubt how completely she is the right woman in the right place. Surely nowhere could the Committee for the National Training School for Cooking have found a lady superintendent better fitted than Lady Barker to put life and spirit into the scheme which they advocate, or one more thoroughly qualified to train and marshal the feminine bands that are now being drilled under her supervision in the South Kensington Schools of Cookery to invade and revolutionise the kitchens of the future in every part of the empire.

In the introductory chapter of her "First Lessons in the Principles of Cooking" the author at once grapples with the chief difficulty of the question at issue, and admitting the fact that fuel and food cost nearly twice as much as they did ten years ago, she tells her readers that this is precisely the reason why it has become the imperative duty of every mistress of a house, and indeed of every member of the community, to learn how materials for warmth or cooking may be made to go twice as far as they have done hitherto. And it is this problem which she here attempts to solve by help of her own practical experience, which was gained in that best of all training-schools, the school of necessity, as it existed in earlier days in the colony in which she learnt her first lessons of cooking. The theoretical knowledge of the "why" and the "how" has, as she informs us, been a far more recent acquisition in her case; but it is evident from the manner in which she discourses on the chemical composition of different articles of food, their various assimilative and other properties, and the confidence with which she tests, by the laws of science, every function of her ovens, pans and kettles, that she has mastered the scientifically theoretical branches of culinary knowledge as successfully as, in bygone times, she overcame its empirically practical difficulties.

Her lessons on baking, roasting and frying, boiling and stewing, and her remarks on fuel and fire, and on the advantages, economical and others, of cleanliness, are so sensible that we may commend them to the careful study of all housekeepers, young and old, who are actuated by the laudable ambition of combining economy and comfort downstairs, with good digestion and its concomitant, good humour, upstairs. When we say that Lady Barker is actually aiming at the daring innovation of making thermometers and "friometers" as indispensable to the cook as the compass is to the helmsman, we need expatiate no further on the debt of gratitude due to her from all long-suffering payers of heavy coal and meat bills. It might be supposed that Lady Barker's book was intended solely for her own sex, but this is not the case; for, more widely expansive in her desires than Mr. Ruskin, who wishes to see "every girl taught at a proper age to cook all food exquisitely," she considers that "a knowledge of cooking is every whit as necessary for a man," although she would not insist, in his case, on anything beyond the simplest forms of the art; and she evidently hopes to see the day when boys and girls will compete together for prizes in the National Cooking Schools. More practically important and worthy of serious consideration is the strongly expressed conviction that "no schoolboy ever gets as much nourishing food as he requires, and that this is the secret why boys of fourteen or fifteen years old scarcely ever look anything but thin and pinched." Furthermore, she wishes their parents and schoolmasters to understand that if they desire to see boys with clear complexions, bright eyes, and active limbs, "every game of football and cricket and every sharp run across country on a paperchase ought to be followed by a hearty meal of good beef or mutton, and not merely by weak tea, poor milk, and bread and butter."

The author's experience of the enormous amount of meat—uncontaminated by stimulants, it must be remembered—which growing boys and young men consumed in New Zealand in the early times of the colony, has also led her to form the opinion that, in spite of all tables and dietary reports, our soldiers and sailors are not allowed food enough for healthy men with good appetites. This, however, is a point that we must leave her to settle with her Majesty's Inspectors of military and naval affairs, to whose notice we would strongly commend her book, as well as to that of all other persons interested in the practical and economical bearing of the relations existing between the consumption of food and of fuel, and the hygienic condition of the consumers. It is quite certain, however, that until the general masses—and consequently all those who have hitherto monopolised the direction and practice of cookery—shall become better acquainted with the ordinary laws of physiology and chemistry, it will be hopeless to look for any radical improvement in the manner of using food and fuel to the best advantage in our households. Hitherto our kitchens have been managed haphazard, without system; the time for allowing such a wasteful condition of things to continue undisturbed is evidently drawing to a close. High prices and diminished supplies require to be met by a new system, based on true scientific principles; and considered from this point of view, we think that this little volume may fairly claim to be considered as supplying the thin end of the wedge, and indicating the manner in which the questions of practical cookery will in future have to be considered.

MAUNDER'S "TREASURY OF NATURAL HISTORY"

The Treasury of Natural History. By Samuel Maunder. Edited by E. W. H. Holdsworth, F.L.S., F.Z.S. (London: Longmans, Green, and Co., 1874).

THERE are few tasks more thankless and disagreeable than that of having to re-edit an encyclopædia or a dictionary, especially when it relates to a subject like Zoology, which is still so much in its infancy. A "Treasury of Biography," or a "Treasury of Bible Knowledge," in each fresh edition cannot, from the nature of its contents, need much modification; the manner in which the points that are dealt with have become stereotyped on the minds of mankind at large, makes the same operation having been performed on the letterpress a comparatively unimportant drawback to its reappearance in a

form which will not be considered antiquated. This is far from the case in a work like the one we are now noticing. The spirit of biological thought changes as rapidly as fresh facts accumulate. The introduction of an all-embracing hypothesis, like that of evolution, shakes previously accepted theories to the foundation; long-known facts are looked at in quite a different aspect to that in which they were received before its introduction, and their relative value is differently estimated.

How then can it be expected that a zoological work, originally written when Cuvier's celebrated "Regne Animal" was the latest text-book on the subject, could be so modified by an editor, however able, as to make it at all a representative of the present state of biological knowledge? To do so the article on the "*Pachydermata*, an order of Mammiferous quadrupeds distinguished by the thickness of their skins," would have to be removed; that on each of its component genera re-written, and the word itself obliterated from the whole work. A similar operation would have to be performed on many of the larger orders; and to such an extent would this process have to be carried on, that it would soon become doubtful whether a new work instead of a fresh edition would not be the more economical as well as the more useful.

This being the case, we are not surprised when we find that nothing more is said of the affinities of the Echidna than that "it has the external coating and general appearance of the porcupine, with the mouth and peculiar generic characters of the ant-eaters;" whilst the word "monotreme" is only mentioned in the second supplement. In like manner we notice that the Dugong and Manatee are said to rank among the Cetacea; whilst the Sirenia are omitted except in the appendix. The word "Chevrotain" refers us to "Musk Deer," thus perpetuating the well-known error; and, on finding it, we are told that there is a Javanese Musk deer (*Moschus javanicus*) rather larger than a full-sized hare, at the same time that "there are other musk deer, which are very small, and to which the general term of *Chevrotains* is given; they are inhabitants of Java, Sumatra, Ceylon, and Southern India." The genus "Ammocetes" has not been removed, and is still said to be "a genus of Chondropterygious fishes, allied to the lampreys," instead of the young of the lamprey, which it has for some time been known to be.

The creatures most fully treated of are the birds, the best known of which are described with fair completeness, with extracts from the works of Mr. Gould and other observant naturalists, as to their habits and coloration. We do not know why the Poe Honey-eater (*Prosthemadera concinnata*) is described both under its English and Latin name, in the same way that it is difficult to account for the Orycteropus and the lady-bird being each represented twice by woodcuts.

Several of the original articles are lacking in important detail. Of the Ammonite and Orthoceras it is only said that they are genera of fossil shells, which leaves their affinities unnecessarily vague. So there is not much to be learnt from the observation that Nummulites are "small round fossil shells, which in various parts of the world are found in immense numbers."

Mr. Holdsworth adds an extra supplement, which contains much useful information of recent origin. It includes an account of the breeding of the hippopotamus and of the Sumatran rhinoceros, specimens of both of which have been born in this country during the last two or three years. The Liberian, or Lesser Hippopotamus, is also described, as is the new Bird of Paradise *Drepanornis d'albertisi*, obtained from New Guinea by Signor d'Albertis, and named by Mr. Sclater. An account is also given of the nesting of the crocodile in Ceylon, and of the incubation of the python.

This second supplement also adds to the palæontological information contained in the first, by giving a description of the *Dinoceras mirabilis* of Prof. Marsh, from Colorado; of *Archæopteryx lithographica*, of the other Odontornithes, and of *Odontopteryx talipoica*.

Notwithstanding the imperfections we have pointed out, there is much information to be obtained from this work, and which can be obtained from it more easily than from any other, on account of its being arranged alphabetically, and from the succinctness of the articles.

OUR BOOK SHELF

The Amateur's Photographic Guide Book. Being a complete *Résumé* of the most useful Dry and Wet Collodion Processes, especially for the use of Amateurs. By W. J. Stillman. (London: C. D. Smith and Co.)

ALTHOUGH we already possess numerous books of this class, the present little volume will doubtless meet with a welcome from amateur photographers, coming as it does from the pen of one well known to be a thoroughly practical worker. The book is small (numbering only 92 pp.), but contains sufficient information for those who desire to master the dry and wet collodion processes. Indeed, more pretentious works on photography which have come under our notice contain a large amount of what we are inclined to regard as utterly superfluous matter, and it is, moreover, refreshing to open a "Guide" which is not made a medium for some dealer's price-catalogue. The present work consists of three chapters and six appendices. The first chapter treats of cameras, and describes the process of taking pictures by the dry-plate method; some useful hints will be found in this chapter by outdoor photographers. The second chapter describes the ordinary wet collodion process—a process which has been so often described before, that Mr. Stillman has little to add by way of novelty; while the third chapter is devoted to positive prints. In the appendices we have special remarks on baths and bath solutions, on cleaning plates, on developers, on dry processes, &c. On this last subject, by the way, we notice that the decimal point has been omitted from several of the numbers in the formulæ, and although these are doubtless typographical errors, the figures as they stand will be apt to mislead beginners: "Sulphuric acid 1840," for instance, would at first sight lead the uninitiated into the belief that an acid in bottle since this date was necessary for success in making pyroxyline, whereas the author only means an acid of sp. gr. 1·840.

On consulting books on practical photography, anyone who pretends to any knowledge of chemical science cannot fail to be struck by the empiricism of the various formulæ proposed, and a feeling akin to regret is experienced on reflecting that this fascinating and useful art has reached its present state of perfection by processes which have been essentially methods of trial and error. The large numbers of practitioners, both professional and amateur, now engaged with this subject ought surely to produce from their ranks investigators willing, as we know they are able, to take up the purely scientific aspect of the subject. The harvest reaped by such an investigator would surely repay him, for we are of opinion that in the theory of the sensitive film lie hid some of the fundamental truths of molecular physics. R. M.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

The Woolwich Aëronautical Experiment

I HAVE read, not without some surprise, the accounts given by the daily papers, stating that the recent experiment at Woolwich had been fruitless. The lessons of the experiment are numerous, although it would have been easy to predict all that happened; but the impressions relating to balloons and ballooning are generally so vague and so incorrect, that I may be justified in trying to summarise the results which were obtained in connection with the siege of Paris, which might otherwise be lost altogether.

As I stated in my article on the "Flying Man" (vol. x. p. 230), the principal object to be considered in the theory of aërial motion is the friction of the moving surface against the air; the friction increasing according to the square of the rate of motion v^2, the force necessary to move the body at a certain rate varies according to v^3. Consequently it is easy to impart a small motion to a balloon; but the difficulty very quickly becomes insuperable except with an almost inexhaustible source of power, such as a powerful steam-engine. *Hand-power cannot be made of any avail;* M. Dupuy de Lome's experiments proved this definitively, and that question must be considered as settled in favour of *steam-power*.

The problem now at issue is to ascertain whether it is possible to construct a *safe* fire-engine balloon, and to use it successfully for travelling to a distance. But I shall give some calculations on the recent experiments with hand power.

If we suppose that the motion of the directing balloon is uniform, the friction consumes all the force which is generated;* consequently, if n = number of men pulling the fan, m = the real motive power generated by each man, k = a coefficient which depends on the nature of the surface of the balloon, l = great axis of balloon, r = radius of equatorial section, v = rate of motion—I suppose that r was the same for Dupuy de Lome as for Bowdler, and that M. Dupuy de Lome's great axis was $2r$, his number of men twelve instead of two, and his rate of motion 9 ft. per second—we shall try to find what ought to be the motion of Bowdler's balloon.

As according to the principles of mechanics

$$v = \sqrt[3]{\frac{n.m.l}{k r^2}}$$

it is easy to find

$$v^1 = \frac{3}{\sqrt[3]{6} \times 2}$$

under these circumstances. But m is not the same, as Dupuy de Lome's men were pulling on a large screw acting without any transmission; Bowdler's apparatus was a small screw 3 ft. in diameter. I suppose Bowdler's utilisation was only half of Dupuy de Lome's; consequently the real equation is

$$\frac{v^1}{v} = \frac{1}{\sqrt[3]{6} \times 4} = \frac{1}{\sqrt[3]{24}}$$

not far from $\frac{1}{3}$. The motion of Bowdler's balloon could not be more than 3 ft. a second.

It was impossible for Major Beaumont to see any difference with the motion of the air being at a distance from the earth. It could be ascertained with very great difficulty even with an aëronautical compass of the best description.

But the fact of the balloon having been put into a state of rotation by the rudder is a demonstration of the fact of a differential motion having been obtained. It is the very pressure resulting from the differential motion which is the only force that rotates the balloon in acting on the rudder. The rudder is pushed as it is in the sea when the ship is acted on by sails or steam, and in the air the action is very easy, as the balloon is almost symmetrical around its vertical axis.

It is true the governing power could be imparted very easily by direct action on an excentric helix adjusted for the purpose, as has been suggested, but not tried, so far as my knowledge goes. I will say the same of the vertical motion, which is very important also for ballooning; but the theory being a little more complex, I shall keep it in reserve for a future communication.

The rotatory power is of importance in making observations in the air, and it is praiseworthy in Major Beaumont and Mr. Bowdler to have directed their attention to that particular point.

The abstract principles of aëronautics have been pretty well ascertained, but the practice is a very difficult thing, and can only be tested by a series of experiments. With such an experienced balloonist as Mr. Coxwell, and the resources of an enlightened Government like that of England, it seems likely that such experiments will be tried more easily than in France. Under the present circumstances, I think it is our duty to assist you so that you may derive benefit from the knowledge we bought so dearly amidst our great national calamities.

W. DE FONVIELLE

* I speak only of the motion in still air.

Fogs, Field-ice, and Icebergs in the Atlantic

THREE unwelcome phenomena have this year, in more than an ordinary degree, vexed the coasts of the United States and the navigation of the Atlantic; I allude to fogs, field-ice, and icebergs. The first have so much interfered with the success of the Nantucket fishermen that but few mackerel have been caught by the seine, the schools cannot be followed, and the boats have frequently remained idle for days. No one who has not met with these fogs can form an idea of their density. With a bright sun shining over head, objects cannot be discerned at the distance of 100 ft Collisions have been numerous in all the great American ports and rivers. On one occasion hundreds of tons of cargo remained two days in New York before it could be transported across the Hudson to Jersey city, although the distance was frequently under a mile from wharf to wharf.

At sea these fogs have extended almost without a break for 1,600 miles, the wind being from east, through south, to west. When sounding the steam whistle I noticed, what has probably been noted before, that the denser the fog the greater were the reverberations, and that the echo was always heard to windward as plainly as if it were deflected from a cliff in that direction. I presume that this arose from the resistance the waves of sound encountered in travelling against the wind, none being heard to leeward. These fogs are attributed to the great difference which exists in spring and summer between the temperatures of the air and water. Having, however, often remarked that they come when these conditions are not found, I am induced to believe the cause must often be looked for in the atmosphere alone, by the mixture and condensation of the different strata of air there. At times these fogs are in streaks, and the alternations of heat and cold, as they sweep by, are very noticeable. Now, if the sole cause were due to a simple difference of temperature between the air and water, I cannot understand why this should be, unless the sea was composed of similar streaks of hot and cold water, which here is not the case.

In the Atlantic, seamen were astonished to find that early in February field-ice and bergs had reached the parallel of Cape Race, and have since been seen as far south as 42° N. lat., drifting to the north-east in the heated waters of the Gulf Stream. Two steamers and an equal number of sailing vessels are known to have been seriously damaged by colliding with them; and the wonder is that so few accidents have taken place when it is borne in mind that for hundreds of square miles the steam and sailing tracks between America and this country are dotted with them. A few of the bergs have been supposed to be three miles in length, and on two occasions steamers passed through or around ice-fields 100 miles in length. It is also alleged that another was stopped five hours by field-ice so far south as the forty-third parallel.

There is a general belief that the vicinity of ice may be readily detected by the fall in the temperature of the water. Unless it be in very large masses, and the ship close to, this test is not of much value, owing to the natural law which causes a cold surface fluid to sink until equilibrium is restored. A better test is the cold, damp feeling of the air, but this is only noticeable when to leeward of the berg or field, and is practically of no value, as the wind passing over the sea-water at 28° will cause a similar sensation. In some states of the atmosphere the clouds near the horizon assume a peculiar grey tint when the ice-field is of large dimensions.

Unless the weather be very foggy, an iceberg is easily distinguished on the darkest night at a considerable distance by the light reflected from it, and to this cause I attribute the great immunity of ships from accidents. Ordinary islets dropped in the Atlantic would cause an infinity of wrecks, owing to the absence of this useful property. When an iceberg reaches a low latitude it loses much of its beauty; the brilliant white and pris-

matic colours which it had in the north disappear, and the whole mass, except under peculiar circumstances, looks like a mountain of soda. At rare intervals, however, during a gorgeous sunset, the tinted clouds are reflected on its sides, and their various colours flash across like the shades of a rich shot silk, but infinitely more beautiful, eliciting terms of admiration alike from the sentimental dandy or the rough emigrant.

The cause of their early appearance so far south this spring is a mystery; many attribute it to a mild season. As I have before stated, I cannot concur in this opinion. No man can with certainty assert that in the Arctic regions a January temperature can cause the fracture of such masses from their original beds.

Celtic, July 28 WM. W. KIDDLE

Science at Cambridge

IN an article on the Public Schools Commission published in NATURE (vol. x. p. 219), the following passage occurs :—"Now it is acknowledged on all hands that the teaching of a subject at school and its recognition at the universities are inseparably connected, and especially with regard to science. The Colleges say, We cannot give more scholarships, because a sufficient number of men of good attainments do not present themselves; and the Schools reply, We cannot spend our time on subjects for which there are so few rewards. Both profess willingness, but each calls on the other to take the initiative." It is implied by this that the schools and universities each shelter themselves in their conservatism by throwing the blame on the other. With respect to the University of Cambridge, at least, I think this is unfair. King's College offered scholarships (of 80*l*. a year for three years) for natural or physical science in the years 1872 and 1873; on both occasions the examiners (who were in no way connected with the college) reported that no candidates of sufficient merit had presented themselves. At length, in the present year, they have awarded a scholarship in these subjects.

Everyone who is conversant with Cambridge knows that the colleges are *anxious* to reward proficiency in science, and that the tendency is distinctly to award scholarships therein on easier terms than in other subjects, but that there is a dearth of candidates. Although the valuable science scholarships at Trinity have always been open to members of all colleges of either university, the number of those who have tried has always been very small.

I maintain, then, that Cambridge *has* taken the initiative as far as it is desirable to do so. It would be a lamentable thing to award prizes too profusely, as we should thereby be stocking the University with an inferior staff of teachers, who would transmit their inferiority to the succeeding generation.

GEORGE DARWIN

Trinity College, Cambridge, July 30

Circulation of Apparatus and Scientific Works

THE letter of Mr. H. W. Lloyd Tanner (NATURE, vol. x. p. 244) has opened up a subject of importance to all science teachers, and surely there are no insuperable difficulties in the way of the Kensington authorities sending out for loan, under proper conditions, apparatus and scientific works. Already there are loan collections of apparatus to be obtained from South Kensington by any recognised science class, but the cost of getting up and sending them out must be far greater than necessary. We were much amused last winter by receiving from the Department of Science and Art, as a loan, *five* huge boxes of elementary chemical apparatus. When these were opened we were quite disappointed, for only a few pieces proved useful in our class. We did not want a lot of big bell jars, glass retorts, Florence flasks, and bits of glass tubing stuck through wretched corks. Anyone can easily understand that it is simply waste of money to send to a science class apparatus on loan that the class already possesses. Why are not teachers allowed to choose the apparatus? In furtherance of the object mentioned by Mr. Tanner, may I be allowed to offer the following suggestions :—

1. That a collection of scientific apparatus and standard works for loan be made at Kensington.
2. That science teachers desirous of using books and apparatus pay a subscription, say, of 10*s*. per annum.
3. That lists of apparatus and books be published, and sold to subscribers at a reasonable figure.
4. That books and apparatus (from list) be lent for a term to subscribers (subject, of course, to conditions of return in good order).
5. That the Department pay the carriage to and from Kensington.

Perhaps other readers of NATURE will kindly give further suggestions.

To such as myself, anything like the above would be a boon indeed. Living in a small country town in which there is neither public reading-room nor library, and being daily engaged in teaching science, and, withal, intensely fond of the study of it, I am thrown almost entirely upon my own resources to provide scientific books and apparatus. Yet I am better off than numbers of science teachers. The trustees of our schools have lately granted 5*l*. a year for scientific apparatus, and to this we get the Government grant of 50 per cent. added. Further, I can at any time borrow a good microscope, and have access to several private libraries belonging to gentlemen of scientific tastes. Still, frequently, the very information wanted is not to be obtained, and I for one should be glad to avail myself of any scheme like the one I have suggested.

Dunstable A. P. W.

Sounding Flames

IN the summer of 1842 I attended the lectures of Dr. William Reid, brother of Dr. David Boswell Reid, the celebrated ventilator of the House of Commons, in the great barn-like class-rooms of the latter chemist. In the practical class we produced sonorous flame vibrations in iron tubes three or four inches in diameter and about 2 ft. long, held over similar tubes covered with wire gauze. These instruments were the property of Dr. D. B. Reid, and produced a noise like the roar of a lion.

Edinburgh, Aug. 7 T. STRETHILL WRIGHT

THE FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THIS Association, as we have already intimated, meets at Lille on Aug. 20, and thus its meetings will be held contemporaneously with those of the British Association; this is perhaps to be regretted, as some of the members of the two Associations might wish to attend the meetings of both. The Lille session promises to be as brilliant as either of the two preceding ones. The proximity of Lille to Paris is very likely to attract a greater number of members than was gathered at Bordeaux or Lyons. A considerable number of foreigners have promised to "assist" at this year's meeting; among whom we notice the names of Prof. Sylvester and Dr. Odling.

The session will be opened at three o'clock on the afternoon of the 20th, by the inaugural address of M. Wurtz, the president for 1874, and also by an address by Lieut.-Col. Laussedat, Professor at the Conservatoire des Arts et Métiers, general secretary of the Association for 1874. There will, of course, be the usual sectional meetings, and several public lectures have been arranged for. Excursions always form an important part of the proceedings of the French Association, and three have been organised for this year; the first excursion, on Aug. 23, will be to Boulogne; the second on Aug. 25, to the coal-mines of the "Compagnie d'Anzin;" the third excursion commences on the 28th, after the conclusion of the meetings, and will probably be to Brussels and Anvers, lasting several days.

To show the magnitude to which this Association has already attained, we may state that about 150 names are down as readers of papers in the various sections, several of whom are to read more than one paper. M. Cornu is to describe a new optic spherometer. Several papers are to be read by M. Marcel Deprez on improvements in electrical apparatus and on certain theoretical aspects of steam-engines. Prof. Giard, of Lille, is to make several communications in Zoology, and M. Hamy in Anthropology; Prof. Houzeau, of Rouen, is down for a paper on Concentrated Ozone; and M. Lallemand, of Poitiers, will describe his researches relative to the Diffusion of Light. M. G. Lemoine will read two papers, one on

researches in Chemical Mechanics, and the other on Equilibrium in Gaseous Systems. Prof. Terquem, of Lille, will read various papers in Optics and Acoustics, and M. G. Tissandier will give a public lecture on Meteorology and Balloons.

On the whole, there will be a fair number of purely scientific papers, though there is an unusually large proportion in medical and industrial subjects.

THE COMETS

THE following communication appears in the *Times* from Mr. J. R. Hind, F.R.S., dated Mr. Bishop's Observatory, Twickenham, August 10 :—

"I send you positions of the last new comet (Borrelly) for the ensuing ten days ; warning the amateur, however, that he must not expect to see it well without a very good telescope. They are deduced from the following orbit, which I have calculated from the first accurate observation at Marseilles on July 26, one at Strasburg on Aug. 1, received from Prof. Winnecke, and a third taken at Mr. Bishop's Observatory on the 4th :—

"Perihelion passage, August, 27·0861 Greenwich time; longitude of perihelion, 344° 24′ 6″; ascending node, 250° 59′ 50″; inclination to ecliptic, 41° 39′ 52″; distance in perihelion, 0·98090 ; heliocentric motion, direct.

"The subjoined places are for midnight :—

	Right Ascension. h. m. s.	Polar Distance. ° ′	Distance from Earth.
Aug. 10	14 33 22	20 40	0·676
,, 12	14 20 44	19 47	0·684
,, 14	14 7 27	18 59	0·692
,, 16	13 53 22	18 15	0·699
,, 18	13 38 18	17 36	0·705
,, 20	13 22 28	17 2	0·711
,, 22	13 5 55	16 34	0·717

"The distances are expressed, as usual, in parts of the earth's mean distance from the sun.

"It appears that efforts in various observatories to obtain a daylight view of the late bright comet have been fruitless. I had been most hopeful of it being thus seen with the powerful telescopes and in the favourable climate of Marseilles ; but I learn from M. Coggia that a close search for the comet in fine skies on July 22, and from morning to evening on the 26th, failed to afford a glimpse of it. At Twickenham, under very advantageous circumstances, about noon on July 23, we could not detect it, when Procyon, the principal star in Canis Minor, at nearly the same angular distance from the sun, was shining brightly in the telescope. It affords additional evidence that proximity to the earth is not so important a condition for visibility of a comet in the daytime as close approach to the sun ; but it was very desirable to have the appearance of Coggia's comet upon record."

*THE FORM OF COMETS**

IV.

WE have seen then that the phenomena of the tails of comets can be explained even including their most complicated appearances. I now proceed to deal with other phenomena, for the best proof of the truth of a theory is its capacity to explain a multitude of details which were not at first considered. Examine in the figure (Fig. 8) which I recently showed you of Donati's comet, that singular dark portion which is seen in the axis of the tail to a very considerable distance from the nucleus, and say if that cylindrical space, void of matter, is not the effect of the interposition of a screen—the nucleus, which intercepts the repulsive force, and suppresses in this region all the molecules driven from the head of the comet. This is because the repulsive force, being a surface-action, is spent against that of the nucleus, and is arrested by this simple screen ; it is quite the reverse of attraction, which acts effectually through all matter as if that matter did not exist. This cannot have been the shadow thrown by the nucleus, for two reasons, of which it is enough to mention the first : the black streak, besides being much too long, is not in the exact direction of the luminous ray ; it is inclined to the radius vector at an angle of several degrees, for which the theory accounts. In short, it widens considerably when tails almost straight, composed of the rarest materials, are about to disappear, and we can often follow its trace to the extremity of the tail.

* Continued from p. 270.

But I must dwell, in conclusion, upon the curious phenomena of the head and upon the luminous sectors which usually appear in the direction of the sun. We find here a new confirmation of the play of the repulsive force. Fig. 15 is a drawing on a large scale of the head of the comet of 1861, made at Rome by Father Secchi.

Let us not forget, in what follows, that one of the characteristic features of the nebulous layers which surround the nucleus, and of which it is perhaps entirely composed, is the transparency which permits us to see small stars through depths much greater than that of our atmosphere. There is reason, then, for believing that the solar rays penetrate across these layers to the central nucleus and heat it, all the more since these same layers are probably not so permeable to dark heat as they are to luminous heat. In the space of three weeks the central heat may thus be raised from the degree of heat of distant space to a temperature sufficiently elevated to volatilise a part of the matter of the nucleus, and perhaps promote chemical reactions arrested till then by the original cold.* Under this increasing influence the matter is dilated and rapidly separates from the nucleus (19 metres per second for Donati's comet) ; but soon this matter, still too dense to be sensibly repelled, reaches the surface limit beyond which it ceases to belong to the comet. This surface limit presents, as we have seen, two opposite conical points by which the emission takes place. At a later period this matter getting further and further away, and becoming more and more rarefied, falls under the action of this repulsive force, which then makes it turn tail and fly to the rear. This species of conical envelope, turned towards the sun, assumes the appearance of a calyx with inverted edges, while the opposite envelope with obscure interior contracts under the influence of the same action, but without changing its curvature. There will be noticed, in front of this species of calyx, exterior strata nearer to the sun, to which they present their convexity instead of being opened out conformably to the theory which M. Roche had hitherto based solely upon attraction. I asked M. Roche to introduce the new force into his investigation of the surfaces assumed by a fluid mass submitted to the double attraction of its own mass and of that of the sun, and we have had the satisfaction of seeing one of the two singular points of the surface limit disappear. The surfaces are completely enclosed and become curved towards the sun ; there is no room on this side for any loss of matter. But this is to be expected in the exterior layers, which have too little density to obey repulsion ; while in the interior of the head, very near the nucleus, attraction still rules exclusively on account of a density still very great.

In order to render these somewhat complicated details of the theory intelligible, we have only to turn round on its axis Fig. 16 ; it will generate a surface of revolution composed of an exterior envelope having a form roughly parabolic, and of two envelopes attached to the

* Spectrum analysis seems to prove that this heat may reach the point of giving to the nucleus a light of its own, presenting, moreover, the characteristics of a light emitted by a gaseous substance. But up to the present time (1870), indications of this kind are too vague and too doubtful to enable us to derive much help from them.

nucleus, one of which is, to use a botanical term, of a cyathiform aspect, while the other is almost conical.

If we compare this theoretical figure with that of the head of the comet of 1861 (Fig. 15) and of other comets, it will account for the transparency of these surfaces and for the effects of perspective. The latter are continually changing, for comets are presented to us in all imaginable positions.* The conical anterior envelope is often described by observers under the name of a luminous sector, a term which gives a false idea of its real form. In the head of Donati's comet, the luminous sector appears to have had an amplitude very much greater than that of the comet of 1861.

You see that all the most constant, the best investigated, the most characteristic details of the figure of comets agree in disclosing the action of a repulsive force which is exerted by the sun not in virtue of his mass, but in virtue of his superficial incandescence. Extinguish the photosphere of the sun, reduce it in thought to the state of crust to which cold has long ago brought the earth, so as to leave nothing more than the solar attraction inherent in its mass, indestructible as the mass itself, and you will suppress at the same time the gigantic tails of comets and the cup-shaped emissions of their heads. They will no doubt still lose some part of their materials in approaching the sun, but these materials will be disseminated along the orbit of the comet instead of flying away from the sun into space with an incredible swiftness. In a word, comets would lose the forms represented in Fig. 7, and would assume those of Fig. 6.

Fig. 15.

It may perhaps appear to you singular that we must go to celestial phenomena for evidence of the existence of a force so widespread as repulsion due to heat when it acts at a sensible distance, and not from molecule to molecule. In reality there is nothing astonishing in this; it was the same with attraction.

Each of you is firmly convinced of the existence of this force; you know that two spherical bodies attract each other in proportion to their mass, and in inverse proportion to the square of their mutual distance, and that notwithstanding that you have not had ocular demonstration, that you have not tested it by experiment; around us, within us, nothing announces to us that bodies attract each other. No direct experiment has ever been made on the point in France, and if any physicist set himself to it, he would require six months at least to prepare for what is known in England as the "Cavendish Experiment."

But if attraction produces around us effects so feeble that no mechanician or physicist ever thinks of taking them into account in his experiments and calculations, on the other hand it acts on a grand scale in celestial space on account of the greatness of the masses. Well, it is the same with the force of repulsion; on account of the incandescence of the surface of the sun, of the enormous extent of that surface, and of the small density which matters may acquire, where they have infinite space in which to expand. Although this repulsive force is acting all round us, just like attraction, it is quite as difficult to prove it, because we cannot attain by means of our furnaces the degree of incandescence of the sun, and above all because we operate only upon insignificant surfaces, and because we work in an atmosphere of an enormous density as compared with cometary materials. It is easy to see, then, that to obtain evidence it would be necessary to resort to combinations as delicate as those of the Cavendish Experiment.

We may, however, do this: the repulsive force, with all the characteristics which we have discovered in it, is yet only a hypothesis which accounts at once for the figure of comets and for the acceleration of their motion. We have connected it, it is true, by the incandescence of the sun, with the familiar phenomena of the repulsion determined by heat between the molecules of bodies; but it remains to show, by a direct experiment, the difficulties of which we have seen, that this repulsion exists beyond the infinitely small distance which separates these molecules. This experimental verification of every hypothesis is an essential thing in astronomy; by this alone can our minds be fully convinced. The physicist, on the contrary, can use more largely the convenient artifice of hypotheses, since he holds in his hand, so to speak, the phenomena which he studies, may reproduce them, call them forth at his pleasure, and regard his subjects in all their aspects. Should an hypothesis be found to contradict certain facts, the physicist imagines for them another more comprehensive which he will subject to the same process. It is not so with astronomy. That which has long been wanting to the theory of attraction in the case of many minds strongly prejudiced, moreover, in favour of another doctrine, is precisely this direct and experimental verification the necessity for which I have pointed out. Everybody did not feel, on the appearance of the *Principia*, that it was implicitly contained in the famous calculus which enabled Newton to see that the force which holds the moon in its orbit is identical with that which every-

Fig. 16.

* Moreover, the least want of homogeneity in the nucleus and a rotatory movement may considerably modify the phenomena and leave only the narrow part of the anterior calyx. But these anomalies do not take away from the phenomenon its characteristic physiognomy, even when they give, or example, to the anterior calyx, a most curious radiated aspect.

where causes bodies to fall to the ground. The learned opponents of the doctrine on the Continent would, without doubt, have been favourably disposed to it before the experiment of Cavendish or that of Maskelyne, if Newton had been able to realise to them so as to show to all eyes that bodies of suitable form and of any nature whatever attract each other in proportion to their mass and in the inverse ratio of the square of their distance.

But how are we to apply the Cavendish balance to the measurement of the repulsive force of an incandescent surface? First of all, the materials of our apparatus are of a density enormously superior to that of comets; then it is necessary to operate in a perfect vacuum, for the least trace of air which remains in the apparatus will give rise to currents under the influence of a surface strongly heated, and will thus obscure the effect which we endeavour to establish. In trying to surmount this difficulty,* I have been led to think that if I could make an incandescent surface act upon the small mass of air itself which acts as an obstacle to us in the vacuum of our best pneumatic machines, I should obtain a very appreciable repulsion; only we must find some means of rendering this air visible. The artifice to which I am about to have recourse before you consists in illuminating this rarefied air by means of the spark of Ruhmkorff's induction apparatus. (See Fig. 17.) This glass bell-jar, in which a vacuum has been made, is traversed by the two conductors of the apparatus, the one vertical and the other horizontal. You see the spark spring out under the form of feebly luminous stratifications of a peculiar rose colour; at the same time the horizontal conductor is covered with a luminous sheath of a well-marked blue colour. It is the air which is thus illuminated by the passage of the current. Remark, however, the particular form of the horizontal wire; it is formed partly of a thin blade of platinum surrounded by a blue aureole. I shall redden this plate by means of an ordinary current, composed of several Bunsen couples. I cause this current to pass through the horizontal conductor, not disturbing in the least the first induction current. The platinum plate becomes incandescent, and you soon see the blue-coloured sheath separate from the platinum plate like two lips which are parted.

I have varied this experiment to obviate the objections to which the increase of the conductibility of the air might give rise; but it has always succeeded. Thus have I obtained an analogous repulsion by acting transversely upon the rose-coloured stratifications; the case was absolutely the same as if a perfect vacuum existed around the plate, a vacuum of definite limits beyond which the electricity would not pass, while an increase of conductivity would simply cause the induction-spark to incline towards the favourable region and so to modify its usual configuration.

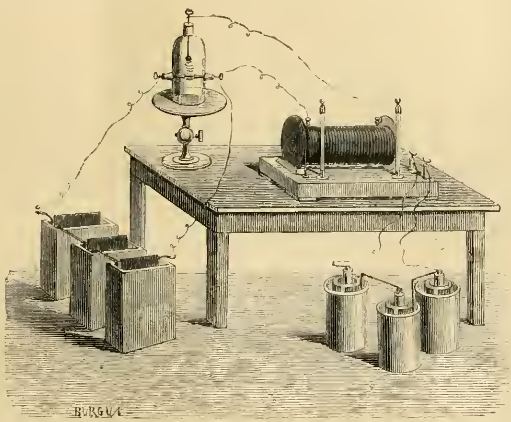


Fig. 17.

Thus have we been led to conclude with perfect certainty (1) that cometary phenomena reveal to us in the universe the existence of a second force totally different from attraction, capable of playing an important part and producing before our eyes gigantic phenomena; (2) with great probability, that this force is nothing else than the repulsion due to heat.

Perhaps we may come upon this force when we investigate more closely the strange phenomena of the solar protuberances which the brilliant discovery of Janssen and Lockyer permits us henceforth constantly to follow, or when science will be in a condition to approach the investigation of those mysterious star clusters which attraction has not been able to unite into a single sun, and which appear to us under forms so strange and withal so geometric.

Whatever may be the value of these experiments, it is of importance, I believe, to science, not to leave this beautiful question of the figure of comets without any other answer than the *je ne sais* of Arago, and it is of not less importance to natural philosophy to prove that the forces which rule the stars are none other than those which act around us at the surface of the earth. If it should displease any sage metaphysician that I have tried to establish a duality of forces in a region where he vainly flattered himself that unity reigned, I pray him to consider that, if it is possible to transform, so to speak, certain forces into each other, to produce, for example, heat by means of the concussion of a body acted on by terrestrial attraction, then electricity by means of this heat, magnetism by means of this electricity, and finally to attract a very peculiar sort of matter by means of this magnetism, we have not succeeded in the least in transforming the attractive force of the least molecule, since its weight remains invariable through all the modi-

* We could assuredly manage it, but it would be necessary to have at our disposal means of execution superior to the resources of a private individual.

fications of the forces which act upon it. The desired unity, then, was far from being realised before the appearance of that repulsive force acting at a distance which the cometary phenomena definitely inscribe in the mechanism of the heavens by the side of attraction, and which I find around us in the phenomena of heat.

At all events, we have got a great way from that judicial astrology which I felt bound to remind you of at the outset, in order to show to you the condition in which we found that branch of celestial science. While, in planetary astronomy, scarcely anything has been done for two hundred years but to develop indefinitely the mathematical formulæ of a force established and defined, we have tried here to put ourselves on the track of a force which rules more especially the cometary world, and have endeavoured to give it a name.

THE AMERICAN OYSTER-TRADE

SOME notion of the extent of the trade in oysters at Baltimore may be gathered from a recent report of the British Consul. Baltimore, it is said, is recognised all the world over as the great centre for raw oysters—New York as well as the Southern and Western States depending on it for their supplies. The packing-houses in Baltimore have agencies in all the large cities and towns, and these agencies have sub-agencies covering the country districts. About twenty firms are engaged in the packing and distribution throughout the States of raw oysters, 5,000,000 bushels of which are annually consumed to meet the demands of the trade, which is one not only incurring great risks, but also requiring some tact for its successful management. Such is the perishable nature of the oyster that the risk in handling them has much to do in determining their price. Delays in the arrival of a vessel will often cause a whole cargo to become putrid, so that it has at once to be thrown overboard. To cover these risks the margin of profit is necessarily large. Large numbers of men, women, and children are employed in opening the oysters and removing them from their shells: for this work they receive 20 cents per gallon, and the average earnings of each person are about two dollars per day of ten hours.

In packing the raw oysters they are, after being opened, washed carefully, then placed in flat cans with a little fresh water, as the liquor or natural juice of the oyster decomposes in twenty-four hours after exposure. These cans are then packed in rows with cakes of ice between them, and shipped by express to their destination. At certain points it is arranged that these cases destined for the far west shall be opened, fresh ice placed between the cans, and then re-shipped to their ultimate destination. Oysters packed in this way and re-iced at certain places on the route can be sent from Baltimore to San Francisco in good condition. Besides this trade in raw oysters as many as 3,000,000 bushels are annually steamed and hermetically sealed in tins for shipment to all parts of North America and to Europe. The season lasts from Oct. 1 to April 1. By the steaming process the oysters are so preserved that after being sealed down they will keep good for an indefinite period of time.

RUDE STONE MONUMENTS OR CHAMBERED BARROWS

I.

THE object of the present and succeeding articles is to discuss some of the opinions which are held by some of the leading antiquaries of the present day with respect to the construction, destination, and also antiquity of these monuments, and to show that, notwithstanding all the advantages presented by the establishment everywhere of Archæological Societies, the publication of their journals, and the increased facilities for travelling, many professed students of this branch of science are still found to be blindly adhering to the views of antiquaries of the past century. There is a very remarkable contrast between the progress made in the study of unchambered, and in that of chambered, barrows. We have now a much sounder knowledge of the former than of the latter, not simply because the latter are more difficult to understand, but because their study requires qualifications not possessed by every investigator. He must have long acquaintance with the monuments, sufficient dexterity in drawing and surveying to make accurate plans, sections, and elevations, be a close and unbiassed observer, and then have leisure to devote his intelligence to the scrutiny. Cursory examination will be always fatal to the acquisition of sound knowledge, and serve to mislead others; and it is greatly to be feared that this has been too common a habit and result.

The first erroneous opinion to which attention is now directed is that very many of the cromlechs or dolmens (to employ terms which are in general use), *i.e.* rude stone structures which in the British Islands and on the Continent are partially or wholly exposed to view, were never in any other condition; that is to say, that although they may be in some measure dilapidated now, yet that they were originally intended to be exposed buildings. They are aware that many other structures of analogous forms are imbedded or enveloped in mounds so as to be invisible externally, but they will not allow that the exposed ones ever were so. As long as these authors confine themselves to the bare declaration of their belief their position is not so assailable; but when they point to the monuments which they say illustrate their arguments the case is altered. The examples are open to the inspection and consideration of everybody, and the accuracy of their descriptions can be tested. This has been done, and the result has been that numberless inaccuracies have been detected in the published accounts and in the plans; and the conclusions which have been deduced from them are consequently pronounced to be erroneous.

It will be sufficient to point out this in a few of the well-known monuments to which they have directed our attention; and as no author has treated the subject so comprehensively as Mr. Fergusson, or been so methodical in the arrangement and classification of the monuments, his recent work * will be particularly referred to in the following pages. He has admitted that he is indebted for much of his information to the published accounts of others. It must be premised that we do not assert there is positive *proof* of the former existence of the mounds, nor do we say that there is any tradition of them, but we say that when the exposed monuments are compared with those which are wholly enveloped, and with those numberless instances in which the traces, in many examples very extensive traces, of the mounds still exist, the fair and legitimate inference is that these so-called "free-standing" structures † were once monuments of the same class as the others, and that they are only in a more advanced stage of decay at the present time.

We go a step further, and say that there are so *very few* instances in which no trace whatever of a mound remains that the argument from inference is greatly strengthened. Have the advocates of the theory ever attempted to sum up *carefully* all the examples of *total* denudation? It has been remarked by the author of "Rude Stone Monuments in all Countries," p. 44, that "probably at least one hundred dolmens in these islands could be enumerated which have not now a trace of any such envelope." There is a confidence in this statement which invites scrutiny, and we venture to say at the outset that it is far from being accurate, for we know that

* "Rude Stone Monuments in all Countries, their Ages and Uses."

† These are defined to be dolmens which were never intended to be hidden in any earthen covering, and about which no trace of a mound exists.

traces of mounds which in some instances no longer exist are upon record, and there is no reason for doubting the record. Immediately following the above statement, a well-known monument is brought forward as one of the unmistakeable hundred examples, and the remark is made that Kits Cotty House, near Aylesford, in Kent, "is exactly now where it was when Stukeley drew it in 1815, and there was no tradition then of any mound ever having covered it," and "we cannot now find a trace of it." But if we pass on to p. 116, where the monument is again mentioned, we find it said, "If we can trust Stukeley's drawing, it was an external dolmen standing on the end of a low long barrow," "the mound has since been levelled by the plough," and "I am inclined to place faith in the drawing." There is no tradition, it is true, of any mound having *covered* it, but how any faith can be put in the drawing, and yet it can be said that the mound has been levelled, which, it is implied at p. 44, never existed, is beyond comprehension. According to Stukeley, therefore, there was not only a trace of the mound, but its form was in his time determinable, and the stone chamber was situated near one of its extremities. This agrees admirably with the construction of many other chambered long barrows where we see the chamber either wholly or in great part enveloped. This monument, therefore, should not be included among the obvious hundred examples.

Pentre Ifan, in Pembrokeshire, is also brought forward by the same author as another remarkable example in support of the "free-standing" theory. He describes it very briefly and inadequately in pp. 168, 169, and compares it with those which "were, or were intended to be, covered with mounds." There is, he thinks, a very wide difference between it and them, for the latter, he admits, are enclosed sepulchral chambers, whereas as regards the former it never could have been erected to be hid, and "besides that, the supports do not and could not form a chamber. The earth would have fallen in on all sides," &c. Unquestionably there would be much to favour the theory, if it could be granted that the monument is in the same condition now as it always was; but it is known for certain that this is not so. There is, fortunately, a description of it written by Owen more than 200 years ago, and there is also another account by Fenton as it appeared in his day, about seventy or eighty years since, and from these we learn that the aspect of the monument was totally unlike what it is now. There were then eight or nine upright stones under the great roofing stone, now there are only three; then there were the remains round about it of a stone circle 50 ft. in diameter, not now existing; and according to the late Rev. H. Longueville Jones, there were traces, when he saw it, of the original mound. Of the eight or nine upright stones, two, or at most three, supported the capstone, which will easily account for the removal of those which gave it no support. So that in this instance, also, here is a monument which should be excluded from the hundred examples.

On a careful inspection of Plas Newydd, another of the hundred, it will be found that there is evidence both of the encircling ring of stones and of a mound.

It would not be necessary to enter into these particulars but for the oft-repeated assertion of Mr. Fergusson, "no trace of the mound can now be found either around the stones or in the neighbourhood," which is expressed in various ways, and by which he conveys the impression that no mound ever existed; and for the argument which this belief is made to sustain, an argument which we think strongly militates against the idea that all these monuments were destined for sepulchral purposes.

Before passing on to monuments of other lands it will be well to point out the error of one who, with every desire to advance archæological science, has been misled by the classification adopted by Mr. Fergusson. It will not be out of place to do so here, because the views of the writer of the present article have been assailed * by this young Cornish antiquary, who has been carried away by his zeal. In order to give support to the "free-standing" theory he enters into a description of Lanyon Quoit, a dolmen standing in the parish of Madron, Cornwall, which he thinks fully establishes it, an opinion shared by Mr. Fergusson (p. 163). But Capt. Oliver, R.A.,† has convincingly shown that the monument is not now in the condition in which it used to be; that it has been rebuilt and the position of its supporters have been altered; that these original supporters were stout stone slabs (4 ft. wide by 1 ft. 6 in. thick), and not slim pillars; that whereas there are now three, there were four upright slabs in old Mr. Borlase's time; that two more slabs are lying prostrate close to the others, which it is fair to presume were once upright walling stones of the chamber; and that the monument stands as much *in* as *on* a long mound, which bears every appearance, he adds, of having been a long barrow. It ought therefore to be struck off the list also.

Arthur's Quoit, in Gower, according to Mr. Fergusson, was probably always "free-standing;" but both Sir Gardner Wilkinson ("Archæologia Cambrensis," 1870) and the Rev. E. L. Barnwell have expressed the contrary opinion. The former believes it to have been covered with a tumulus, and the latter writes, "there are cart-loads of stones still remaining, and so little disturbed in position that their outline gives that of the base of the once existing mound." This monument therefore may rightly be excluded from the list.

The elder Borlase describes very accurately all the most remarkable exposed monuments existin , in Cornwall in his day, and speaks of the traces of their mounds in every case, *e.g.* Mulfra Quoit, in the remains of a stone barrow; Bosporthenis Cromlech, once in a mound of stones and earth; and Zennor Cromlech, once in a stone barrow.

According to Norden, who described Trevethy Cromlech in 1610, it was "standing on a little hill within a feilde." ‡ Lower Lanyon chamber was discovered in 1790 in a bank of earth and stones; and only one upright stone and the fallen capstone now remain. Pawton Cromlech is still partly "buried in the tumulus which no doubt formerly covered the whole" ("Nænia Cornubia," p. 32). Chywoone or Chûn Cromlech was in a barrow or cairn, 32 ft. in diameter (ibid., pp. 56, 58), and the author of this book says that it so closely resembles a dolmen at Moytura, Ireland, and another at Halskov, in Scandinavia, that the drawings of one might pass for those of the other two. This is a repetition of Mr. Fergusson's remark §—the monument "at Halskov is so like the dolmen and circle represented in woodcut 61 that the one might almost pass for the other."

The "free-standing" theory receives no support whatever from the monuments of the Channel and Scilly Islands, nor yet from those of the Isle of Man, so that the area of the British Isles is circumscribed within which the more than hundred examples are to be found. England, Wales, Scotland,¶ and Ireland contain a large number of rude stone monuments, and the area is sufficiently wide to produce as many as Mr. Fergusson supposes. But it would be a most difficult—we should say a hopeless—task for anyone to attempt to enumerate them and to hand in the required tale.

The writer of the present article has examined the group of monuments known as those of Beni-Messous, or El-Kalaa, in Algeria, and planned several of them. They are all of similar construction, and are simple cists, averaging about 7 ft. by 2 ft. 6 in. (internal dimensions)

* NATURE, vol. viii. p. 202. † Ibid p. 344.
‡ For account and drawings see "Nænia Cornubia," pp. 46, 47.
§ Op. cit, pp. 304, 305.
¶ At p. 240, Mr. Fergusson says—"The free-standing dolmens are few and far between, some half-dozen for the whole country," which again diminishes the area.

without galleries. These cists point east and west, with slight variations, and are built with unhewn stones of the locality—tufa and pudding-stone. The mounds, which in a few instances remain intact, are small and of stone, and the chambers which are visible are in various stages of dilapidation and exposure, traces of the mounds being clearly indicated by the quantity of loose stones which are round about them. The place has served for many years as a convenient quarry for the Trappist monks of Staouli, and for the French colonists who have located themselves at Guyotville and Cheragas. If it had not been for a Government order the whole of these monuments would have been carted away for the sake of their building materials. When first discovered they are said to have numbered about 100; about 30 are now left. They are scattered over an area of a few acres, and are arranged without any regularity; and at the period of their completion must have presented a remarkable collocation of stone heaps. The late M. Berbrugger, who was Inspector-General of Historical Monuments in Algeria, was the first to make their existence known, about thirty-seven years ago. Dr. E. Bertherand, the present secretary of the Algerian Acclimatisation Society, has described them in a pamphlet printed by that Society. In 1859 Mr. A. H. Rhind communicated an article upon them to the Society of Antiquaries, London, which is printed in "Archæologia," vol. xxxviii. M. René Galles, the well-known explorer of Brittany dolmens, has also written about them; and the late Mr. J. W. Flower, who visited the spot in 1868, has compiled an article from the foregoing pamphlets, which he read at the International Congress of Prehistoric Archæology held at Norwich in the same year. All these writers have classified them as covered and uncovered tombs, implying, if not asserting in so many words, that the latter had never been covered; *i.e.* "free-standing." Mr. Fergusson has followed their lead, and adopted their classification; but a careful inspection of each exposed monument will convincingly prove that the stone heaps which surround them strongly testify against the theory.

When, however, our attention is directed by Mr. Fergusson to continental examples our astonishment at the glaring inaccuracies and contradictory statements is increased, and we wonder that several well-known monuments should have been brought forward to support a theory which their prominent features most clearly refute. There are two in the south of Brittany which have been described by him as belonging to the uncovered class, viz. Dol-ar-Marchand at Locmariaker, and Courconno, in the parish of Plouharnel. Of the latter, he says, "it certainly never was covered up" (p. 343). This is a plain and positive assertion; yet a few pages further on (p. 363) he writes doubtfully, if not contradictingly, on this point: it is "a magnificent cist, walled with rude stone, and such as would form a chamber in a tumulus if buried in one, though whether this particular example was ever intended to be so treated or not is by no means clear." Of the former he writes, it is "the most interesting, if not the finest, free-standing dolmen in France," and "the great stone, like that of most free-standing dolmens, rests on three points, their architects having early learned how difficult it was to make sure of their resting on more. So that, unless they wanted a wall to keep out the stuff of which the tumulus was to be composed, they generally poised them on three points, like that at Castle Wellan."

The question bears quite another aspect, however, when these monuments are carefully inspected, and the treatment they have received at the hands of the inhabitants of late years is inquired into. We thus ascertain that the great dolmen of Courconno is in a very different state now from what it was in 1847, when drawn and described by Cayot-Delandre, the historian of the Morbihan, and that it has been further curtailed of its proportions since 1854. It was then not a mere cist of gigantic size but a huge chamber to which a long covered way or passage was attached, the dimensions of which are given; and there were also traces of the enveloping mound, some of which still exist.

So, too, with regard to the great dolmen of Dol-ar-Marchand, it is not at all as described by Mr. Fergusson. Its chamber has also a long covered way attached to it, which fact he does not mention; both the chambers and the covered way are buried to a depth of several feet in the remains of a circular mound which can be measured: and regular walls line the chamber and the covered way for the express purpose of keeping out the earth composing the tumulus. All these features are incontestably visible. These monuments, therefore, do not sustain the theory.

There are other well-known examples of exposed monuments in France, respecting which a great deal might be written to invalidate the "free-standing" theory. The above will be sufficient to show upon what a weak and indefensible basis it rests.

The theory is supposed, however, to receive the strongest support from a singular monument near Confolens, near St. Germain-sur-Vienne, which is also thought to have been erected as late as the tenth or eleventh century of the Christian era. It is considered of such great importance that it has been engraved and stamped in gold upon the cover of the book which has been so often referred to. It will not be right, therefore, to pass it by. The monument is really a remarkable one, and merits a most careful study on the spot. Owing to its situation in a most out-of-the-way part of France, which entails a very fatiguing journey to reach, few archæologists have had the temerity to undertake the journey, and very few Englishmen have seen it. At a first view it is a very staggering example, but on investigation its simple history unfolds itself in a convincing manner, and quite upsets Mr. Fergusson's conclusions. In brief, it is an ancient sepulchre which has been altered and converted to another use many centuries later. The covering stone is the only remaining relic of the primitive building, and there are incised designs upon its under surface, which point to its early age and use. These designs have only been recently noticed, and the tale they disclose is unmistakeable. This monument was most certainly not a "free-standing" one in the sense implied by Mr. Fergusson, nor was it originally erected at the period he supposes.

The "free-standing" theory, having been adopted, required further confirmation than the external appearance of the monuments was supposed to give it, and its advocates have considered that it is strengthened by the "impossibility of accounting for the disappearance of the mounds," and Mr. Fergusson has followed in the wake of Baron Bonstetten,* whose accuracy of observation does not seem to have been of a high order, and has adopted his language. The Baron says that both Brittany and the Department of the Lot are "pays à dolmens apparents par excellence," by which he means, as he afterwards shows, dolmens which are now as they have always been. This observation proves that he must have given them a very cursory examination. His objection to the tumular belief is thus stated:—"Les dolmens se rencontrent les plus souvent dans des landes incultes et impropres aux défrichements par la nature même du sol. D'ailleurs, dans un but de nivellement on ne se bornerait pas à enlever le tumulus, mais on détruirait encore le dolmen. Les pierres seraient utilisées ou on les enfouirait assez profondément en terre pour qu'elles ne heurtent pas le soc de la charrue," pp. 7, 8. This objection he applies to both the Brittany and the Lot monuments; but what are the real facts? Very many, indeed the larger number, of the dilapidated or partially covered monuments of Brittany are not far from habitations, and although they may

* "Essai sur les dolmens," Geneva, 1865.

stand on uncultivated plots of ground, are surrounded by cultivated lands which are inclosed by loose stone walls. Again, numbers of chambered mounds have been wholly swept away and the materials utilised within the memory of man. Others have been partially removed, and the stone chambers reduced to ruinous heaps; and in some cases, as is well known, deep holes have been dug, and the obstructing blocks buried. And this work of destruction, which is still going on in spite of the prohibitions of the French Government and the legal penalties threatened, has been in operation for centuries. Ought not the knowledge of these facts to have been acquired by the authors, and have made them hesitate before attempting to classify monuments according to their present aspects, without carefully taking into account every possible circumstance connected with the past history of the localities in which they are situated?

Another Continental writer * has fallen into the like errors through the objectionable practice of following in the track of other authors, and seeing with others' eyes. M. da Costa, following the lead of Baron de Bonstetten, has adopted the classification of these monuments into (1) "dolmins apparentes," (2) "dolmins occultos," and (3) "dolmins construidos sobre um monticulo artificial," against which last class we shall raise a vehement protest by and by.

It results from what has been said, that what is really needed when treating of rude stone monuments is perfect accuracy of description and no omission of any detail or feature which may reasonably be supposed to be connected with the structures. Important omissions of this nature frequently occur, not intentionally, but because of the defective archæological education of the writers, and their want of experience. It is very damaging to the cause of scientific truth when such a theory as the one here exposed is asserted to be supported by examples which really tell against it. Our antiquarian ancestors, who knew very little respecting these monuments, and had few opportunities of comparing them with others in distant localities, who did not know what their true construction and destination were, and mistook the weathering effects on the capstones for channels artificially made, called these structures Druids' Altars, and invented horrible stories of human sacrifices. Assuredly, if it be once admitted that there were "free-standing" monuments which were never inclosed in mounds, then their views may not have been so very far wrong, and some of these buildings may, after all, have been erected for altars of sacrifice. There would be very little proof that they were intended for burial-places. The difference between them (especially those which one author describes as resembling "three-legged milking stools," and another calls "tripod dolmens") and the carefully covered ones, out of whose vaults the earth of the mounds is thoroughly excluded by means of walls of dry masonry, is so great and so striking that the exposed ones could scarcely be with any certainty declared to have been tombs. There is abundant evidence betokening what the covered ones were destined for, and hardly more than a mere assumption as regards the others.

W. C. LUKIS

(*To be continued.*)

NOTES

As usual at this season, scientific congresses are coming thick upon us. The British Association commences its sittings next Wednesday at Belfast, when Prof. Tyndall will give his presidential address. The French Association, as we have said in another column, holds its session at Lille contemporaneously with our own. The British Medical Association commenced its yearly meeting at Norwich on Tuesday, when Dr. Copeman, the president, gave his address; and the British Pharmaceutical Conference brought its eleventh annual meeting to a close in London on Saturday last. The tone of the presidentiai address by Mr. T. B. Groves, F.C.S., at the last-mentioned meeting, as well as that of Mr. F. J. Bramwell, F.R.S., on the 4th inst. at Cardiff, to the Institution of Mechanical Engineers, was, we are glad to see, decidedly in favour of a more thorough education of those who desire to enter upon these callings in the scientific principles which underiie Pharmacy and Mechanical Engineering. The British Archæological Association at Bristol have been working hard and well in their own interesting department. It has become the fashion in certain quarters to speak slightingly of these annual meetings as being meetings for mere talk and enjoyment; they may be so, but it seems to us that, on the whole, the proceedings prove that much really good hard work is being done year after year in all scientific departments; and it is surely something gained that scientific congresses should have come to be regarded as "popular," and should have all the important cities in the kingdom eager for the honour of their presence.

THE following are the titles of the Evening Discourses to be given at the Belfast meeting of the British Association:—Friday, Aug. 21, by Sir John Lubbock, Bart., F.R.S., "On common Wild Flowers considered in relation to Insects;" Monday, Aug. 24, by Prof. Huxley, Sec. R.S., "On the hypothesis that Animals are Automata; and its history."

THE following foreigners and members of the British Association, among others, have signified their intention of being present at the meeting in Belfast:—Dr. Schweinfurth, Prof. Knoblauch, Prof. Gluge, M. Khanikof, Prof. Delffs, M. Bréguet, Prof. Stoletoff, M. Mannoir, Dr. Williamson, Dr. Hooker, Prof. Stokes, Prof. Adams, Dr. Tyndall, Lord Rosse, Prof. Tait, Prof. Clerk Maxwell, Prof. F. Fuller, Lord Enniskillen, Lord O'Hagan, Prof. Jellett, Mr. Huggins, Dr. Balfour, Dr. Carpenter, Prof. Huxley, Dr. Crum Brown, Prof. Herschel, Prof. W. G. Adams, Mr. Stoney, Dr. Roscoe, Dr. Maxwell Simpson, Prof. G. Foster, Mr. Young, Prof. Hull, Prof. Geikie, Prof. Harkness, Major Wilson, Dr. Odling, Sir John Lubbock, Mr. Bramwell, Prof. James Thomson, Mr. Crookes, Dr. Gwyn Jeffreys, Admiral Ommaney, General Strachey, General Smythe, Col. Strange, Capt. Galton, Mr. Spottiswoode, Prof. Michael Foster, Mr. Ray Lankester, Prof. Clifford, Mr. T. W. Glaisher, Mr. F. Galton, Dr. Pye Smith, Mr. Rodwell, Mr. Chandler Roberts, Prof. Rowney, Prof. Corfield, Dr. W. Farr, Col. Grant, General Alexander, Col. Home, General Jenkins, Capt. Jenkins, Lieut. Conder, Major St. John, Dr. Debus, Mr. Paxton, Mr. Seeley, Prof. Thorpe, Prof. Thiselton Dyer, Mr. Miall, Mr. Symes, Mr. Corbett, Mr. Shoolbred, Mr. Thomas, &c.

DR. COPEMAN, in his presidential address at the Norwich meeting of the British Medical Association, spoke of the impossibility of regular practitioners being able to engage in pure scientific research. "All persons engaged in physiological research," he said, "ought to be provided with sufficient means to enable them to devote their whole time and attention to their work, without the cares and troubles of practice; while, on the other hand, those who were engaged in the great and paramount object of curing disease could not possibly spare the necessary time for minute physiological investigations. Each, however, could materially assist the other; the practitioner could furnish facts and observations which might greatly assist the physiologist in his experiments, and the latter could enlighten the former by giving reasons for the facts presented to his notice. The majority of medical men must be practitioners and earn their living by practice; but he hoped that in a society like the British Medical Association means would before long be found to supply the

* "Descripcao de alguns Dolmins ou Antas de Portugal," por F. A Pereira da Costa. (Lisboa, 1868.)

necessary funds to a certain number of gentlemen with young and healthy minds congenial to the work to enable them to devote their time and energies to physiology as a separate study."

IN many French daily newspapers predictions of the future weather have been recently given, which were attributed to the Paris Observatory. Although the Observatory, however, published nothing on the subject, the statement was so widely believed that M. Leverrier felt it necessary to protest against it in his *Daily Meteorological Bulletin*. French meteorology, as we recently intimated, is undergoing a reorganisation in consequence of the vote of the Council of the Observatory. No final decision has been arrived at, although we learn on M. Leverrier's authority that a decision may be speedily expected. We hope to be able to give details when the arrangements have been finally made.

THERE is some hope that an Arctic expedition of discovery may be despatched in the spring of 1875. The Prime Minister has undertaken to consider the subject carefully in all its bearings, and on the 1st of this month the presidents of the Royal Society and of the Royal Geographical Society, accompanied by a gallant admiral of long Arctic experience, had a preliminary interview with Mr. Disraeli.

THE French Alpine Club has sent a party of ten young men under the guidance of M. Albert Tissandier to travel on the Alps and draw up a report of their excursion; others will be sent next year, this being the inauguration trip of the society.

FROM a recent report on the trade of Bremen we learn that a branch of industry, which is gradually increasing in importance, has arisen of late in the barren moorlands of North-western Germany by the preparation of peat or turf. This material is largely used in Germany as fuel both in private dwelling-houses as well as in some large establishments, and, it is stated, also on the Oldenburg Railway. Two companies have lately been formed in Oldenburg for the purpose of manufacturing peat on a large scale, and of supplying it to the inhabitants of Bremen, Oldenburg, and other towns in the neighbourhood, at a far cheaper rate than that now paid to the peasants, who have hitherto almost had a monopoly of the trade in this article. The peat is cut out of the soil of the marshy moors or bogs which extend from Bremen to the Dutch frontier, by machinery; by the removal of the peat a network of canals is formed, which are of use for conveying the peat itself to market, and which likewise form new permanent channels of communication available for all other purposes. The peat-cutting machine consists of a large flat-bottomed steam-vessel, which, when set to work, is able to cut a canal 20 (German) ft. in breadth and 6 ft. in depth, whilst proceeding at the rate of from 10 to 12 ft. per hour. The soil thus cut out by this floating peat manufactory is lifted into the vessel by steam power, and after being thoroughly ground is deposited, by means of a long pipe running out of the side of the vessel, alongside the bank of the canal, where it is subsequently cut into the shape of bricks and dried. It is stated that by this method about 1,000 centners (55 tons English) of a very good kind of peat may be manufactured per day. In view of the present high price of coal, particularly in Britain, and of the great importance which attaches to the question of obtaining a cheap kind of fuel at all times, it might perhaps be well worth while to consider whether this system of peat manufacture could not be introduced in many other parts of Europe, where the soil is doubtless as well suited for the purpose as in Oldenburg.

IN the *American Journal of Science and Arts* for August, Prof. A. W. Wright, of Yale College, describes his polariscopic observations of Coggia's comet. On the evening of July 6 the polariscope showed the bands, both bright and dark, quite definitely, and they were seen with comparative ease. Observations repeated a number of times agreed in showing that the light was polarised in a plane passing through the axis of the tail, that is, as nearly as could be estimated, in a plane passing through it and the sun. Other observations made on the evening of July 14, when the sky was quite clear, gave the same result, though less satisfactorily, as the twilight had begun to interfere with the observations. After waiting until this had disappeared, it was possible to see the bands, though with some difficulty, and the degree of the polarisation appeared to be decidedly less than on the previous occasion. The circumstances were too unfavourable to admit of any determination of the percentage of light polarised, but it was certainly not large. The fact of polarisation shows that a considerable portion of the light of the coma is derived from the sun by reflection.

A COMPANY has been formed to work the sulphur deposits at White Island, a marine volcano 140 miles from Auckland. It is estimated that 100,000 tons of sulphur in an almost pure state are lying on the island ready for shipment. Chemical works are likely to be established soon, and the island leased.

A NEW university will be opened at Agram, in Croatia, in October next. It will have the name of the "Francis-Joseph University."

H.M.S. *Shearwater* left Capetown on July 14 for Mauritius, with the members of the expedition who are to observe the Transit of Venus from that island.

DETAILS appear in the *Times* and *Daily News* of the expedition of H.M.S. *Basilisk*, which, as we have already (vol. x. p. 215) intimated, has been exploring the north-eastern shores of New Guinea. The ship had arrived at Singapore at the end of June, the expedition and the survey of Goschen Strait and the coast from East Cape to Cape Rigny, of the Astrolabe Gulf—about 500 miles—having occupied four months. Lieut. Dawson was to return on July 15 by Torres Straits to Sydney, whence he proceeds to Fiji to survey and report upon the harbours and passages. Riche—the island of D'Entrecasteaux, who visited these coasts in search of La Perouse in 1793—was found not to exist now. To the large D'Entrecasteaux group the names of Normanby, Fergusson, and Goodenough were given by Capt. Moresby. The coast was varied in feature, being at times bold and steep, with lofty mountains, at others low and wooded, with off-lying coral banks and dangers. The natives became less friendly as the expedition went westward. Venomous snakes were found, but no wild animals. About 300 miles westward of East Cape the natives were stark-naked and more debased. Collections of implements, articles of dress, and ornaments were obtained in great quantities; among the former, tortoise-shell axes and models of the war canoes. A few botanical and natural history specimens were obtained by the medical officers, as well as a rough vocabulary of the language. At Amboyna (Dutch settlement) the *Basilisk's* officers met Mr. Alexander Miclucho Macleay, the Russian traveller, who had recently returned from the north-west coast, where the natives had been hostile and had eventually ousted him. Full of zeal in his work, he had overdone it, and was suffering at Amboyna from scurvy, and afterwards erysipelas. The Dutch medical authorities thought his condition serious when the *Basilisk* left Amboyna. The surveys of the *Basilisk* have opened up a new route to Sydney, which is 280 miles shorter than the shortest previously known route.

MR. HENRY SKEY, of the Observatory, Dunedin, Otago, New Zealand, writes in reference to the mention which is made in NATURE, vol. vii. p. 25, of Prof. Capocci's idea of constructing a revolving mercurial speculum for a reflecting telescope, that he would like to know if such an instrument has actually been constructed. The same idea, Mr. Skey states, presented itself to

himself, and he also constructed a telescope on this principle many years ago in England without knowing that the method was engaging the attention of others. He sends an account of a mercurial reflecting telescope exhibited by him before the New Zealand Institute, Nov. 19, 1872, which is published in the Transactions of that Institute, vol. v. p. 119.

THE *Times* of Monday and Tuesday contains some interesting details concerning Col. Gordon's African Expedition from one of his staff. The latest date is June 18, when the various detachments were in boats on the White Nile, making the best of their way to Gondokoro. One of the objects of this expedition, as our readers no doubt know, is to carry out the work so well begun by Sir Samuel Baker in the suppression of slavery. Col. Gordon expects to have steamers on Lake Albert Nyassa by November next; and the Rev. H. Waller, writing in the *Times*, states that by taking the Suez, Souakim, Berber, and Khartoum route, it is quite possible to reach Gondokoro in forty-eight days from England, including a week's rest at Khartoum.

IN the "Tijdschrift voor entomologie nitgegeven door de Nederlandsche entomologische vereeniging" is a useful paper On *Acentropus* (Curt.), by Mr. Ritsema. He refers to the passage in the preface to the *Zoologist* for 1857: "We have an aquatic section of Diptera, Neuroptera, Coleoptera and Hemiptera; it is in perfect accordance with the known laws of Nature that there should be an aquatic section of Lepidoptera;" and he quotes the opinion given by Dr. Hagen in July 1856, that *Acentropusniveus* is a lepidopterous insect of the family Crambidæ. He then gives in chronological order extracts from writers in different countries who regard *Acentropus* as lepidopterous, and adds in conclusion a list of the streams and ponds where it has been found. Stephens, in 1835, raised the question whether his *Acentropidæ* ought not to be placed under Lepidoptera, but Dr. Ritsema does not quote him.—There is also a continuation of a new catalogue of the Hymenoptera of the Netherlands, by Snellen van Vollenhoven, with localities and list of synonyms. 1,072 species are enumerated, of which 13 are described in full as new to Science.—Dr. Ritsema describes the male of a Xylocopa, of which he says he knows only some eight or nine examples, and of which there is no specimen mentioned in the British Museum Catalogue. He gives two coloured figures.

AN Entomological Club has been formed at Cambridge, Massachusetts, having for its object the mutual interchange of discoveries and observations in regard to entomology. It has been determined to undertake the publication of a monthly organ to be called *Psyche*. This will contain such a part of the proceedings of the Society as are considered of general interest, communications, lists of captures, and especially a *Bibliographical Record*, in which will be given a list of all writings upon entomology published in North America, and all foreign writings upon North American entomology from the beginning of the year 1874. The editor is Mr. B. Pickman Mann, of Cambridge, Massachusetts. The first number contains an article by Mr. Scudder, on the English names for butterflies, and the first part of the *Bibliographical Record*.

WE have received from the Royal Observatory, Cape of Good Hope, "The Cape Catalogue of 1,159 Stars, deduced from Observations at the Royal Observatory, Cape of Good Hope, 1856 to 1861, reduced to the epoch 1860," under the superintendence of E. J. Stone, F.R.S., H.M. Astronomer at the Cape.

WE learn from the *Gardener's Chronicle* that there is to be an exhibition of useful and noxious insects during next month at the Tuileries, Paris. The exhibition commences on the 6th and is under the auspices of the Société Générale d'Insectologie. In a country where the vines are being devastated by *Phylloxera* and where an epidemic disease has been spreading among the silk-worms, the value of such exhibitions cannot be over-estimated.

A PAPER by Mr. N. Whitley, C.E., entitled "The Palæolithic Age Examined," read before the Victoria Institute, has been published (Hardwicke) in a separate form, along with the subsequent interesting discussion, in which Dr. W. B. Carpenter, F.R.S., Mr. John Evans, F.R.S., Mr. W. C. Borlase, Mr. Charlesworth, and others took part.

MESSRS. BLACKWOOD and Sons have in the press and nearly ready for publication, "Economic Geology; or, Geology in its relations to the Arts and Manufactures," by David Page, LL.D.

MESSRS. LONGMAN will shortly publish the following works bearing upon Science:—"The Primeval World of Switzerland," by Dr. Oswald Heer, translated from the German and edited by James Heywood, F.R.S.; this work will be illustrated. "The Sun: an account of the principal modern discoveries respecting the Structure of the Sun of our System," by Father Secchi, translated and edited by Richard A. Procter. "The Star Depths; or, other Suns than ours," by Richard A. Procter. "An Introduction to Experimental Physics," by Adolf F. Weinhold. And a new edition of Dr. Neil Arnott's "Elements of Physics," edited by Alexander Bain and Alfred Swain Taylor.

M. GÖPPERT has issued a little "Guide to the Royal Botanic Garden of the University of Breslau," containing an interesting account of its various collections, and of the most important plants grown in it, illustrated by a map.

WE have received Mr. Ellery's *Monthly Record* of observations taken at Melbourne Observatory in December and January last. The mean temperature in the former month was 67·2°, being 3·6° higher than the last fifteen years' average, and the highest on record with one exception. The highest temperature in the shade was 101·2°, the range in the month being 56·3°.

THE most recently published parts of the new edition of "Griffith and Henfrey's Micrographic Dictionary" bring the work down as far as "Mouth." The publication continues to maintain its high scientific character.

THE additions to the Zoological Society's Gardens during the past week include two Egyptian Gazelles (*Gazella dorcas*) from Egypt, presented by Mr. G. Muscat; four Rufous Tinamons (*Rhynchotus rufescens*) from the Argentine Republic, presented by Mr. Alfred O. Lumb; three Mastigures (*Uromastix sp.* ?) from Persia, presented by Captain Phillips; one Yaguarundi Cat (*Felis yaguarundi*) from South America, deposited.

U. S. WEATHER MAPS

THE *American Journal of Science and Arts* for July contains an article on Results derived from an Examination of the United States Weather Maps for 1872 and 1873, by Elias Loomis, Professor of Natural Philosophy in Yale College.

Prof. Loomis had a number of outline maps of the United States prepared, and on these he traced the tracks of all the storms, whenever a storm-centre could be satisfactorily located, for two successive days, the maps exhibiting, on the aggregate, storm-paths for 314 days. These results were then reduced to a tabular form by measuring with a protractor the bearing of each storm-path with reference to a meridian, and measuring the daily progress of the storm on a scale of inches. This table showed the date of each storm, the velocity of its progress, the direction of its path, together with readings of the barometer before, during, and after a storm, and from it were calculated the following:—The average direction of the storm-paths for two years was 8° to the north of east, and the average velocity wa s 25·6 miles per hour. July is the month in which the course is most south, and October in which it is most north. February

is the month of greatest, and August of least velocity, the former exceeding the latter by 75 per cent. In some instances a storm-centre has remained stationary for twenty-four hours, and in four cases it travelled 1,200 miles in that time. In one case a speed of 57·5 miles per hour was reached. In April 1873 a storm-centre changed its path 360° in 24 hours. Taking into account the actual motion of a storm-centre from hour to hour, it seems that a storm-path may have every possible direction, and the velocity of progress may vary from 15 miles per hour westward to 60 miles per hour eastward.

The fall of rain seems to have a decided influence in modifying the course of a storm-path. The rainfall area is usually much larger to the east of a storm-centre than the west, 500 miles being the average length on the east side. There is a connection between the velocity of the storm's progress and the extent of this rain area—for example, when the eastern extent is 100 miles greater than the mean (500 miles), then the hourly velocity increased 14·9 miles beyond the mean (25·6), but when the eastern extent of the rain area is 100 miles less than the mean, the hourly velocity of the storm's progress is diminished 8·1 miles.

As to the direction in which the rain area is most extended, the axes of the areas were compared with the storm-paths, and gave this result, that the average course of a storm-path for twenty-four hours coincides very closely with the position of the axis of the rain area for the preceding eight hours.

Prof. Loomis says: "The progress of a storm eastward is not wholly due to a *drifting*, resulting from the influence of an upper current of the atmosphere from the west, but the storm works its own way eastward in consequence of the greater precipitation on the eastern side of the storm. Thus the barometer is continually falling on the east side of the storm and rising on the west side, in consequence of the flowing in of colder air on that side."

In order to trace the influence of the wind's velocity upon the progress of storms, Prof. Loomis divides a circle into four quadrants, and by an arrow in each, showing the average direction of the wind, it is at once perceived that there is a strong tendency of the winds inward to the centre of the storm; but the average direction in each quadrant differed from what it would be if the wind revolved in a circle round the storm-centre.

The velocity is greatest in the west quadrant and diminishes in the successive quadrants as we pass round the circle from west by south to north. On each side of the storm's centre the wind blows obliquely inward, and hence it is inferred that in the central region of the storm there is an upward motion of the air, and this is the cause of the precipitation of vapour; that is, the cause of the rainfall.

The average rise of a barometer for twenty-four hours in the rear of a storm is sensibly greatest when the velocity of progress is greatest. Prof. Loomis believes it is possible to predict where a storm-centre will be at the end of twenty-four hours.

His inquiries into the relation between the velocity of the wind and the velocity of a storm's progress have led to the conclusion that at a height of 6,000 ft. in the western quadrant of a storm the velocity of the wind is 68 per cent. greater than the velocity with which the storm advances.

He then considers how to determine whether a storm is increasing or diminishing in intensity, and concludes that when the barometer rises more rapidly than usual as the storm passes by, the pressure at the centre of the storm is increasing; but when in the rear of the storm the barometer rises less rapidly than usual, the pressure on the centre is diminishing or the storm is increasing in intensity. Sections on "The Form of Isobaric Curves," on "The Classification of Storms," and "Where do the Storms which seem to come from the far west originate?" conclude the article.

SCIENTIFIC SERIALS

The Geological Magazine, August.—This number contains five original articles. 1. Notes on fossil Orthoptera related to Gryllacris, by A. H. Swinton. The fossil remains are two from the eocene and three from the coal formation. The two eocene are, *Gryllacris Ungeri* of Heer, and *G. Charpentieri* of Heer. The coal species are, *Gryllacris lithanthraca*, two species, and *Gryllacris* [*Corydalis*] *Brougniarti* (Aud.). In the specimen *G. Brougniarti* there are indications of the "file," on which Mr. Swinton remarks: "We see this ancient instrument of music had already attained to all appearance an efficiency at least thrice that of our modern house cricket, and must have emitted notes that rang widely over the tropical forests that clothed our island in the old days of the coal period."—2. On the Source of Volcanic Heat, by Mr. G. Poulett-Scrope. Four-and-a-half pages are occupied in disavowing the views "saddled" upon him by Mr. Mallet, and in saying that Mr. Mallet's "definition" is a statement of a series of conjectures.—3. On the Glacial Epoch, by Mr. Croll. This is a continuation of the article commenced last month. The probable thickness of the Antarctic ice-cap was then considered, and now the results of the melting of a portion of it are calculated. The Antarctic ice-cap is equal in area to 1–23·46 of that covered by the ocean; therefore 25 ft. 6 in. melted off would raise the general level of the ocean one foot, and one mile melted would raise the level 200 ft. Mr. Croll takes for the time of his calculation the period when cold was increasing in the northern hemisphere and warmth in the southern. The lessening of ice-cap in the southern and an accumulation of ice in the northern would displace the centre of gravity of the earth leading to a rise in the sea-level in the northern hemisphere. This, with the rise resulting from the melting, Mr. Croll calculates would give for the latitude of Edinburgh a rise of sea-level of 800 to 1,000 ft. The supposition of the subsidence of land during our glacial period may therefore, he argues, be dispensed with; and he proceeds to show how this theory avoids many difficulties which the elevation and subsidence theory leads to. Further: the oscillations of sea level resulting from the displacement of the earth's centre of gravity throw light on many obscure points connected with the geographical distribution of animals and plants. For example, during the warm periods the English Channel would be dry land, and during the cold animals might cross to England from the north upon a frozen sea. And still further: if we knew (1) the extent of the general submergence of the glacial epoch and (2) the present amount of ice in the southern hemisphere, we could determine whether or not the earth is fluid in the interior.—4. Geological notes from the neighbourhood of Cairo, by John Milne. The article, which is too long for us to notice, is illustrated by a section and sketch maps.—5. The Red Chalk in Yorkshire, by the Rev. J. F. Blake. The paper principally refers to the occurrence of *Ammonites Deshayesi* in the red chalk, in the pebble-beds below it, at Hunstanton, in the Specton clay, and in the gault of Folkestone. The chalk is a deep-sea deposit, and in the sinking of the land in Upper Cretaceous times the passage beds from the Upper Neocomian to the Aptien were laid down in various areas from various sources. *A. Deshayesi* evidently lingered on during the time these changes were taking place till the red chalk set in in Yorkshire and the gault at Folkestone. —Among the reports is a notice of the Cotswold Club visit to Bath and a *résumé* of a paper, read by Dr. Wright, On the genesis of the oolites.

Proceedings of the Liverpool Naturalists' Field Club, 1873-74, —This club, which is fourteen years old, we are glad to see continues in a flourishing condition as regards members and funds, and has, during the session 1873-74, been doing a fair amount of work. The present number of the Proceedings contains the address of the president, the Rev. H. H. Higgins, at the annual meeting, in which he touches on a variety of topics more or less connected with Natural History; following this is a list, prepared by Mr. Higgins, of all works bearing on the Natural History of the district of Liverpool from 1705 to the present time. The club made ten excursions during the summer and autumn of 1873, and an account of these, with the detailed results of some of them, occupies part of the number. Appended is a list of excursion prizes to be competed for this summer, and the names of last years' winners.

Proceedings of the Winchester and Hampshire Scientific and Literary Society, vol. 1, part iii. (1872-3).—We learn from the Fourth Annual Report of the society that as a consequence of altering the rules so as to admit ladies, several ladies have become members. We are glad to see also that sections have been formed for the special study of botany, entomology, and zoology, and that work has already been done in each of these departments. During 1873, eighteen papers have been read in the society, most of them on subjects connected with science. In an introductory lecture, the Rev. E. Firmstone gives an interesting *résumé* of what is known about the "Star Depths." Among the other papers we would note an ingenious one On the probable origin of flints, by Mr. A. Angell, jun.; "The Heraldry of the World," a long paper, amply illustrated, by Miss Zornlin;

On some of the parasitic fungi common in the neighbourhood, by Mr. F. J. Warner, F.L.S.; Notes on new or rare Hampshire insects, by the Rev. W. Spicer; and an interesting paper on Lapland.

THE *Geographical Magazine*, August.—This number opens with an interesting account, illustrated by a map, of the Cameron African Expedition up to the beginning of the present year. In "The Lufiji River and the Copal Trade," some account is given of recent explorations of the delta of this little-known African river. Capt. Davis continues his notes on the voyage of the *Challenger*, Mr. G. Turner his "Impressions of Jamaica," and Mr. H. P. Malet his "Sign-posts on Ocean's Highway," in which he brings together various theories on the formation of mountains. "Djetyshahr (Eastern Turkestan), its Sovereign and its Surroundings," is the title of a paper, with a map, by Mr. R. Michell. In an article on "The Archæological Survey of India," an account is given of some important discoveries recently made among the Buddhist remains of Bharahut, in the Central Provinces. The number also contains a very interesting account of a recent visit to the Caroline Islands.

Bulletin de la Société d'Anthropologie de Paris, t. viii.—The diminution in the population of France which had taken place between the census of 1866 and that of 1872, and is far in excess of what may be referred to losses in battle and the annexation by Germany of the Alsace-Lorraine territory, has been made the subject of a series of papers by M. Bertillon. The whole subject of the decrease of the population in France is one that is necessarily engaging the attention of medical as well as statistical writers. In the discussion which M. Bertillon's paper raised at the ordinary meeting of the Society, M. Lagneau drew attention to the results given in a paper read by himself before the Académie de Médecine On the census of 1872 and the condition of the population of France, in which he has attempted to show that the small number of births when compared with the deaths is to be referred, not to any special ethnogenic or climatic relations, but rather to the influence of certain laws of succession and subdivision of property, and to the agency of military enactments, the one inducing late marriages and the other enforcing celibacy on a large proportion of men in the prime of life.—A valuable Report has been drawn up under the direction of the Commissioners for Algeria, by M. le Général Faidherbe and others, on the anthropology of that province, and has been formally presented to the Anthropological Society of Paris. After a general preliminary dissertation by M. Faidherbe on the different races which have occupied or still occupy the Algerine territory, Dr. Topinard considers at great length the ethnological, social, moral, linguistic and other relations of the Arabs and Berbers, who constitute the main branches of the French tributary tribes.—M. Roujou attempts in a lecture, which he delivered before the Society in the course of last year, to prove that a fair-haired race occupied the Gallic soil before the advent of the Germanic tribes, including Gauls under that denomination. He is of opinion that the ancestors of the Hellenes, the constructors of those megalithic remains which extend from the Atlantic to the Indian Ocean and from Scandinavia to Africa, and the fair-haired invaders of Egypt, who sixteen or seventeen centuries before our era had reached the Nile from the north-west, all belonged to one ancient blonde race, which long before the appearance of Teutons and Gauls had occupied Western Asia, Northern Africa, and the lands of Europe as the dominant or aristocratic class. M. Roujou discusses the much-vexed question whether the primitive Celtic races were fair or dark, dolichocephalic or brachycephalic, the former opinion being maintained by Dr. Pruner Bey, while the latter view is supported by all the learning that the great anthropologist, Dr. Broca, can advance in its favour.

Annali di Chimica applicata alla medicina, vol. lviii. No. 6, June.—This part concludes the eighteenth volume and contains the following papers:—In pharmacy, G. Righini furnishes a contribution on the iodides of sodium and ammonium and the production of iodoform in a mixture of these salts.—Dr. Coutinho furnishes a paper on the use of *Jaborandi*, a tree growing in North Brazil.—There is also a paper in this section on Anglo-Saxon condensed milk, reprinted from *Le Mouvement Médical* for March.—In hygiene, there is a paper by Pietro Carpani On a simple method for determining the quantity of lead contained in pewter vessels.—Action of water on lead, by Fordos.—In dietetics, Dr. F. Turbacco furnishes the concluding part of his paper On cheese and its alimentary use.—In physiology, Dr. G. Cappelli has a communication On the anti-fermentative action of boric acid and its efficacy in certain diseases.—Studies relating to the question of heterogenesis, by Prof. G. Cantoni.—Under the heading "Varieties" there is a paper by Gioachino Curti On the substitution of the earth of the *solfatara* of Pozzuoli for sulphur in the sulphurisation of vines.

Gazzetta Chimica Italiana, fascicolo iv.—This number commences with a paper by Prof. E. Pollacci On the mode of action of sulphur on calcium carbonate. Dr. Giuseppe Bellucci furnishes also a contribution on the same subject.—Chemical analysis of a marine plant (*Posidonia oceanica*, Koen) used in Liguria as manure, by Fausto Sestini.—Hugo Schiff contributes a paper On some derivatives of phloretine. The author describes in detail the method of preparing this substance, also the preparation of phloroglucine, phloretic acid, phloroglucide and triphloretide.—A. Pavesi and E. Rotondi give an account of the work done in the chemical laboratory of the Agricultural College of Milan. This comprises papers On rice oil; On the analysis of volcanic ashes which fell at Naples; the solubility of calcium phosphate in sulphurous acid; On parabussine, a new alkaloid contained in *Buxus sempervirens* (the sulphate has the formula $C_{26}H_{48}N_2OSO_4H_2$); On a practical method of determining the degree of acidity of milk; and, finally, On the quantitative determination of tannin especially in the must of grapes and in wine, modification of Flek's method.—The following papers are communicated from the station at Asti:—On the chalkiness of must, by Dr. I. Macagno.—Influence of light on vegetation, by the same author.—Experiments on the process of fermentation, by the same author.—The remainder of this part consists of a summary of foreign journals.

SOCIETIES AND ACADEMIES

LONDON

Royal Horticultural Society, August 5.—W. A. Lindsay in the chair.—The Rev. M. J. Berkeley called attention to *Fuchsia procumbens*, an interesting species—probably nearly hardy and suitable for rockwork—from New Zealand; *Pavia macrostachya* and *Clethra arborea* were sent from the gardens of Syon House.—Mr. H. B. Hennel exhibited a large plant of *Lilium auratum* with two stems—one fasciated, bearing forty-eight, and the other seventeen flowers.

PHILADELPHIA

Academy of Natural Sciences, Feb. 3.—Dr. Ruschenberger, president, in the chair.—Dr. Chapman exhibited a dissection of one of the hind legs of a musk-rat, *Fiber zibethicus*. The tendons of the tibialis anticus, extensor proprius hallucis, and extensor longus digitorum, pass down a groove in the tibia and under a little process of bone. The extensor longus digitorum is held down by an additional process. This arrangement seems to quicken the extension of the foot, and is of use apparently to the animal in swimming.—Prof. Leidy remarked that while it was exceptional to find the same species of the higher sub-kingdoms in the different parts of the world, it appeared to be the rule that most species of *Protozoa* were found everywhere under the same conditions. A large number of our fresh-water forms he had recognised as the same as those described by European authors. A less number of species are probably peculiar to every region. Among our fresh-water *Rhizopods* he had observed not only the genera *Amœba*, *Arcella*, *Difflugia*, *Euglypha*, *Trinema*, *Lagynis*, *Actinophrys*, &c., but also most of the species of these as indicated by European naturalists. It is an interesting question whether our fresh-water *Protozoa* have reached us from the same sources as those of Europe and other remote countries. If derived from the same sources they were probably infused in the waters of the different continents at an early age when the latter were not separated by ocean barriers. It thus early infused we have a remarkable instance of a multitude of specific forms retaining their identity through a long period of time. Such a view might appear to oppose the doctrine of evolution, but not justly so, for the simplest forms would be the slowest or least likely to vary, while the most complex, from their extended relationships, would be most liable to variation. Perhaps, however, the simplest forms of life, of the same species, may have originated independently of one another, not only in different places, but also at different times, and may yet continue to do so. While the highest forms of life may have been slowly evolved from the

simplest forms of the remotest age, equally simple forms may have started into existence at all times down to the present period. From the later original forms new ones may have been evolved to speed towards the same goal as those which preceded them.

Feb. 17.—Dr. Ruschenberger, president, in the chair.—Prof. Leidy made some remarks on the mode of reproduction and growth of the *Desmids*. In illustration he described a common species of *Docidium* or *Pleurotænium*. This consists of a long cylindroid cell constricted at the middle and slightly expanded each side of the constriction. When the plant is about to duplicate itself the cell-wall divides transversely at the constriction. From the open end of each half-cell there protrudes a colourless mass of protoplasm defined by the primordial utricle. The protrusions of the half-cells adhere together and continue to grow. The bands of endochrome now extend into the protrusions and subsequently keep pace with their growth. The protrusions continue to grow until they acquire the length and form of the half-cells from which they started. The exterior of the new half-cells thus produced hardens or becomes a cell-wall like that of the parent half-cells. In this condition two individuals of *Docidium* are frequently observed before separation. During the growth of the new half-cells the circulation of granules in the colourless protoplasm is quite active. In a species of *Docidium* $1\frac{1}{2}$ mm. long by $\frac{1}{10}$ mm. broad, the growth of the new half-cells was observed to be at the rate of about $\frac{1}{8}$ mm. in an hour.

March 3.—Dr. Ruschenberger, president, in the chair.—Prof. Leidy read an extract from a letter relating to mammalian fossils in California, from Dr. Lorenzo G. Yates, of Centreville, Alameda County, California.

March 10.—Dr. Ruschenberger, president, in the chair.—Elevation of the trunk of trees.—Mr. Thomas Meehan suggested on a former occasion that trees growing on a rock, by the natural thickening of the roots beneath would lift the tree four inches in forty years. Since that time, however, Dr. Lapham, the botanist, and State geologist of Wisconsin, had suggested to him that frost gradually lifted trees so that the trunk would sometimes appear in time to have elongated a foot or more. Since Dr. Lapham had made the suggestions, he had examined trees in the vicinity of Philadelphia and found unmistakable evidence that large numbers of trees had been raised in the manner stated. It was likely that one of the chief offices of the tap roots was to guard the tree from this frost-lifting as much as possible. His impression was that the trees of tropical climates had not near the development of tap roots which are found in the more northern ones, but this was a matter for further investigation.

March 24.—Dr. Ruschenberger, president, in the chair.—Prof. Leidy read a paper on *Actinophrys sol*.

Vienna

Imperial Academy of Sciences, March 26.—Prof. Freih. von Ettingshausen presented a memoir On the history of the development of terrestrial vegetation. The first part treats of Tertiary floral elements and the genetic relation of these to present flora; the second, the elements of European flora. —Dr. Schrötter spoke on the transformation of ordinary into amorphous phosphorus, through action of electricity, and described three forms of apparatus prepared by Dr. Geissler, of Bonn, for the purpose. There is evidence that the change is wrought neither by the light nor by the heat accompanying the current, but by the electricity itself.—Dr. Meyer presented a second paper On new and imperfectly known birds of New Guinea and the islands of the Bay of Geelvinks.—Dr. Frombeck communicated a memoir On an extension of the doctrine of sphere functions and the forms of development, from these, of a function in infinite series.

Paris

Academy of Sciences, Aug. 3.—M. Bertrand in the chair. —The following papers were communicated:—Double series of drawings representing terrestrial cyclones and solar spots, executed by M. Faye. The drawings are to be published in the Mémoires; the present communication contains a detailed description of them.—Eighth note on guano, by M. E. Chevreul. The author has detected the following salts in guano:—Ammonium carbonate and chloride, calcium urate, phosphate, and oxalate; certain potassium salts of volatile organic acids. The following double salts have been recognised:—Potassium ammonium oxalate, potassium ammonium sulphate, sodium ammonium phosphate, and magnesium ammonium phosphate.—Note on a meteorite which fell on May 20, 1874, in Turkey, at Virba, near Vidin, by M. Daubrée. The fall was accompanied by a loud noise, and the mass, weighing 3·6 kilogrs., penetrated 1 metre into the soil. Analysis showed that the meteorite contained nickel-iron, chrome-iron, ferric sulphide, and an insoluble residue, probably containing enstatite.—Additional note on the fall of meteorites which took place on July 23, 1872, in the district of Saint-Amand (Loir-et-Cher), by M. Daubrée. By an attentive examination of the surface of the soil, four other meteorites weighing respectively 3, 0·3, 0·6, and 0·6 kilogrs. have been discovered.—Blast of sirocco experienced in Algiers on June 20, 1874, and followed over a great part of Algeria, by M. Ch. Sainte-Claire Deville.—Observations made during the last days of the appearance of Coggia's comet; a letter from P. A. Secchi to the perpetual secretary. The author obtained undoubted evidence of polarisation. The linear spectrum of the nucleus apparently continuous was resolved by careful examination into a banded spectrum, the interruptions of which were most apparent near the bands of the second spectrum superposed upon the continuous spectrum of the nucleus. A drawing of the spectrum accompanied the letter.—Indication of a method of establishing the properties of the ether, by M. X. Kretz.—Reply to a former note by M. Houyvet on the scheme for re-establishing a central sea in Algeria, by M. E. Roudaire The author does not fear that the evaporation would dry up the proposed sea into a salt lake as suggested by M. Houyvet; he is of opinion that such a circumstance would be entirely prevented by the establishment of an inferior counter current.—Memoir on the thermal effects of magnetism, by M. A. Cazin. The author has determined approximately the magnetic equivalent of a *calorie*.—Researches on explosive bodies; explosion of powder; by MM. Noble and F. A. Abel: continuation of first memoir.—Fourth note on the electric conductivity of ligneous bodies, by M. T. du Moncel. —On the passivity of iron, by M. P. de Reynon. The author attempts to explain this phenomenon by a voltaic action transferring oxygen to the iron, and thus polarising the surface of this metal.—On some bismuth and tungsten minerals from the Meymac mine (Corrèze), by M. Ad. Carnot.—Observations on the development of the peripheral nerves of the larvæ of Batrachians and Salamanders, primary and secondary fibres, M. Ch. Roget.—Reproduction by photography of different crystallisations such as are seen under the microscope, by M. J. Girard. — Note on the stratification of the tail of Coggia's comet, by M. A. Barthélemy.—On isoterebenthene from a physical point of view, by M. J. Riban. The author has instituted comparisons between the physical properties of this substance, terebene, and terebenthene.—Constitution of ordinary brominated propylene, by M. E. Reboul.—Action of nitric acid on paraffin; different products obtained; by M. A. G. Pouchet. Among other substances, *paraffinic acid* ($C_{26}H_{26}NO_{10}$) is obtained, which the author has examined in some detail.—On the action of chloral on the blood, by MM. V. Feltz and E. Ritter.—Observations on the hailstones which fell at Toulouse during the storm of July 28, 1874, by M. N. Joly.—Reply to M. Leymerie on the subject of the carboniferous limestone of the Pyrenees and the St. Béat marbles, by M. F. Garrigou.—Observations of a bolide at Versailles on the evening of July 27, by M. Martin de Brettes.—Observation of a bolide at Toulon on July 27, by M. Lecourgeon.

CONTENTS

THURSDAY, AUGUST 20, 1874

SCIENTIFIC WORTHIES
IV.—JOHN TYNDALL

IN the valleys of Gloucestershire may still be seen a few clothiers' mills, the residue of a once extensive industry. Almost exactly two centuries ago some members of the Tyndall family inhabiting these valleys, and engaged for the most part in this industry, crossed over to the opposite coast of Ireland. This fact, the date of which is fixed by Mr. Greenfield, coupled with family tradition, points to the origin of Prof. Tyndall. In Ireland the Tyndalls fared variously, dividing themselves into magistrates, aldermen, medical men, farmers, and tradesmen. To the last, and indeed to the poorest of the last, Prof. Tyndall's father belonged. He was a man of singular force of intellect and independence of character, and he kept his son at school until his nineteenth year. In accordance with transmitted family habit, Prof. Tyndall, when young, was exercised in all the subtleties of the controversy between Protestantism and Catholicism. In 1839 he quitted school to join a division of the Ordnance Survey, with which he remained connected for nearly five years. His excellent chief, now his intimate friend, General George Wynne, R.E., gave him an opportunity of mastering all the details of the survey, in the office and in the field. For four years subsequently he was engaged on railway work; and while thus employed met Mr. Hirst, who is now the Director of Studies in the Royal Naval College, Greenwich, who afterwards joined him in Marburg, and with whom his relations are more those of a brother than a friend. In 1847, with a view to self-improvement, he accepted a post in Queenwood College, Hampshire, where Dr. Frankland was chemist; and in 1848 they went together to the University of Marburg, Hesse Cassel. Bunsen and others had rendered the little University celebrated; and to Bunsen, whose lectures he attended and in whose laboratory he worked, Prof. Tyndall owes obligations never to be forgotten. He found in Germany a second home. With Stegmann he studied mathematics; he heard Gerling lecture on physics, and subsequently Knoblauch, who, preceded by a distinguished reputation, and accompanied by a choice collection of instruments, came to Marburg as Extraordinary Professor when Tyndall was there. Prof. Knoblauch, in conjunction with whom Tyndall subsequently conducted various inquiries on diamagnetism, supports his old friend and pupil in Belfast; Wiedemann is also there, and Bunsen would have been there if he could. Tyndall subsequently worked in the laboratory of Prof. Magnus in Berlin. In 1851 he accompanied Prof. Huxley to the meeting of the British Association at Ipswich, and thus commenced a friendship which has never faltered to the present hour. Dr. Bence Jones heard of Tyndall in Berlin, and, always alert in the promotion of science and in aiding those who pursued it, had him invited in 1853 to give a Friday evening lecture at the Royal Institution. Soon afterwards, on the proposal of Faraday, Tyndall was appointed Professor of Physics in the Institution, where he still remains.

In 1852 he was one of the secretaries of the Physical Section of the British Association, which then met for the first time in Belfast. Its president was Col. Sabine, to whom Tyndall was indebted in those days for various acts of kindness and encouragement, and who took, unsolicited, charge of his candidature for the Royal Society. But Tyndall's earliest scientific memory happens to be associated with Belfast. In the school to which he was sent in his childhood three different arithmetical treatises were made use of, one written by Gough and another by Voster; but young Tyndall was the only boy in the school who could speak of his *Thomson*. The first germ of science was dropped into Prof. Tyndall's mind by the father of Sir William Thomson, who was then Professor of Mathematics in the Belfast Institution. He also remembers distinctly, many years afterwards, reading in a Glasgow magazine about Davy's experiments on Radiant Heat, and the longing which they excited in him to be able to do something of the kind. With the very apparatus there figured Prof. Tyndall now illustrates his own lectures. In the "Kildare Street Schools," to which he was sent when a little boy, he learned very little, being, indeed fonder of play than of school. His first serious application to study was under a clever teacher of a national school named John Conwill, with whom he mastered Euclid, some algebra, conic sections, and plane trigonometry. Prof. Tyndall is now about fifty-four years of age. He was born in 1820 in the village of Leighlin Bridge, County Carlow, situated on the Barrow, but a fragment of which only now remains. When a boy he was expert at climbing trees; he was a good swimmer, a good runner, and though not unfrequently thrashed by an antagonist, a fair fighter. His first mountain experience was among the hills of Westmoreland eight-and-twenty years ago; his first visit to the Alps was in 1849; his second visit, in company with the present President of the Royal Society and Prof. Huxley, was in 1856; and he has continued to visit them every year since. In 1859, having paid his summer visit, he reached the Montanvert at the end of December and determined the winter motion of the Mer de Glace. At the Bel Alp, this year, he prepared his address to the British Association.

That our readers may have the opportunity of knowing the opinion of an eminent continental physicist as to the importance of good popular expositions of scientific subjects, and as to the special talent which Prof. Tyndall has shown in this direction, we give some extracts from a preface to the recently published German translation of Tyndall's "Fragments of Science," which the writer, Professor Helmholtz, has been good enough to revise and send to us for that purpose.

The awakening desire for scientific instruction, ever finding new expression among the educated classes of all European countries, we must consider not merely as a striving after new forms of amusement, or a mere empty and barren curiosity; it is rather a well-justified intellectual necessity, and is in close connection with the most important springs of mental development in these times. The natural sciences have become a powerful influence in the formation of the social, industrial, and political life of civilised nations, not only from the fact that the great forces of nature have been subordinated to the aims of man, and have supplied him

with a host of new means to attain them; though this mode of their action is sufficiently important that the statesman, the historian, and the philosopher, as well as the manufacturer and the merchant, cannot pass without participation in, at least, the practical results; but because there is another form of their action which goes much deeper and further, though it is, perhaps, more slow in manifesting itself; I mean their influence in the direction of the intellectual progress of humanity. It has often been said, and even brought as a charge against the natural sciences, that, through them, a schism (*zwiespalt*), formerly unknown, has been introduced into modern education. And, indeed, there is truth in this. A schism *is* perceptible; yet such must mark every new step of intellectual development wherever the New has become a power, and the question to be settled is, the definition of its just claims, as against the just claims of the Old. The past progress of education of civilised nations has had its central point in the study of language. Language is the great instrument through possession of which man is most distinctly separated from the lower animals; through use of which he is able to share the experience and knowledge of other individuals of his time, as also those of past generations; without which each man would, like the lower animals, be limited to his instinct and to his own particular experience. That therefore the improvement of language was formerly the first and most necessary work of a growing race, and that the most refined perfection of its comprehension and its use is, and must ever be, the primary problem in the education of each individual, is undoubted. The culture of modern European nations has a peculiarly intimate connection with the study of the remains of antiquity; and thereby, directly with the study of language. With the latter study was associated that of the forms of thought, which are coined in speech; logic and grammar, that is, according to the original meaning of the words, the art of speaking and the art of writing, both taken in the highest sense, have therefore been hitherto the natural hinge points of mental education.

But while language is the means of handing down and preserving truth once recognised, we must not forget that its study teaches nothing as to how fresh truth is to be found. Similarly, logic shows how, from the proposition which forms the major of a syllogism, conclusions are to be drawn; but it can tell us nothing as to whence this proposition has come. He who will convince himself of its independent truth must, on the other hand, begin with knowledge of the individual cases which fall under the law, and which afterwards, if this have been established, may doubtless also be accepted as deductions from the law. But only where a knowledge of the law is one which has been communicated by others, does it actually take precedence of knowledge of the deductions, and in such a case, the treatises of the old formal logic assume their undeniable practical importance.

Thus all these studies do not themselves lead us to the proper source of knowledge—do not bring us face to face with the reality which we seek to know. There is therefore, undoubtedly, a danger in communicating to each one, by preference, a knowledge the source of which he has not personally contemplated. Comparative mythology and the criticism of the metaphysical systems can tell a great deal of how figurative word-expression has in time been exalted to the importance of real knowledge and even become valued as ultimate wisdom.

While fully recognising, then, the significance (not to be sufficiently appreciated), of the finely elaborated art of communicating the acquired knowledge of others, and receiving in return such communications from others, in regard to the mental improvement of our race; while also recognising the importance attaching to the contents of the classical writings, for the cultivation of the moral and æsthetic sentiments, for the development of an intimate knowledge of human feelings, conceptions, and conditions of culture; we must yet hold that an important element is wanting from the exclusively literary-logical mode of education; and that is the methodical discipline of the activity by which we reduce the confused material which meets us in the actual world, apparently (at first sight) ruled by wild chance rather than reason, to clear conception, and thereby make it fit for expression in speech. Such an art of observation and experiment, methodically developed, we have hitherto found in the natural sciences alone; and our hope, that the psychology of individuals and peoples, with the practical sciences of education and of social and political government based upon it, will attain the same end, can only be fulfilled in a distant future.

This new enterprise, prosecuted by natural science on new paths, has quickly enough yielded fresh and, of their kind, unheard-of results, evidencing what achievements human thought is capable of, where it can go the whole way from the facts to the full knowledge of the law under favourable conditions, testing and knowing everything for itself. The simple relations, especially those of inorganic nature, permit of our posessing such a penetrating and accurate knowledge of their laws, such far-reaching deduction of inferences from them, and the testing and verification of these by such an exact reference to fact, that, with the systematic unfolding of such conceptions (*e.g.* with the deduction of astronomical phenomena from the law of gravitation), there is hardly any other edifice of human thought which, for strict logic, certainty, correctness, and productiveness, can at all be compared with it.

I point out these relations merely with the view of showing in what sense the natural sciences are a new and essential element of human education; of indestructible importance, also, for all further development of this in the future; and that a complete education of the individual man, as of nations, will no longer be possible without a union of the past literary-logical with the new natural-science direction of study.

Now, the majority of the educated hitherto have been instructed only in the old way—have hardly at all come into contact with the work of thought in natural science; at the most, perhaps, a little with mathematics. It is men of this kind of education that our Governments appoint, by preference, to educate our children, to maintain reverence for moral order, and to preserve the treasures of knowledge and wisdom of our forefathers. It is they, too, who must organise the changes in the mode of education of the rising generation; where such changes are required they must be encouraged or compelled thereto by the public opinion of the intelligent classes of the whole community, both men and women.

Apart from the natural impulse of every warm-hearted

man to lead others to that which he has found to be true and right, there will be in every friend of natural science a strong motive to share in such work, in the reflection that the further development of these sciences themselves, the unfolding of their influence on human education, and, so far as they are a necessary element of this education, the healthiness of the future mental development of the people, depend on an insight being afforded to the educated classes, into the nature and the results of scientific investigation, such as is generally possible, without a personal engrossing occupation with these subjects.

And in proof that the need of such an insight is felt even by those who have grown up under the predominant linguistic and literary instruction, may be cited the large number of popular books of natural science annually published, and the eagerness with which lectures of a popular character on subjects in natural science are attended.

It lies in the nature of the case, however, that the essential part of this want, owing to the depth of its roots, is not easily satisfied. It is true that what science may have established and wrought out in solid results can, by intelligent compilers, be put together and brought into suitable form, so that a reader without previous knowlege of the subject may, with some perseverance and patience, understand it. But such a knowledge, limited to the actual results, is not properly that which we have in view. These books, indeed, compiled with the best intentions, often lead into devious paths. To prevent weariness, they must seek to rivet the attention of the reader by an accumulation of curiosities, whereby the image of science is rendered quite false. One often feels this when the reader begins from his own impulse to tell what he has considered important. Then there are the further objections that the book can give only word-descriptions, or, at the most, drawings representing more or less imperfectly the things and processes of which it treats; and that the reader's power of imagination is thereby subjected to a much greater strain, with much less satisfactory results, than that of the investigator or student who, in museum collections and laboratories, sees the things before him in their living reality. A portion of the difficulties named may readily be obviated in popular lectures, if, at least, some objects or experiments can be shown: the opportunities of doing so in Germany, hitherto, have been mostly very limited.

It appears to me, however, that it is not so much a knowledge of results of scientific investigations in themselves, that the most intelligent and well-educated of the laity ask, but rather a perception of the mental activity of the investigator, of the individuality of his scientific procedure, of the aims at which he strives, of the fresh point of view which his work affords in reference to the great problems of human existence. There can hardly be anything of all this in the properly scientific treatment of scientific objects; on the contrary, the severe discipline of the exact method requires that, in scientific treatises, only that be spoken of which is surely ascertained, hypotheses only where equivalent to the proposal of questions for further investigation, a certain answer to these appearing probable from the next progress of the research. A natural prudence recommends great rigour in this connection. For it is pretty much the same to the greater number even of the instructed hearers whether a man of science says "I know," or "I suppose;" they only ask after the result and the authority by which it is supported, not the grounds or the doubts. It is thus not to be wondered at if earnest investigators do not willingly shock the confidence of their readers in what the former may think true and demonstrable, by the enumeration of ideas of the correctness of which they do not feel themselves quite secure. These may be very probable, and may be expressed with ever so much prudence and careful guardedness; they still expose him who utters them to the danger of vexatious misrepresentation.

It is, further, not to be overlooked, that the peculiar discipline of scientific thought which is necessary for the most abstract and rigorous grasp possible of newly-found ideas and laws, and for the purification from all accidents of the sensuous order of phenomena, along with the habitual residence of the mind among a circle of ideas far removed from general interest, are not quite favourable preparatives for a popular intelligible exposition of the insights obtained, to hearers who have not had the like discipline. For this task there is rather required an artistic talent of exposition, a certain kind of eloquence. The lecturer or writer must find generally accessible standpoints from which he may call forth new representations with the most vivid distinctness, and then allow the abstract principle, which he seeks to make intelligible, to derive from these concrete life. This is almost an opposite mode of treatment to that which obtains in scientific treatises, and it can readily be understood that the men are rare who are equally fitted for both these kinds of intellectual labour.

Owing to all these circumstances a sort of dividing wall is raised between the men of science and the laity who might obtain instruction and guidance from them. That many, and indeed some of the most able, investigators have the qualities and peculiarities belonging to abstract work is natural, and will, in each individual case, be at once willingly excused. I have here merely to guard against the reversal of this relation, as if the defects named were necessary, or at all constituted a prerogative.

The compilers can give no help in those directions where the original thinkers have neglected or avoided expressing themselves. So much the more gratifying is it, I consider, in such a state of things, when, among those who have shown the highest ability for original scientific work, there is found, at times, a man like Tyndall, full of enthusiasm for the problem of making the newly-acquired insights and outlooks of his science available for the wider circle of the people, and, at the same time, endowed with other qualities which are the necessary conditions of success towards this end, eloquence and the gift of lucid exposition.

In England the custom of popular scientific lectures has been much longer in existence than in Germany. Since the constitution of the English Universities is very different from ours, fewer individuals are there in a position to prosecute scientific research, or give scientific instruction to regularly prepared scholars, as their life-calling. This generally makes it much more difficult for individuals to go deeply into a special depart-

ment of study, though Genius of course everywhere breaks through these and other hindrances. The same circumstance has, on the other hand, maintained a closer connection of the workers in science with all other classes of the population, and incited to a more liberal care for the instruction of the student not regularly trained. While this has hitherto been quite rare in Germany, there have long been in England solid and well-furnished institutions for the purpose.

In the two circumstances, first that in England courses of a moderate number of connected lectures can be delivered, and secondly that this can be done in buildings well suited for demonstrations and experiments of every kind, there is a great advantage over the general custom in Germany, where each lecturer only delivers one lecture.

Now, it is intelligible that during the seventy years since this state of things has arisen, and under so much more favourable external conditions, the English public have educated their lecturers, and the lecturers their public, much better than has hitherto been the case in Germany. The Royal Institution has had, among its professors, two men of the first rank, Sir Humphry Davy and Faraday, who have co-operated to that end. At present Prof. Tyndall is held in peculiarly high esteem, both in England and in the United States, on account of his talent for popular expositions of scientific subjects. Anyone who is conscious within himself of the gift and the power of working in a particular direction for the mental development of humanity, has usually a pleasure in such activity, and is ready to devote to it a good share of his time and his energies. This is especially the case with Prof. Tyndall. He has, therefore, remained true to his post at the Royal Institution, though other honourable posts have been offered him. But it would be quite an erroneous conception to think of him merely as the able, popular lecturer; for the greater part of his activity has always been given to scientific investigation, and we owe to him a series of (in part) highly original and remarkable researches and discoveries in physics and physical chemistry.

In his discourse On the scientific use of the Imagination, delivered before the British Association at Liverpool, Prof. Tyndall has given a peculiarly characteristic description of his manner of intellectual working. There are two ways of searching out the system of laws in nature—that of abstract ideas, and that of thorough experimental research. The former way leads ultimately, through mathematical analysis, to an accurate quantitative knowledge of the phenomena. But it can only advance where the other has already, in some measure, opened up the region, *i.e.* given an inductive knowledge of the laws, at least, for some groups of the phenomena belonging to it, and the point is merely the testing and clearing up of the already found laws, the passage from them to the last and most general laws of the region in question, and the complete unfolding of their consequences. This other way leads to a rich knowledge of the behaviour of natural substances and forces, in which at first the law-element is recognised only in the form in which artists perceive it, through vivid sensuous contemplation of the type of its action, in order to a later working out of it in the pure form of an idea. These two sides of the physicist's work are never quite separate from each other, though sometimes the diversity of individual gifts will adapt one man for mathematical deduction, another for the inductive activity of experimentation. Should the first method, however, become wholly divorced from actual observations, it falls into the danger of laboriously building castles in the air, on unstable foundations, and of not finding the points at which it may verify the agreement of its deductions with fact. The second, on the other hand, would lose sight of the proper aim of science, if it did not work towards ultimately bringing its observations into the precise form of the idea.

The first discovery of laws of nature previously unknown, that is, of new forms of likeness in the course of apparently unconnected phenomena, is a matter of sense (taking this word in its widest meaning), and must nearly always be accomplished only by comparison of numerous sensuous perceptions. The perfection and purification of that which has been found falls afterwards under the working of the deductive method of thinking, and preferentially of mathematical analysis, as the final question is ever about equality of quantities.

Now Mr. Tyndall is *par excellence* an experimenter; he forms his generalisations from extensive observations of the play of natural forces, and carries over what he has seen, in some cases to the greatest, in others to the smallest relations of space (as appeared in the lecture referred to). It is quite a mistake to consider what he calls imagination as mere fancy (*Phantasterei*). It is exactly the opposite that is meant—full sensuous contemplation. To this mode of working is evidently to be attributed the clearness of his lectures on physical phenomena, as also his success as a popular lecturer.

H. HELMHOLTZ

GROVE'S "CORRELATION OF PHYSICAL FORCES"

The Correlation of Physical Forces. Sixth edition. With other Contributions to Science. By the Hon. Sir W. R. Grove, M.A., F.R.S., one of the judges of the Court of Common Pleas. (London: Longmans, 1874).

THERE are few instances in which anyone whose life has not been exclusively scientific has made such valuable contributions to science as those of Sir W. R. Grove. His nitric acid battery, to the invention of which he was led, not by accident, but by a course of reasoning, which in the year 1839 was as new as it was original, is a contribution to science the value of which is proved by its still surviving and continuing in daily use in every laboratory as the most powerful generator of electric currents, while hundreds of batteries invented since that of Grove have fallen into disuse, and become extinct in the struggle for scientific existence.

The gas battery, though not of such practical importance, is still of great scientific interest, and the collection which we have before us of those contributions to science which took the form of papers, tempts us to indulge in speculations as to the magnitude of the results which would have accrued to science if so powerful a mind could have been continuously directed with undivided energy towards some of the great questions of physics.

But the main feature of the volume is that from which it takes its name, the essay on the Correlation of Physical Forces, the views contained in which were first advanced in a lecture at the London Institution in January 1842, printed by the proprietors, and subsequently more fully developed in a course of lectures in 1843, published in abstract in the *Literary Gazette*. This essay has a value peculiar to itself. Though it has long ago accomplished the main point of its scientific mission to the world, it will always retain its place in the memory of the student of human thought, as one of the documents which serve for the construction of the history of science.

It is not by discoveries only, and the registration of them by learned societies, that science is advanced. The true seat of science is not in the volume of Transactions, but in the living mind, and the advancement of science consists in the direction of men's minds into a scientific channel; whether this is done by the announcement of a discovery, the assertion of a paradox, the invention of a scientific phrase, or the exposition of a system of doctrine. It is for the historian of science to determine the magnitude and direction of the impulse communicated by either of these means to human thought.

But what we require at any given epoch for the advancement of science is not merely to set men thinking, but to produce a concentration of thought in that part of the field of science which at that particular season ought to be cultivated. In the history of science we find that effects of this kind have often been produced by suggestive books, which put into a definite, intelligible, and communicable form, the guiding ideas that are already working in the minds of men of science, so as to lead them to discoveries, but which they cannot yet shape into a definite statement.

In the first half of the present century, when what is now called the principle of the conservation of energy was as yet unknown by name, it "flung its vague shadow back from the depths of futurity," and those who had greater or less understanding of the times sketched out with greater or less clearness their view of the form into which science was shaping itself.

Some of these addressed themselves to the advanced cultivators of science, speaking, of course, in learned phraseology; but others appealed to a larger audience, and spoke in language which they could understand. Mrs. Somerville's book on the "Connection of the Physical Sciences" was published in 1834 and had reached its eighth edition in 1849. This fact is enough to show that there already existed a widespread desire to be able to form some notion of physical science as a whole.

But when we examine her book in order to find out the nature of the connection of the physical sciences, we are at first tempted to suppose that it is due to the art of the bookbinder, who has bound into one volume such a quantity of information about each of them. What we find in fact is a series of expositions of different sciences, but hardly a word about their connection. The little that is said about this connection has reference to the mutual dependence of the different sciences on each other, a knowledge of the elements of one being essential to the successful prosecution of another. Thus physical astronomy requires a knowledge of dynamics, and the practical astronomer must learn a certain amount of optics in order to understand atmospheric refraction and the adjustment of telescopes. The sciences are also shown to have a common method, namely mathematical analysis; so that analytical methods invented for the investigation of one science are often useful in another.

The unity shadowed forth in Mrs. Somerville's book is therefore a unity of the method of science, not a unity of the processes of nature.

Sir W. Grove's essay may be fairly called a popular book, as it has reached its sixth edition. It is, therefore, not merely a record of the speculations of the author, but an index of the state of scientific thought among a large number of readers. It has not the universal facility and occasional felicity of exposition which distinguish Mrs. Somerville's writings. No one could use it as a text-book of any science, or even as an aid to the cultivation of the art of scientific conversation. The design of the book is to show that of the various forms of energy existing in nature, any one may be transformed into any other, the one form appearing as the other disappears. This is what is meant in the essay by the "correlation of the physical forces," and the whole essay is an exposition of this fact, each of the physical forces in turn being taken as the starting-point, and employed as the source of all the others.

We are sorry that we are not at present able to refer to the early reviews of the essay as indicating the reception given to the doctrine by the literary and scientific public at the time of its original publication. It has certainly exercised a very considerable effect in moulding the mass of what is called scientific opinion, that is to say the influence which determines what a scientific man shall say when he has to make a statement about a science which he does not understand. Many things in the essay which were then considered contrary to scientific opinion, and were therefore objected to, have since then become themselves part of scientific opinion, so that the objections now appear unintelligible to the rising generation of the scientific public.

Helmholtz's essay "On the Conservation of Force," published in 1847, undoubtedly masters a far greater step in science, but the immediate influence was confined to a small number of trained men of science, and it had little direct effect on the public mind.

The various papers of Mayer contain matter calculated to awaken an interest in the transformation of energy even in persons not exclusively devoted to science, but they were long unknown in this country, and produced little direct effect, even in Germany, at the time of their publication.

The rapid development of thermodynamics, and of other applications of the principle of the conservation of energy, at the beginning of the second half of this century, belongs to a later stage of the history of science than that with which we have to do.

To form a just estimate of the value of Sir W. Grove's work we must regard it as the instrument by which certain scientific ideas were diffused over a large area, in language sufficiently appropriate to prevent misapprehension, and yet sufficiently familiar to be listened to by persons who would recoil with horror from any statement in which literary convention is sacrificed to precision.

It is worth while, however, to take note of the progress of evolution by which the words of ordinary language are gradually becoming differentiated and rendered scientifically precise. The fathers of dynamical science found a number of words in common use expressive of action and the results of action, such as force, power, action, impulse, impetus, stress, strain, work, energy, &c. They also had in their minds a number of ideas to be expressed, and they appropriated these words as they best could to express these ideas. But the equivalent words Force, *Vis*, *Kraft*, came most easily to hand, so that we find them compelled to carry almost all the ideas above mentioned, while the other words which might have borne a portion of the load were long left out of scientific language, and retained only their more or less vague meanings as ordinary words.

Thus we have the expressions *Vis acceleratrix*, *Vis motrix*, *Vis viva*, *Vis mortua*, and even *Vis inertiæ*, in every one of which, except the second and fourth, the word *Vis* is used in a sense radically different from that in which it is used in the other expressions.

Confusion may perhaps be avoided in scientific works when read by scientific students, by means of a careful appropriation of epithets such as those which distinguish the meanings of the word *Vis*, but as soon as science becomes popularised, unless its nomenclature is reformed and arranged upon a better principle, the ideas of popular science will be more confused than those of so-called popular ignorance.

Thus the "Physical Forces," whose correlation is discussed in the essay before us, are Motion, Heat, Electricity, Light, Magnetism, Chemical Affinity, and "other modes of force." According to the definition of force, as it has been laid down during the last two centuries in treatises on dynamics, not one of these, except perhaps chemical affinity, can be admitted as a force. According to that definition, "force is that which produces change of motion, and is measured by the change of motion produced."

Newton himself reminds us that force exists only so long as it acts. Its effects may remain, but the force itself is essentially transitive. Hence, when we meet with such phrases as Conservation of Force, Persistence of Force, and the like, we must suppose the word Force to be used in a sense radically different from that adopted by scientific men from Newton downwards. In all these cases, and in the phrase "The Physical Forces" as applied to heat, we are now, thanks to Dr. Thomas Young, able to use the word Energy instead of Force, for this word, according to its scientific definition as "the capacity for performing work," is applicable to all these cases. The confusion has extended even to the metaphorical use of the word Force. Thus, it may be a legitimate metaphor to speak of the force of public opinion as being brought to bear on a statesman so as to exert an overpowering pressure upon him, because here we have an action tending to produce motion in a particular direction; but when we speak of "the Queen's Forces," we use the term in a sense as unscientific as when we speak of the Physical Forces. The author, in his concluding remarks, points out the confusion of terms which embarrassed him in his endeavours to enunciate scientific propositions, on account of the imperfection of scientific language. This, he tells us, "cannot be avoided without a neology which I have not the presumption to introduce or the authority to enforce."

Such a confession, proceeding from so great a master of the art of "putting things," is a most valuable testimony to the importance of the study and special cultivation of scientific language; and a comparison of many passages in the essay with the corresponding statements in more recent books of far inferior power, will show how much may be gained by the successful introduction of appropriate neologies. What appeared mysterious and even paradoxical to the giant, labouring among rough-hewn words, dwindles into a truism in the eyes of the child, born heir to the palace of truth, for the erection of which the giant has furnished the materials.

Thus the appropriation of the word "Mass" to denote the quantity of matter as defined by the amount of force required to produce a given acceleration, has placed the students of the present day on a very different level from those who had to puzzle out the meaning of the phrase *Vis Inertiæ* by combining the explanation of *Vis* as force, with that of *Inertia* as laziness. In the same way the word "stress" as an equivalent for "action and reaction," and as a generic name for pressure, tension, &c., will save future generations a great deal of trouble; and the distinction between the possession of energy and the act of doing work, which is now so familiar to us, would have obviated several objections to the doctrine of the essay, which are founded on statements in which the production of one form of energy and the maintenance of another are treated as if they were operations of the same kind. We read at p. 163:—Thus, "a voltaic battery, decomposing water in a voltameter, while the same current is employed at the same time to make (maintain) an electromagnet, gives nevertheless in the voltameter an equivalent of gas, or decomposes an equivalent of an electrolyte for each equivalent of decomposition in the battery cells, and will give the same ratios if the electro-magnet be removed."

Here the maintenance of a magnet is a thing of a different order from the decomposition of an electrolyte; the first is maintenance of energy, the other is doing work. This is well explained in the essay; but if appropriate language had been used from the first, the objection could never have been put into form.

J. C. CLERK-MAXWELL.

FIRST FORMS OF VEGETATION

First Forms of Vegetation. By the Rev. Hugh Macmillan, LL.D. Second edition, corrected and revised. (London: Macmillan and Co.)

DR. MACMILLAN explicitly informs his readers in his preface to his book, that his object is not so much to impart cut-and-dried information as to kindle their sympathy and awaken their interest "in a department of nature with which few, owing to the technical phraseology of botanical works, are familiar." Such a purpose is very laudable indeed, and the book which carried it into effect might have been a very valuable one. Science has great need of evangelists. Students of its various branches experience the keenest interest in following up the lines of research and investigating the problems which belong to their own departments. But to feel this

interest it is necessary to be instructed; and in an immense number of cases it is impossible to convey in non-technical language, so as to be understood by the uninstructed, in what the interest consists. Hence it follows that a large number of scientific workers have conceived a decided contempt for all attempts to popularise science. Their position is so far sound. Still, it is extremely important in the interests of science itself that its investigations should not be wholly withdrawn from the notice of the general community and confined to a small esoteric class. Here the function of the evangelists needs to be properly recognised; we want men with Dr. Macmillan's sympathy with the subject-matter and liking for exposition to take a wider view of it in respect to general interest than it will ever be possible for the special student to take. If public funds are to be devoted to scientific purposes, it is absolutely necessary that the public mind should have some idea that they are being expended on something of more general importance than individual hobbies, as they will be too apt to believe, unless their sympathy with the work is occasionally kindled. It is not every branch of science which is capable of yielding results which can at once be turned to commercial profit, and though knowledge in every line of investigation may be expected to yield practical applications in the most unexpected directions, it would be an evil time for scientific advancement when the community determined to shut its eyes and close its ears to everything which could not be shown to pay. It is very likely, however, to begin to do this unless scientific men take measures to excite intelligent interest where there is no obvious suggestion of profit to gratify the natural cupidity of a commercial country.

It is worth while making these remarks, because it deserves to be borne in mind that the work—though apt to be contemned is not easy to do; nor is it easy to find men fit to do it. And the criticisms which we shall now proceed to make on Dr. Macmillan's book are made by no means from a desire to find fault, but rather to bring into prominence the inherent difficulty which exists in writing such a book as it should be written. If the author has not had a thorough drilling in the technicalities of the subject, then, as Dr. Macmillan has done, he will make some exceptionable statements and stray into sundry grievous pitfalls. If, on the other hand, he is quite and fully competent to write the book, it is tolerably certain he will never write it at all. The general reader wants his science skimmed for him—and this is an operation which a competent student particularly dislikes to perform.

It is a pity that some of Dr. Macmillan's friends "whose scientific position lends weight to their opinions" did not assist him in issuing the work in its new form. This in fact seems to be the only chance of doing the thing properly. The aid of those who would not actually write such books might at any rate be given for the purpose of keeping them free from glaring blunders.

Mosses, for example, we are told (p. 27) belong to the highest division of flowerless plants. This statement can only be met by a categorical negative. As to their being "prefigurations of the flowering plants, epitomes of archetypes in trees and flowers," if this is the alternative for technical language, the general reader can hardly be congratulated on the change. But the author seems not to have a very clear conception of the structural rank of mosses. He tells us on the next page that "through the cone-like spikes of the club-mosses they approximate to the pine tribe in their fructification." This is a *rapprochement* which no modern systematist would think of making. In fact, mosses and club-mosses have the same kind of relationship and no more that ants have with white ants or the albumen of an egg with the albumen of a seed.

On p. 37, it takes one's breath away to read, "*Besides* these curious capsules there are other organs of fructification which clearly demonstrate the sexuality of mosses." It hardly at first occurs to the reader that the author has no notion that the capsules are really the fertilised product derived from the sexual apparatus. The capsule—and this is one of the most remarkable things in the whole vegetable kingdom—is gradually developed from the oospore; its being composed of modified leaves, as Dr. Macmillan explains on p. 40, is an antiquated idea. There is something indeed to strike an intelligent curiosity on almost every page. At p. 80 we are told of Lycopods "becoming slightly arborescent in tropical countries, *particularly* New Zealand." On p. 84 "some species" are said "to have little cone-like spikes at the tips of their branches under the scales of which, as in the pine tribe, lurk the reproductive embryos." This is simply utter nonsense. In so far as the process is understood we have spores borne in spore cases at the base of the upper surface of the fruiting scales, and these spores when disseminated undergo a further process of development, which results in the formation of an embryo.

Dr. Macmillan dismisses Schwenderer's theory of lichens in a very *ex cathedrâ* fashion. *En revanche*, he is equally decided in rejecting Dr. Bastian's views on heterogenesis.

We regret that this book has not been put into a more satisfactory shape, for the author has industriously collected a great deal of very interesting matter.

W. T. T. D.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Bright Meteors

On Saturday last I saw *two* very bright meteors, each coming from the Perseus radiant point, and isolated from smaller ones by such a length of time that my (possible) watch error of perhaps one minute will not prevent their being identified if they have been observed at other stations.

A very bright one, almost like a rocket, passed exactly over Vega at 10.35.

Another, nearly as bright, passed through the intersection of the diagonals of the quadrilateral of Monoceros at 10.55.

P. G. Tait

St. Andrew's, N.B., Aug. 13

Mr. Herbert Spencer and Physical Axioms

I cannot help thinking that something of importance still remains to be said on the subject of the laws of motion, recently argued in your columns with so much ability by Spencer, Tait, and others.

There are three species of magnitude, viz., number, extended magnitude, and magnitude of degree. Magnitude of degree ad-

mits in itself no other mathematical comparison than that of equality and inequality, and no other mathematical treatment than simple increase or decrease, and in consequence it does not admit directly of ordinary mathematical investigation. Number and extended magnitude, such as length, duration, &c., admits of comparison by ratio, and of addition, subtraction, multiplication, division, &c. Magnitudes of degree are only brought under mathematical processes by means of conventional measurement. That is to say, some number or extended magnitude, which is found by experience to vary with the magnitude of degree, is adopted eventually as the measure of that magnitude, and mathematical processes are applied to the measure. It is incorrect, however, to say that we take an extended magnitude which varies in direct proportion with the magnitude of degree, as its measure, because direct proportion of magnitudes which vary together involves inequality of ratio of corresponding value, and, as already stated, the proportion of ratio does not really subsist between different values of a magnitude of degree, though from the intimate mental connection between certain magnitudes of degree and their measures, we often think it does.

When, for instance, we say that the brightness of two equal lights is double that of either, the statement is quite incapable of proof by experiment, and is certainly not intuitional; it is simply conventional. If we agreed that the brightness of a number of equal lights should be measured by the square root of the number, we should have to consider that the brightness of light varies inversely as its distance instead of as the square of its distance from its origin,—a result against which nothing could be urged but its practical inconvenience. Or, to take the example of a magnitude of degree whose conventional movement is somewhat less familiar to our minds: when we say that our expectation of an event which happens on an average three out of four times is double of our expectation of an event which happens once out of four times, we are clearly using words in a conventional way. The one belief is not really double of the other, but the average by which we agree to measure it is double.

Now with respect to force and mass, both magnitudes of degree, it so happens that there are two almost equally natural methods of measuring them consistent with, but nevertheless independent of, each other. Each of these may be conventionally adopted, but in either case its consistence with the other can only be demonstrated by experiment.

If you agree to measure force as directly proportionate to the acceleration it produces on a given mass, and mass as inversely proportionate to the acceleration produced by a given force, then, to that extent, the second law of motion, and the law which is sometimes adopted in place of Newton's third, are the results neither of experience nor intuition, but simply of convention; but then, on the other hand, it must be held that it is by experience we come to the conclusion that the mass of two bodies, *as above measured*, is the sum of their two masses, and the weight of two bodies the sum of their weights. If, on the other hand, you conventionally measure forces by the number of equal weights which will produce the same effect, and masses by the number of bodies of equal mass which make them up, then clearly the truth of the above portion of the laws of motion can only be proved by experience.

The mistake made by some mathematicians is that while ostensibly assuming the one conventional measure of force and mass they tacitly assume the other, and then illogically profess to demonstrate the necessary consequences of their own conventions by reference to experience founded on the other. They agree to measure force by the acceleration it produces in its own direction on a given mass, and then profess to prove forces do produce such proportionate acceleration by reference to experience, on the assumption that forces are to be measured by the number of equal weights or other forces which will produce the same effect.

In the case of the first law of motion, mathematicians often commit an error even more flagrant. To define force as that which affects motion, and then to profess that it is proved by experience that a body acted on by no force will remain at rest or move uniform, is on the face of it absurd. As well might Euclid, after defining a circle, have appealed to experience to show that a figure, every point of whose circumference is not equally distant from the centre, is not a circle. Or as well might a doctor begin by defining intoxication to be a state produced by taking alcohol, and then appeal to the experience of the Good Templars to prove that in the absence of alcohol there is no intoxication.

Herbert Spencer seems to me to be wrong, therefore, in concluding that our belief in the laws of motion is in the true sense (if it has any true sense) intuitive; but his error is the more excusable on account of the confusion of ideas involved in most mathematical explanations of these laws.

F. GUTHRIE

Graaff Reinet College, Cape of Good Hope, June 21

ORGANISATION OF THE FRENCH METEOROLOGICAL SERVICE

THE measures we alluded to in NATURE, vol. x. p. 294, with respect to the French Meteorological Service, have been partially adopted, and will be shortly followed by others. The Meteorological Service has been divided between two astronomers—M. Rayet, who has under his special care the magnetical map of France, the official observations taken at the observatory, and the several French stations; and M. Froat, who has been appointed to investigate the great disturbances of the atmosphere, to send warnings to the principal French seaports, to publish the atlas, and correspond with the several departmental commissions which have been already appointed. These departmental commissions are appointed by the prefect of each department, and funds are granted to them out of the departmental budget and voted by the Council-General of each department.

M. Leverrier issued, on August 5, a circular to these general commissions, informing them that the printing of the storm-maps, which had been stopped owing to the country's calamities, was to be resumed.

Special mention is made in this circular of the hailstorms which have been studied most carefully by MM. Becquerel, father and son. Nothing has been done yet to increase the efficiency of lightning conductors.

The several departmental commissions, numbering about ninety, including Algiers, have been grouped into six natural regions. M. Ch. Sainte-Clair Deville has been sent to Algiers to organise the meteorology of that country, from the sea to the remotest parts of the French possessions in the desert. He has not finished his tour yet. He is General Inspector for Meteorology, and had issued an order for altering the hours of observation, which order was cancelled by the Ministry.

Some arrangements have yet to be made with the navy for the storm warnings. Very likely French seaports will continue to receive warnings from England, which are very popular, as well as warnings from their own observatory.

NOTES

MR. BRIAN HODGSON, F.Z.S., has presented to the library of the Zoological Society a large collection of original drawings of Himalayan Mammals, made during his residence in Nepaul. They are of much scientific value, as being in many cases taken from the types on which his species are founded.

M. MAREY has recently published the results of experiments undertaken to determine by the graphic method what is the true movement of the legs in walking. His results prove convincingly that the brothers Weber were wrong in assuming that the oscillation of the leg which is not in contact with the ground is the same as that of a pendulum; for when it is represented on a uniformly moving plane, the line drawn is a straight and not a curved one. The movement of the suspended foot is therefore uniform, depending on muscular action, in combination with that of gravity.

DR. MORRISON WATSON, Senior Demonstrator of Anatomy in the University of Edinburgh, has been appointed Professor of Anatomy in the Owens College, Manchester.

A PARTICULARLY closely reasoned and valuable paper has just been published by Dr. William Marcet, F.R.S., entitled "An Experimental Inquiry into the Nutrition of Animal Tissues," in which the author argues out, and substantiates by careful analysis, his division of the constituents of animal tissues into the parts which constitute the working or ripe tissue, insoluble in water; the nutritive material of the tissue, colloid and soluble; and the products of tissue-destruction, crystalloid and soluble. We hope to be able to give an abstract of this paper on a future occasion.

Les Mondes announces the death, on July 21, of Count Gustave Doulcet de Pontécoulant, who was born in 1798.

THE seventh session of the International Congress of Anthropology and Prehistoric Archæology was closed at Stockholm on Sunday, after having fixed on Buda-Pesth as the next place of meeting. The number of members of this Association is upwards of 1,550: of these, 800 were present at the Stockholm meeting, which commenced on the 7th instant, when the following officials were chosen :—Patron, Oscar II., King of Sweden and Norway; president, Count Hammig Hamilton, Grand Chancellor of the Swedish Universities; honorary presidents, MM. Desor, Capellini, and Worsaae; vice-presidents, MM. Hildebrandt, sen., and Nilsson (Sweden), De Quatrefages (France), Franks (England), Virchow (Germany), Dupont (Belgium), Leemans and Bogdanow (Russia); general secretary, M. Hans Hildebrandt; secretaries, MM. Montelius, Retzius, Chantre, and Cazalis de Fondouce; assistant secretaries, MM. Stolpe and Landberg; council, MM. Bertrand, Berthelot, Evans, Von Quast, Schaffhausen, Pigorini, Van Beneden, Engelhardt, Rygh, Von Düben, Aspelin, Lerch, Romer, Whitney. The sittings were held at the *Riddarhus*, or "House of Knights," a house as old as the time of Gustavus Adolphus, which belongs to the Swedish nobility. Stockholm was very appropriately fixed upon as the place of meeting for this year's Congress, as the northern antiquaries and archæologists have done a great deal to form the departments of research with which the Congress deals; we need only mention the names of Bruzelius, Thomsen (Denmark), Nilsson, Retzius, and Hildebrandt. The magnificent museum of Stockholm was commenced in 1850, and finished in 1863, and the collection has been arranged by the Government Antiquary, M. Hildebrandt, and is one of the finest collections of prehistoric archæology in existence. Both the King and the city of Stockholm gave the antiquaries a splendid welcome.

THE British Medical Association meets next year in Edinburgh, the president-elect being Prof. Sir Robert Christison, Bart.

A NEW physiological laboratory, and also an addition to the chemical laboratory of Westminster Hospital, are rapidly approaching completion.

AT the meeting of the Paris Academy of Sciences on the 10th inst., a letter from the Minister of Public Instruction was read, informing the Academy that in consequence of the proposition made to the National Assembly in the month of July last to establish in the neighbourhood of Paris a Physical Observatory independent of the Astronomical Observatory, it was decided to consult the Academy as to the appropriateness and utility of such an establishment. The Minister requested the Academy to consider the question and let him know what conclusion they came to.

WITH reference to Prof. Newcomb's investigation of the moon's motion, the superintendent of the U.S. Naval Observatory reports that the work has been nearly accomplished and prepared for the press according to the original plan; but on examining certain terms troublesome to calculate, which it was supposed were entirely unimportant, it was found that the work could not be properly completed without them. The preparations for observing the transit of Venus have interfered with the development of these important terms. The second part of the work, namely, the tables founded upon Prof. Newcomb's theory, has been carried as far as it can be without the data that will be attainable as soon as the preparations for observing the transit of Venus are completed.

ADMIRAL SANDS, in his annual report with reference to the work of the U.S. Naval Observatory, states that observations, to be of any value to the world, must be published. If they are not, the time and labour spent upon them are simply wasted; and yet they are so much more easily made than reduced, that nothing is more common than to see them lie for years before the computations necessary to fit them for publication are completed. The Naval Observatory has been enabled to resuscitate from its store-rooms the zones of stars observed by Capt. Gilliss, in Chili, in 1850-52, and their reductions are now in such a state of forwardness that the resulting star catalogue will appear in the volume of Washington Observations for 1873. Thus it will be seen that nearly all the valuable observations which were at one time locked up in the archives of the observatory have been given to the world.

WE notice with much pleasure that the Society of Arts has issued a prospectus of Examinations in the Technology of Agriculture and Rural Economy, proposed to be held annually by the Society, as a part of its excellent system of technological examinations in the various industries of the country. We sincerely hope that the proposed examinations will be largely the means of carrying out the object which the Society has in view in instituting them, viz., the promotion of a more extended and intelligent study of agriculture and of the sciences bearing upon it, by those intending to adopt farming as an occupation. The examinations will consist of three parts :—(1) General Science, in which a very wide knowledge of the various sciences which lie at the basis of successful agriculture is demanded from the candidates; there are three certificates in this department—the Elementary Certificate, the Advanced Certificate, and Honours. (2) Technology, in which a knowledge of the many points connected with agriculture and rural economy will be demanded from the candidates proportioned to the class in which they may have passed in the previous examinations; this examination looks very formidable on paper, and to pass creditably in it will demand extensive reading and hard work on the part of the candidates. (3) Practical Knowledge: under this head the candidate must forward to the Society of Arts a certificate, on a form supplied, signed by some agriculturist with whom he may have been practically engaged in farming operations, showing that he has a practical acquaintance with the subject. In order to render these examinations really useful, the Council are making application to the Agricultural Societies, local and general, for assistance in founding scholarships for successful candidates to undergo a regular course of instruction at an Agricultural College. We hope the scheme of the Society of Arts will be productive of excellent results on the agriculture of the country.

M. RÉNAN has brought out a new work, "La Mission de Phénicie," being an account of the scientific researches in Syria during the sojourn of the French army in 1860-61.

A COMMITTEE has been formed to consider what means ought to be taken for the construction of an aquarium at Herne Bay.

PROF. GERVAIS (U.S.) has made a communication upon the teeth of the American reptile known as *Heloderma*. A species of the genus is abundant in Southern Arizona, where it is called a scorpion, and is reputed by the natives to be extremely venomous, although experiments carefully prosecuted by Dr. B. J. D. Irwin, of the United States army, failed to exhibit any evidence

of this fact. There is, as Gervais and others have found, a striking relationship between it and some of the poisonous serpents in the possession of a longitudinal furrow on the back part of the teeth, as if to carry poison from a gland. Whether the animal be actually poisonous or not, Gervais calls attention to the peculiar structure of the teeth (as shown by the microscope in a cross section), the basal part of which is filled by folds or plications directed outward toward the fine exterior coat of enamel.

Two new medical bi-monthly journals come to us from Paris; one, the *Paris Medical Record*, is in English, and in general appearance and arrangement resembles the *London Medical Record*; its declared intention is to supplement the efforts of other medical journals. The other, *Echo de la Presse Médicale*, is intended as the complement of the above, and is to be published every alternate week.

The Wheeler U.S. expedition started from Washington to concentrate at Pueblo, Colorado, on July 15, leaving there as soon thereafter as the different parties can be got into shape. It will move in three separate divisions, which will occupy portions of South-western Colorado and Northern New Mexico. The principal localities to be examined are south of the thirty-eighth parallel of north latitude, in the neighbourhood of the Rio San Juan, and the northern tributaries of the Rio Grande, Rio Chamas, Pecos, and Canadian, a region extremely interesting, and which must shortly be opened up for mining purposes. There will be two separate astronomical parties, one in charge of Mr. John H. Clark, with one assistant, at the observatory, Ogden, Utah; the other in charge of Dr. F. L. Kampf, who will have two assistants, and will occupy stations at Las Vegas, Cimmaron, Sidney Barracks, Julesburgh, and the crossing of the Union Pacific Railroad at the one hundredth meridian. In New Mexico there will be a special party operating, consisting of Prof. E. D. Cope, palæontologist, and Dr. H. C. Yarrow, naturalist of the survey, and one assistant. These gentlemen will visit certain specified areas in the valley of the Rio Grande and Rio San Juan. The main division will be in charge of Lieut. Wheeler, assisted by Lieut. C. W. Whipple and six civilian assistants. The first party of the first division will be in charge of Lieut. W. L. Marshall, assisted by three civilian assistants. The second party consists of Lieut. Rogers Birnie and five civilian assistants. The second division of the first party, Lieut. P. M. Price and four civilian assistants; second party, Lieut. S. E. Blunt and three civilian assistants. There is also a special natural history party, at present operating in portions of Arizona and New Mexico, consisting of Dr. J. T. Rothrock, botanist, Prof. H. W. Henshaw, ornithologist, and James Rutter, general collector. Dr. Oscar Loew will acompany the expedition as chemist and mineralogist, and will be assigned to one of the above-named sections. The entire expedition is made up of nine different parties, and will cover a wide and interesting field; and it is hoped that our geographical knowledge, in the broadest sense of the word, will be greatly augmented by its labours and investigations. Mr. Henshaw and his associates of the special party, above referred to, have been heard from in the vicinity of Fort Wingate, New Mexico, where they were making the best of their way south. They have already secured extensive collections of specimens, and a box has been received at the Washington office containing a number of bird-skins, Indian crania, fish, reptiles, insects, plants, &c. This party will proceed south to near the Mexican boundary, and then retrace their steps, disbanding at Santa Fé in the fall.

In a paper reprinted from the *American Journal of Science and Arts*, On the connection between isomorphism, molecular weight, and physiological action, by James Blake, M.D., the author gives the following results of investigations on the action of substances when introduced into the veins or arteries of living animals:—1. In the changes induced in living matter by inorganic compounds, the character of the change depends more on the physical properties of the reagent than on its more purely chemical properties. 2. That the character of the changes is determined by the isomorphous relations of the electro-positive element of the reagent. 3. That among the compounds of the more purely metallic elements, the quantity of substances in the same isomorphous group required to produce analogous changes in living matter, is less as the atomic weight of the electro-positive element increases. 4. That the action of inorganic compounds on living matter appears not to be connected with the changes they produce in the proximate elements of the solids and fluids, when no longer forming part of a living body, at least in so far as our present means of research enable us to judge. 5. That in living matter we possess a reagent capable of aiding us in our investigations on the molecular properties of substances.

There have been found in the Waiora district, Central India, in a coalfield of about 1,000 acres, two seams, one 15 ft. and the other 20 ft. thick, close together. In other parts the seam is from 50 ft. to 60 ft. thick. It is also said there are millions of tons of iron ore yielding 70 per cent. of metallic iron.

Among other recent interesting announcements is that by Mr. O. Harger of the discovery in the coal measures of Illinois of a fossil spider, to which the name *Arthrolycosa antiqua* has been applied.

The telegraphic apparatus at the U.S. Naval Observatory at Washington is now connected with the main lines of the Western Union Telegraph Company, so that not only is the time-ball dropped daily at noon, but the same signal is widely distributed by the telegraph company. It goes directly from the observatory to the main office in New York city, and thence it is sent to nearly every State in the Union. The immediate object of these signals is to furnish accurate and uniform time to the railroads, and throughout the whole of the vast territory in question there is scarcely a train whose movements are not regulated by the observatory clocks. The clocks at the Navy Department, at the Army Signal Office, at the Treasury Department, and at the Western Union Telegraph Company's office are all constructed on the system known as Hamblett's, and are directly controlled by electric currents sent every second by the standard clock at the observatory.

The additions to the Zoological Society's Gardens during the past week include a Puma (*Felis concolor*), and three Kinkajous (*Cercoleptes caudivolvulus*), from South America, presented by Mr. W. Delisle Powles; a Cuvier's Toucan (*Ramphastos cuvieri*), from Brazil, presented by Mr. Philip Harrington; a Macaque Monkey (*Macacus cynomolgus*), white variety, from India, presented by Sir Andrew Clarke; a West African Python (*Python sebæ*), deposited; a Crested Agouti (*Dasyprocta cristata*), from South America; five common Kingfishers (*Alcedo ispida*), British, purchased.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The forty-fourth Annual Meeting of the Association was opened yesterday at Belfast, when Prof. A. W. Williamson resigned the Presidency to Prof. Tyndall, who delivered the opening Address.

As in former years, we are able, by the courtesy of the officers of the Association, to publish this week the Address of the President of the Association, and the Addresses of some of the Presidents of Sections.

INAUGURAL ADDRESS OF PROF. JOHN TYNDALL, D.C.L., LL.D., F.R.S., PRESIDENT.

AN impulse inherent in primeval man turned his thoughts and questionings betimes towards the sources of natural phenomena. The same impulse, inherited and intensified, is the spur of scientific action to-day. Determined by it, by a process of abstraction from experience we form physical theories which lie beyond the pale of experience, but which satisfy the desire of the mind to see every natural occurrence resting upon a cause. In forming their notions of the origin of things, our earliest historic (and doubtless, we might add, our prehistoric) ancestors pursued, as far as their intelligence permitted, the same course. They also fell back upon experience, but with this difference—that the particular experiences which furnished the weft and woof of their theories were drawn, not from the study of nature, but from what lay much closer to them, the observation of men. Their theories accordingly took an anthropomorphic form. To supersensual beings, which, "however potent and invisible, were nothing but a species of human creatures, perhaps raised from among mankind, and retaining all human passions and appetites,"* were handed over the rule and governance of natural phenomena.

Tested by observation and reflection, these early notions failed in the long run to satisfy the more penetrating intellects of our race. Far in the depths of history we find men of exceptional power differentiating themselves from the crowd, rejecting these anthropomorphic notions, and seeking to connect natural phenomena with their physical principles. But long prior to these purer efforts of the understanding the merchant had been abroad, and rendered the philosopher possible; commerce had been developed, wealth amassed, leisure for travel and for speculation secured, while races educated under different conditions, and therefore differently informed and endowed, had been stimulated and sharpened by mutual contact. In those regions where the commercial aristocracy of ancient Greece mingled with its eastern neighbours, the sciences were born, being nurtured and developed by free-thinking and courageous men. The state of things to be displaced may be gathered from a passage of Euripides quoted by Hume. "There is nothing in the world; no glory, no prosperity. The gods toss all into confusion; mix everything with its reverse, that all of us, from our ignorance and uncertainty, may pay them the more worship and reverence." Now, as science demands the radical extirpation of caprice and the absolute reliance upon law in nature, there grew with the growth of scientific notions a desire and determination to sweep from the field of theory this mob of gods and demons, and to place natural phenomena on a basis more congruent with themselves.

The problem which had been previously approached from above was now attacked from below; theoretic effort passed from the super to the sub-sensible. It was felt that to construct the universe in idea it was necessary to have some notion of its constituent parts—of what Lucretius subsequently called the "First Beginnings." Abstracting again from experience, the leaders of scientific speculation reached at length the pregnant doctrine of atoms and molecules, the latest developments of which were set forth with such power and clearness at the last meeting of the British Association. Thought no doubt had long hovered about this doctrine before it attained the precision and completeness which it assumed in the mind of Democritus,† a philosopher who may well for a moment arrest our attention. "Few great men," says Lange, in his excellent "History of Materialism," a work to the spirit and the letter of which I am equally indebted, "have been so despitefully used by history as Democritus. In the distorted images sent down to us through unscientific traditions there remains of him almost nothing but the name of the 'laughing philosopher,' while figures of immeasurably smaller significance spread themselves at full length before us." Lange speaks of Bacon's high appreciation of Democritus—for ample illustrations of which I am indebted to my excellent friend Mr. Spedding, the learned editor and biographer of Bacon. It is evident, indeed, that Bacon considered Democritus to be a man of weightier metal than either Plato or Aristotle, though their philosophy "was noised and celebrated in the schools, amid the din and pomp of professors." It was not they, but Genseric and Attila and the barbarians, who destroyed the atomic philosophy. "For at a time when all human learning had suffered shipwreck, these planks of Aristotelian and Platonic philosophy, as being of a lighter and more inflated substance, were preserved and come down to us, while things more solid sank and almost passed into oblivion."

* Hume, "Natural History of Religion."
† Born 460 B.C.

The principles enunciated by Democritus reveal his uncompromising antagonism to those who deduced the phenomena of nature from the caprices of the gods. They are briefly these:—1. From nothing comes nothing. Nothing that exists can be destroyed. All changes are due to the combination and separation of molecules. 2. Nothing happens by chance. Every occurrence has its cause from which it follows by necessity. 3. The only existing things are the atoms and empty space; all else is mere opinion. 4. The atoms are infinite in number, and infinitely various in form; they strike together, and the lateral motions and whirlings which thus arise are the beginnings of worlds. 5. The varieties of all things depend upon the varieties of their atoms, in number, size, and aggregation. 6. The soul consists of free, smooth, round atoms, like those of fire. These are the most mobile of all. They interpenetrate the whole body, and in their motions the phenomena of life arise. Thus the atoms of Democritus are individually without sensation; they combine in obedience to mechanical laws; and not only organic forms, but the phenomena of sensation and thought are also the result of their combination.

That great enigma, "the exquisite adaptation of one part of an organism to another part, and to the conditions of life," more especially the construction of the human body, Democritus made no attempt to solve. Empedocles, a man of more fiery and poetic nature, introduced the notion of love and hate among the atoms to account for their combination and separation. Noticing this gap in the doctrine of Democritus, he struck in with the penetrating thought, linked, however, with some wild speculation, that it lay in the very nature of those combinations which were suited to their ends (in other words, in harmony with their environment) to maintain themselves, while unfit combinations, having no proper habitat, must rapidly disappear. Thus more than 2 000 years ago the doctrine of the "survival of the fittest," which in our day, not on the basis of vague conjecture, but of positive knowledge, has been raised to such extraordinary significance, had received at all events partial enunciation.*

Epicurus,† said to be the son of a poor schoolmaster at Samos, is the next dominant figure in the history of the atomic philosophy. He mastered the writings of Democritus, heard lectures in Athens, returned to Samos, and subsequently wandered through various countries. He finally returned to Athens, where he bought a garden, and surrounded himself by pupils, in the midst of whom he lived a pure and serene life, and died a peaceful death. His philosophy was almost identical with that of Democritus; but he never quoted either friend or foe. One main object of Epicurus was to free the world from superstition and the fear of death. Death he treated with indifference. It merely robs us of sensation. As long as we are, death is not; and when death is, we are not. Life has no more evil for him who has made up his mind that it is no evil not to live. He adored the gods, but not in the ordinary fashion. The idea of divine power, properly purified, he thought an elevating one. Still he taught, "Not he is godless who rejects the gods of the crowd, but rather he who accepts them." The gods were to him eternal and immortal beings, whose blessedness excluded every thought of care or occupation of any kind. Nature pursues her course in accordance with everlasting laws, the gods never interfering. They haunt

> "The lucid interspace of world and world
> Where never creeps a cloud or moves a wind,
> Nor ever falls the least white star of snow,
> Nor ever lowest roll of thunder moans,
> Nor sound of human sorrow mounts to mar
> Their sacred everlasting calm." ‡

Lange considers the relation of Epicurus to the gods subjective; the indication probably of an ethical requirement of his own nature. We cannot read history with open eyes, or study human nature to its depths, and fail to discern such a requirement. Man never has been and he never will be satisfied with the operations and products of the understanding alone; hence physical science cannot cover all the demands of his nature. But the history of the efforts made to satisfy these demands might be broadly described as a history of errors—the error consisting in ascribing fixity to that which is fluent, which varies as we vary, being gross when we are gross, and becoming, as our capacities widen, more abstract and sublime. On one great point the mind of Epicurus was at peace. He neither sought

* Lange, 2nd edit., p. 23. † Born 342 B.C.
‡ Tennyson's "Lucretius."

nor expected, here or hereafter, any personal profit from his relation to the gods. And it is assuredly a fact that loftiness and serenity of thought may be promoted by conceptions which involve no idea of profit of this kind. "Did I not believe," said a great man to me once, "that an Intelligence is at the heart of things, my life on earth would be intolerable." The utterer of these words is not, in my opinion, rendered less noble but more noble, by the fact that it was the need of ethical harmony here, and not the thought of personal profit hereafter, that prompted his observation.

A century and a half after the death of Epicurus, Lucretius * wrote his great poem, "On the Nature of Things," in which he, a Roman, developed with extraordinary ardour the philosophy of his Greek predecessor. He wishes to win over his friend Memmius to the school of Epicurus; and although he has no rewards in a future life to offer, although his object appears to be a purely negative one, he addresses his friend with the heat of an apostle. His object, like that of his great forerunner, is the destruction of superstition; and considering that men trembled before every natural event as a direct monition from the gods, and that everlasting torture was also in prospect, the freedom aimed at by Lucretius might perhaps be deemed a positive good. "This terror," he says, "and darkness of mind must be dispelled, not by the rays of the sun and glittering shafts of day, but by the aspect and the law of nature." He refutes the notion that anything can come out of nothing, or that that which is once begotten can be recalled to nothing. The first beginnings, the atoms, are indestructible, and into them all things can be dissolved at last. Bodies are partly atoms and partly combinations of atoms; but the atoms nothing can quench. They are strong in solid singleness, and by their denser combination all things can be closely packed and exhibit enduring strength. He denies that matter is infinitely divisible. We come at length to the atoms, without which, as an imperishable substratum, all order in the generation and development of things would be destroyed.

The mechanical shock of the atoms being in his view the all-sufficient cause of things, he combats the notion that the constitution of nature has been in any way determined by intelligent design. The interaction of the atoms throughout infinite time rendered all manner of combinations possible. Of these the fit ones persisted, while the unfit ones disappeared. Not after sage deliberation did the atoms station themselves in their right places, nor did they bargain what motions they should assume. From all eternity they have been driven together, and after trying motions and unions of every kind, they fell at length into the arrangements out of which this system of things has been formed. His grand conception of the atoms falling silently through immeasurable ranges of space and time suggested the nebular hypothesis to Kant, its first propounder. "If you will apprehend and keep in mind these things, Nature, free at once, and rid of her haughty lords, is seen to do all things spontaneously of herself, without the meddling of the gods." †

During the centuries between the first of these three philosophers and the last, the human intellect was active in other fields than theirs. The Sophists had run through their career. At Athens had appeared the three men, Socrates, Plato, and Aristotle, whose yoke remains to some extent unbroken to the present hour. Within this period also the School of Alexandria was founded, Euclid wrote his "Elements," and he and others made some advance in optics. Archimedes had propounded the theory of the lever and the principles of hydrostatics. Pythagoras had made his experiments on the harmonic intervals, while astronomy was immensely enriched by the discoveries of Hipparchus, who was followed by the historically more celebrated Ptolemy. Anatomy had been made the basis of scientific medicine; and it is said by Draper ‡ that vivisection then began. In fact, the science of ancient Greece had already cleared the world of the fantastic images of divinities operating capriciously through natural phenomena. It had shaken itself free from that fruitless scrutiny "by the internal light of the mind alone," which had vainly sought to transcend experience and reach a knowledge of ultimate causes. Instead of accidental observation, it had introduced observation with a purpose; instruments were employed to aid the senses; and scientific method was rendered in a great measure complete by the union of induction and experiment.

What, then, stopped its victorious advance? Why was the scientific intellect compelled, like an exhausted soil, to lie fallow for nearly two millenniums before it could regather the elements necessary to its fertility and strength? Bacon has already let us know one cause; Whewell ascribes this stationary period to four causes—obscurity of thought, servility, intolerance of disposition, enthusiasm of temper; and he gives striking examples of each.* But these characteristics must have had their causes, which lay in the circumstances of the time. Rome and the other cities of the empire had fallen into moral putrefaction. Christianity had appeared, offering the gospel to the poor, and by moderation if not asceticism of life, practically protesting against the profligacy of the age. The sufferings of the early Christians and the extraordinary exaltation of mind which enabled them to triumph over the diabolical tortures to which they were subjected,† must have left traces not easily effaced. They scorned the earth, in view of that "building of God, that house not made with hands, eternal in the heavens." The Scriptures which ministered to their spiritual needs were also the measure of their science. When, for example, the celebrated question of antipodes came to be discussed, the Bible was with many the ultimate court of appeal. Augustine, who flourished A.D. 400, would not deny the rotundity of the earth, but he would deny the possible existence of inhabitants at the other side, "because no such race is recorded in Scripture among the descendants of Adam." Archbishop Boniface was shocked at the assumption of a "world of human beings out of the reach of the means of salvation." Thus reined in, science was not likely to make much progress. Later on, the political and theological strife between the Church and civil governments, so powerfully depicted by Draper, must have done much to stifle investigation.

Whewell makes many wise and brave remarks regarding the spirit of the Middle Ages. It was a menial spirit. The seekers after natural knowledge had forsaken that fountain of living waters, the direct appeal to nature by observation and experiment, and had given themselves up to the remanipulation of the notions of their predecessors. It was a time when thought had become abject, and when the acceptance of mere authority led, as it always does in science, to intellectual death. Natural events, instead of being traced to physical, were referred to moral causes, while an exercise of the phantasy, almost as degrading as the spiritualism of the present day, took the place of scientific speculation. Then came the mysticism of the Middle Ages, magic, alchemy, the Neo-platonic philosophy, with its visionary though sublime attractions, which caused men to look with shame upon their own bodies as hindrances to the absorption of the creature in the blessedness of the Creator. Finally came the scholastic philosophy, a fusion, according to Lange, of the least mature notions of Aristotle with the Christianity of the west. Intellectual immobility was the result. As a traveller without a compass in a fog may wander long, imagining he is making way, and find himself, after hours of toil at his starting-point, so the schoolmen, having tied and untied the same knots, and formed and dissipated the same clouds, found themselves at the end of centuries in their old position.

With regard to the influence wielded by Aristotle in the Middle Ages, and which, though to a less extent, he still wields, I would ask permission to make one remark. When the human mind has achieved greatness and given evidence of extraordinary power in any domain, there is a tendency to credit it with similar power in all other domains. Thus theologians have found comfort and assurance in the thought that Newton dealt with the question of revelation, forgetful of the fact that the very devotion of his powers, through all the best years of his life, to a totally different class of ideas, not to speak of any natural disqualification, tended to render him less instead of more competent to deal with theological and historic questions. Goethe, starting from his established greatness as a poet, and indeed from his positive discoveries in natural history, produced a profound impression among the painters of Germany when he published his "Farbenlehre," in which he endeavoured to overthrow Newton's theory of colours. This theory he deemed so obviously absurd, that he considered its author a charlatan, and attacked him with a corresponding vehemence of language. In the domain of natural history Goethe had made really considerable discoveries; and we have high authority for assuming that

* Born 99 B.C.

† Monro's translation. In his criticism of this work (*Contemporary Review*, 1867) Dr. Hayman does not appear to be aware of the really sound and subtile observations on which the reasoning of Lucretius, though erroneous, sometimes rests.

‡ "History of the Intellectual Development of Europe," p. 295.

* "History of the Inductive Sciences," vol. i.

† Depicted with terrible vividness in Renan's "Antichrist."

had he devoted himself wholly to that side of science, he might have reached in it an eminence comparable with that which he attained as a poet. In sharpness of observation, in the detection of analogies, however apparently remote, in the classification and organisation of facts according to the analogies discerned, Goethe possessed extraordinary powers. These elements of scientific inquiry fall in with the discipline of the poet. But, on the other hand, a mind thus richly endowed in the direction of natural history, may be almost shorn of endowment as regards the more strictly called physical and mechanical sciences. Goethe was in this condition. He could not formulate distinct mechanical conceptions; he could not see the force of mechanical reasoning; and in regions where such reasoning reigns supreme he became a mere *ignis fatuus* to those who followed him.

I have sometimes permitted myself to compare Aristotle with Goethe, to credit the Stagirite with an almost superhuman power of amassing and systematising facts, but to consider him fatally defective on that side of the mind in respect to which incompleteness has been justly ascribed to Goethe. Whewell refers the errors of Aristotle, not to a neglect of facts, but to "a neglect of the idea appropriate to the facts; the idea of mechanical cause, which is force, and the substitution of vague or inapplicable notions, involving only relations of space or emotions of wonder." This is doubtless true; but the word "neglect" implies mere intellectual misdirection, whereas in Aristotle, as in Goethe, it was not, I believe, misdirection, but sheer natural incapacity which lay at the root of his mistakes. As a physicist, Aristotle displayed what we should consider some of the worst attributes of a modern physical investigator—indistinctness of ideas, confusion of mind, and a confident use of language, which led to the delusive notion that he had really mastered his subject, while he as yet had failed to grasp even the elements of it. He put words in the place of things, subject in the place of object. He preached induction without practising it, inverting the true order of inquiry by passing from the general to the particular, instead of from the particular to the general. He made of the universe a closed sphere, in the centre of which he fixed the earth, proving from general principles, to his own satisfaction and that of the world for near 2,000 years, that no other universe was possible. His notions of motion were entirely unphysical. It was natural or unnatural, better or worse, calm or violent—no real mechanical conception regarding it lying at the bottom of his mind. He affirmed that a vacuum could not exist, and proved that if it did exist motion in it would be impossible. He determined *à priori* how many species of animals must exist, and showed on general principles why animals must have such and such parts. When an eminent contemporary philosopher, who is far removed from errors of this kind, remembers these abuses of the *à priori* method, he will be able to make allowance for the jealousy of physicists as to the acceptance of so-called *à priori* truths. Aristotle's errors of detail were grave and numerous. He affirmed that only in man we had the beating of the heart, that the left side of the body was colder than the right, that men have more teeth than women, and that there is an empty space, not at the front, but at the back of every man's head.

There is one essential quality in physical conceptions which was entirely wanting in those of Aristotle and his followers. I wish it could be expressed by a word untainted by its associations; it signifies a capability of being placed as a coherent picture before the mind. The Germans express the act of picturing by the word *vorstellen*, and the picture they call a *vorstellung*. We have no word in English which comes nearer to our requirements than *imagination*, and, taken with its proper limitations, the word answers very well; but, as just intimated, it is tainted by its associations, and therefore objectionable to some minds. Compare, with reference to this capacity of mental presentation, the case of the Aristotelian, who refers the ascent of water in a pump to Nature's abhorrence of a vacuum, with that of Pascal when he proposed to solve the question of atmospheric pressure by the ascent of the Puy de Dome. In the one case the terms of the explanation refuse to fall into place as a physical image; in the other the image is distinct, the fall and rise of the barometer being clearly figured as the balancing of two varying and opposing pressures.

During the drought of the Middle Ages in Christendom, the Arabian intellect, as forcibly shown by Draper, was active. With the intrusion of the Moors into Spain, cleanliness, order, learning, and refinement took the place of their opposites. When smitten with the disease, the Christian peasant resorted to a shrine; the Moorish one to an instructed physician. The Arabs encouraged translations from the Greek philosophers, but not from the Greek poets. They turned in disgust "from the lewdness of our classical mythology, and denounced as an unpardonable blasphemy all connection between the impure Olympian Jove and the Most High God." Draper traces still further than Whewell the Arab elements in our scientific terms, and points out that the under garment of ladies retains to this hour its Arab name. He gives examples of what Arabian men of science accomplished, dwelling particularly on Alhazen, who was the first to correct the Platonic notion that rays of light are emitted by the eye. He discovered atmospheric refraction, and points out that we see the sun and moon after they have set. He explains the enlargement of the sun and moon, and the shortening of the vertical diameters of both these bodies, when near the horizon. He is aware that the atmosphere decreases in density with increase of height, and actually fixes its height at $58\frac{1}{2}$ miles. In the Book of the Balance Wisdom, he sets forth the connection between the weight of the atmosphere and its increasing density. He shows that a body will weigh differently in a rare and a dense atmosphere: he considers the force with which plunged bodies rise through heavier media. He understands the doctrine of the centre of gravity, and applies it to the investigation of balances and steelyards. He recognises gravity as a force, though he falls into the error of making it diminish at the distance, and of making it purely terrestrial. He knows the relation between the velocities, spaces, and times of falling bodies, and has distinct ideas of capillary attraction. He improves the hydrometer. The determination of the densities of the bodies as given by Alhazen approach very closely to our own. "I join," says Draper, in the pious prayer of Alhazen, "that in the day of judgment the All-Merciful will take pity on the soul of Abur-Raihân, because he was the first of the race of men to construct a table of specific gravities." If all this be historic truth (and I have entire confidence in Dr. Draper), well may he "deplore the systematic manner in which the literature of Europe has contrived to put out of sight our scientific obligations to the Mahommedans." *

Towards the close of the stationary period a word-weariness, if I may so express it, took more and more possession of men's minds. Christendom had become sick of the school philosophy and its verbal wastes, which led to no issue, but left the intellect in everlasting haze. Here and there was heard the voice of one impatiently crying in the wilderness, "Not unto Aristotle, not unto subtle hypotheses, not unto Church, Bible, or blind tradition, must we turn for a knowledge of the universe, but to the direct investigation of nature by observation and experiment." In 1543 the epoch-making work of Copernicus on the paths of the heavenly bodies appeared. The total crash of Aristotle's closed universe with the earth at its centre followed as a consequence; and "the earth moves" became a kind of watchword among intellectual freemen. Copernicus was the Canon of the Church of Frauenburg, in the diocese of Ermeland. For three-and-thirty years he had withdrawn himself from the world and devoted shimself to the consolidation of his great scheme of the solar system. He made its blocks eternal; and even to those who feared it and desired its overthrow it was so obviously strong that they refrained from meddling with it. In the last year of the life of Copernicus his book appeared: it is said that the old man received a copy of it a few days before his death, and then departed in peace.

The Italian philosopher Giordano Bruno was one of the earliest converts to the new astronomy. Taking Lucretius as his exemplar, he revived the notion of the infinity of worlds; and combining with it the doctrine of Copernicus, reached the sublime generalisation that the fixed stars are suns, scattered numberless through space and accompanied by satellites, which bear the same relation to them as the earth does to our sun, or our moon to our earth. This was an expansion of transcendent import; but Bruno came closer than this to our present line of thought. Struck with the problem of the generation and maintenance of organisms, and duly pondering it, he came to the conclusion that nature in her productions does not imitate the technic of man. Her process is one of unravelling and unfolding. The infinity of forms under which matter appears were not imposed upon it by an external artificer; by its own intrinsic force and virtue it brings these forms forth. Matter is not the mere naked, empty *capacity* which philosophers have pictured her to be, but

* "Intellectual Development of Europe," p. 359.

the universal mother, who brings forth all things as the fruit of her own womb.

This outspoken man was originally a Dominican monk. He was accused of heresy and had to fly, seeking refuge in Geneva, Paris, England, and Germany. In 1592 he fell into the hands of the Inquisition at Venice. He was imprisoned for many years, tried, degraded, excommunicated, and handed over to the civil power, with the request that he should be treated gently and "without the shedding of blood." This meant that he was to be burnt; and burnt accordingly he was, on Feb. 16, 1600. To escape a similar fate, Galileo, thirty-three years afterwards, abjured, upon his knees and with his hand on the holy gospels, the heliocentric doctrine. After Galileo came Kepler, who from his German home defied the power beyond the Alps. He traced out from pre-existing observations the laws of planetary motion. The problem was thus prepared for Newton, who bound those empirical laws together by the principle of gravitation.

During the Middle Ages the doctrine of atoms had to all appearance vanished from discussion. In all probability it held its ground among sober-minded and thoughtful men, though neither the Church nor the world was prepared to hear of it with tolerance. Once, in the year 1348, it received distinct expression. But retractation by compulsion immediately followed, and thus discouraged, it slumbered till the 17th century, when it was revived by a contemporary of Hobbes and Descartes, the Père Gassendi.

The analytic and synthetic tendencies of the human mind exhibit themselves throughout history, great writers ranging themselves sometimes on the one side, sometimes on the other. Men of lofty feelings, and minds open to the elevating impressions produced by nature as a whole, whose satisfaction, therefore, is rather ethical than logical, have leaned to the synthetic side; while the analytic harmonises best with the more precise and more mechanical bias which seeks the satisfaction of the understanding. Some form of pantheism was usually adopted by the one, while a detached Creator, working more or less after the manner of men, was often assumed by the other.* Gassendi is hardly to be ranked with either. Having formerly acknowledged God as the first great cause, he immediately drops the idea, applies the known laws of mechanics to the atoms, and thence deduces all vital phenomena. God who created earth and water, plants and animals, produced in the first place a definite number of atoms, which constituted the seed of all things. Then began that series of combinations and decompositions which goes on at the present day, and which will continue in the future. The principle of every change resides in matter. In artificial productions the moving principle is different from the material worked upon; but in nature the agent works within, being the most active and mobile part of the material itself. Thus this bold ecclesiastic, without incurring the censure of the Church or the world, contrives to outstrip Mr. Darwin. The same cast of mind which caused him to detach the Creator from his universe led him also to detach the soul from the body, though to the body he ascribes an influence so large as to render the soul almost unnecessary. The aberrations of reason were in his view an affair of the material brain. Mental disease is brain-disease; but then the immortal reason sits apart, and cannot be touched by the disease. The errors of madness are errors of the instrument, not of the performer.

It may be more than a mere result of education, connecting itself probably with the deeper mental structure of the two men, that the idea of Gassendi, above enunciated, is substantially the same as that expressed by Prof. Clerk Maxwell at the close of the very noble lecture delivered by him at Bradford last year. According to both philosophers, the atoms, if I understand aright, are the *prepared materials*, the "manufactured articles," which, formed by the skill of the Highest, produce by their subsequent interaction all the phenomena of the material world. There seems to be this difference, however, between Gassendi and Maxwell. The one *postulates*, the other *infers* his first cause. In his manufactured articles, Prof. Maxwell finds the basis of an induction which enables him to scale philosophic heights considered inaccessible by Kant, and to take the logical step from the atoms to their Maker.

The atomic doctrine, in whole or in part, was entertained by Bacon, Descartes, Hobbes, Locke, Newton, Boyle, and their successors, until the chemical law of multiple proportions enabled Dalton to confer upon it an entirely new significance. In our day there are secessions from the theory, but it still stands firm. Only a year or two ago Sir William Thomson, with characteristic penetration, sought to determine the sizes of the atoms, or rather to fix the limits between which their sizes lie; while only last year the discourses of Williamson and Maxwell illustrate the present hold of the doctrine upon the foremost scientific minds. What these atoms, self-moved and self-posited, can and cannot accomplish in relation to life, is at the present moment the subject of profound scientific thought. I doubt the legitimacy of Maxwell's logic; but it is impossible not to feel the ethic glow with which his lecture concludes. There is, moreover, a Lucretian grandeur in his description of the stedfastness of the atoms:—"Natural causes, as we know, are at work, which tend to modify, if they do not at length destroy, all the arrangements and dimensions of the earth and the whole solar system. But though in the course of ages catastrophes have occurred and may yet occur in the heavens, though ancient systems may be dissolved and new systems evolved out of their ruins, the molecules out of which these systems are built, the foundation stones of the material universe, remain unbroken and unworn."

Ninety years subsequent to Gassendi the doctrine of bodily instruments, as it may be called, assumed immense importance in the hands of Bishop Butler, who, in his famous "Analogy of Religion," developed, from his own point of view, and with consummate sagacity, a similar idea. The bishop still influences superior minds; and it will repay us to dwell for a moment on his views. He draws the sharpest distinction between our real selves and our bodily instruments. He does not, as far as I remember, use the word soul, possibly because the term was so hackneyed in his day, as it had been for many generations previously. But he speaks of "living powers," "perceiving" or "percipient powers," "moving agents," "ourselves," in the same sense as we should employ the term soul. He dwells upon the fact that limbs may be removed and mortal diseases assail the body, while the mind, almost up to the moment of death, remains clear. He refers to sleep and to swoon, where the "living powers" are suspended but not destroyed. He considers it quite as easy to conceive of an existence out of our bodies as in them; that we may animate a succession of bodies, the dissolution of all of them having no more tendency to dissolve our real selves, or "deprive us of living faculties—the faculties of perception and action—than the dissolution of any foreign matter which we are capable of receiving impressions from, or making use of, for the common occasions of life." This is the key of the bishop's position: "Our organised bodies are no more a part of ourselves than any other matter around us." In proof of this he calls attention to the use of glasses, which "prepare objects" for the "percipient power" exactly as the eye does. The eye itself is no more percipient than the glass, and is quite as much the instrument of the true self, and also as foreign to the true self, as the glass is. "And if we see with our eyes only in the same manner as we do with glasses, the like may justly be concluded from analogy of all our senses."

Lucretius, as you are aware, reached a precisely opposite conclusion; and it certainly would be interesting, if not profitable, to us all, to hear what he would or could urge in opposition to the reasoning of the bishop. As a brief discussion of the point will enable us to see the bearings of an important question, I will here permit a disciple of Lucretius to try the strength of the bishop's position, and then allow the bishop to retaliate, with the view of rolling back, if he can, the difficulty upon Lucretius. Each shall state his case fully and frankly; and you shall be umpire between them. The argument might proceed in this fashion:—

"Subjected to the test of mental presentation (*Vorstellung*) your views, most honoured prelate, would present to many minds a great, if not an insuperable difficulty. You speak of 'living powers,' 'percipient or perceiving powers,' and 'ourselves;' but can you form a mental picture of any one of these apart from the organism through which it is supposed to act? Test yourself honestly, and see whether you possess any faculty that would enable you to form such a conception. The true self has a local habitation in each of us; thus localised, must it not possess a form? If so, what form? Have you ever for a moment realised it? When a leg is amputated the body is divided into two parts; is the true self in both of them or in one? Thomas Aquinas might say in both; but not you, for you appeal to the consciousness associated with one of the two parts to prove that the other is foreign matter. Is conscious-

* Boyle's model of the universe was the Strasburg clock with an outside artificer. Goethe, on the other hand, sang

"Ihm ziemt's die Welt im Innern zu bewegen,
Natur in sich, sich in Natur zu hegen."

The same repugnance to the clockmaker conception is manifest in Carlyle.

ness, then, a necesary element of the true self? If so, what do you say to the case of the whole body being deprived of consciousness? If not, then on what grounds do you deny any portion of the true self to the severed limb? It seems very singular that, from the beginning to the end of your admirable book (and no one admires its sober strength more than I do), you never once mention the brain or nervous system. You begin at one end of the body, and show that its parts may be removed without prejudice to the perceiving power. What if you begin at the other end, and remove, instead of the leg, the brain? The body, as before, is divided into two parts; but both are now in the same predicament, and neither can be appealed to to prove that the other is foreign matter. Or, instead of going so far as to remove the brain itself, let a certain portion of its bony covering be removed, and let a rhythmic series of pressure and relaxations of pressure be applied to the soft substance. At every pressure 'the faculties of perception and of action' vanish; at every relaxation of pressure they are restored. Where, during the intervals of pressure, is the perceiving power? I once had the dischage of a Leyden battery passed unexpectedly through me: I felt nothing, but was simply blotted out of conscious existence for a sensible interval. Where was my true self during that interval? Men who have recovered from lightning-stroke have been much longer in the same state; and indeed in cases of ordinary concussion of the brain, days may elapse during which no experience is registered in consciousness. Where is the man himself during the period of insensibility? You may say that I beg the question when I assume the man to have been unconscious, that he was really conscious all the time, and has simply forgotten what had occurred to him. In reply to this, I can only say that no one need shrink from the worst tortures that superstition ever invented if only so felt and so remembered. I do not think your theory of instruments goes at all to the bottom of the matter. A telegraph operator has his instruments, by means of which he converses with the world; our bodies possess a nervous system, which plays a similar part between the perceiving powers and external things. Cut the wires of the operator, break his battery, demagnetise his needle: by this means you certainly sever his connection with the world; but inasmuch as these are real instruments, their destruction does not touch the man who uses them. The operator survives, *and he knows that he survives*. What is it, I would ask, in the human system that answers to this conscious survival of the operator when the battery of the brain is so disturbed as to produce insensibility, or when it is destroyed altogether?

"Another consideration, which you may consider slight, presses upon me with some force. The brain may change from health to disease, and through such a change the most exemplary man may be converted into a debauchee or a murderer. My very noble and approved good master had, as you know, threatenings of lewdness introduced into his brain by his jealous wife's philter; and sooner than permit himself to run even the risk of yielding to these base promptings he slew himself. How could the hand of Lucretius have been thus turned against himself if the real Lucretius remained as before? Can the brain or can it not act in this distempered way without the intervention of the immortal reason? If it can, then it is a prime mover which requires only healthy regulation to render it reasonably self-acting, and there is no apparent need of your immortal reason at all. If it cannot, then the immortal reason, by its mischievous activity in operating upon a broken instrument, must have the credit of committing every imaginable extravagance and crime. I think, if you will allow me to say so, that the gravest consequences are likely to flow from your estimate of the body. To regard the brain as you would a staff or an eyeglass—to shut your eyes to all its mystery, to the perfect correlation that reigns between its condition and our consciousness, to the fact that a slight excess or defect of blood in it produces that very swoon to which you refer, and that in relation to it our meat and drink and air and exercise have a perfectly transcendental value and significance—to forget all this does, I think, open a way to innumerable errors in our habits of life, and may possibly in some cases initiate and foster that very disease, and consequent mental ruin, which a wiser appreciation of this mysterious organ would have avoided."

I can imagine the bishop thoughtful after hearing this argument. He was not the man to allow anger to mingle with the consideration of a point of this kind. After due consideration, and having strengthened himself by that honest contemplation of the facts which was habitual with him, and which includes the desire to give even adverse facts their due weight, I can suppose the bishop to proceed thus:—"You will remember that in the 'Analogy of Religion,' of which you have so kindly spoken, I did not profess to prove anything absolutely, and that I over and over again acknowledged and insisted on the smallness of our knowledge, or rather the depth of our ignorance, as regards the whole system of the universe. My object was to show my deistical friends who set forth so eloquently the beauty and beneficence of Nature and the Ruler thereof, while they had nothing but scorn for the so-called absurdities of the Christian scheme, that they were in no better condition than we were, and that for every difficulty they found upon our side, quite as great a difficulty was to be found on theirs. I will now with your permission adopt a similar line of argument. You are a Lucretian, and from the combination and separation of atoms deduce all terrestrial things, including organic forms and their phenomena. Let me tell you in the first instance how far I am prepared to go with you. I admit that you can build crystalline forms out of this play of molecular force; that the diamond, amethyst, and snow-star are truly wonderful structures which are thus produced. I will go further and acknowledge that even a tree or flower might in this way be organised. Nay, if you can show me an animal without sensation, I will concede to you that it also might be put together by the suitable play of molecular force.

"Thus far our way is clear, but now comes my difficulty. Your atoms are individually without sensation, much more are they without intelligence. May I ask you, then, to try your hand upon this problem. Take your dead hydrogen atoms, your dead oxygen atoms, your dead carbon atoms, your dead nitrogen atoms, your dead phosphorus atoms, and all the other atoms, dead as grains of shot, of which the brain is formed. Imagine them separate and sensationless; observe them running together and forming all imaginable combinations. This, as a purely mechanical process, is *seeable* by the mind. But can you see, or dream, or in any way imagine, how out of that mechanical act, and from these individually dead atoms, sensation, thought, and emotion are to arise? You speak of the difficulty of mental presentation in my case; is it less in yours? I am not all bereft of this *Vorstellungs-kraft* of which you speak. I can follow a particle of musk until it reaches the olfactory nerve; I can follow the waves of sound until their tremors reach the water of the labyrinth, and set the otoliths and Corti's fibres in motion; I can also visualise the waves of ether as they cross the eye and hit the retina. Nay, more, I am able to follow up to the central organ the motion thus imparted at the periphery, and to see in idea the very molecules of the brain thrown into tremors. My insight is not baffled by these physical processss. What baffles me, what I find unimaginable, transcending every faculty I possess—transcending, I humbly submit, every faculty *you* possess—is the notion that out of those physical tremors you can extract things so utterly incongruous with them as sensation, thought, and emotion. You may say, or think, that this issue of consciousness from the clash of atoms is not more incongruous than the flash of light from the union of oxygen and hydrogen. But I beg to say that it is. For such incongruity as the flash possesses is that which I now force upon your attention. The flash is an affair of consciousness, the objective counterpart of which is a vibration. It is a flash only by our interpretation. *You* are the cause of the apparent incongruity; and *you* are the thing that puzzles me. I need not remind you that the great Leibnitz felt the difficulty which I feel, and that to get rid of this monstrous deduction of life from death he displaced your atoms by his monads, and which were more or less perfect mirrors of the universe, and out of the summation and integration of which he supposed all the phenomena of life—sentient, intellectual, and emotional—to arise.

"Your difficulty, then, as I see you are ready to admit, is quite as great as mine. You cannot satisfy the human understanding in its demand for logical continuity between molecular processes and the phenomena of consciousness. This is a rock on which materialism must inevitably split whenever it pretends to be a complete philosophy of life. What is the moral, my Lucretian? You and I are not likely to indulge in ill-temper in the discussion of these great topics, where we see so much room for honest differences of opinion. But there are people of less wit, or more bigotry (I say it with humility) on both sides, who are ever ready to mingle anger and vituperation with such discussions. There are, for example, writers of note and influence at the present day who are not ashamed to assume the 'deep personal sin' of a great logician to be the cause of his unbelief in a theologic dogma. And there are others who hold that we, who cherish our noble Bible, wrought as it has been into the constitution of our fore-

fathers, and by inheritance into us, must necessarily be hypocritical and insincere. Let us disavow and discountenance such people, cherishing the unswerving faith that what is good and true in both our arguments will be preserved for the benefit of humanity, while all that is bad or false will disappear."

It is worth remarking that in one respect the bishop was a product of his age. Long previous to his day the nature of the soul had been so favourite and general a topic of discussion, that when the students of the University of Paris wished to know the leanings of a new professor, they at once requested him to lecture upon the soul. About the time of Bishop Butler the question was not only agitated but extended. It was seen by the clear-witted men who entered this arena that many of their best arguments applied equally to brutes and men. The bishop's arguments were of this character. He saw it, admitted it, accepted the consequences, and boldly embraced the whole animal world in his scheme of immortality.

Bishop Butler accepted with unwavering trust the chronology of the Old Testament, describing it as "confirmed by the natural and civil history of the world, collected from common historians, from the state of the earth, and from the late inventions of arts and sciences." These words mark progress: they must seem somewhat hoary to the bishop's successors of to-day.* It is hardly necessary to inform you that since his time the domain of the naturalist has been immensely extended—the whole science of geology, with its astounding revelations regarding the life of the ancient earth, having been created. The rigidity of old conceptions has been relaxed, the public mind being rendered gradually tolerant of the idea that not for six thousand, nor for sixty thousand, nor for six thousand thousand, but for æons embracing untold millions of years, this earth has been the theatre of life and death. The riddle of the rocks has been read by the geologist and palæontologist, from sub-cambrian depths to the deposits thickening over the sea-bottoms of to-day. And upon the leaves of that stone book are, as you know, stamped the characters, plainer and surer than those formed by the ink of history, which carry the mind back into abysses of past time compared with which the periods which satisfied Bishop Butler cease to have a visual angle. Everybody now knows this; all men admit it; still, when they were first broached these verities of science found loud-tongued denunciators, who proclaimed not only their baselessness considered scientifically, but their immorality considered as questions of ethics and religion: the Book of Genesis had stated the question in a different fashion; and science must necessarily go to pieces when it clashed with this authority. And as the seed of the thistle produces a thistle, and nothing else, so these objectors scatter their germs abroad, and reproduce their kind, ready to play again the part of their intellectual progenitors, to show the same virulence, the same ignorance, to achieve for a time the same success, and finally to suffer the same inexorable defeat. Sure the time must come at last when human nature in its entirety, whose legitimate demands it is admitted science alone cannot satisfy, will find interpreters and expositors of a different stamp from those rash and ill-informed persons who have been hitherto so ready to hurl themselves against every new scientific revelation, lest it should endanger what they are pleased to consider theirs.

The lode of discovery once struck, those petrified forms in which life was at one time active, increased to multitudes and demanded classification. The general fact soon became evident that none but the simplest forms of life lie lowest down, that as we climb higher and higher among the superimposed strata more perfect forms appear. The change, however, from form to form was not continuous—but by steps, some small, some great. "A section," says Mr. Huxley, "a hundred feet thick will exhibit at different heights a dozen species of ammonite, none of which passes beyond its particular zone of limestone, or clay, into the zone below it, or into that above it." In the presence of such facts it was not possible to avoid the question, Have these forms, showing, though in broken stages and with many irregularities, this unmistakable general advance, been subjected to no continuous law of growth or variation? Had our education been purely scientific, or had it been sufficiently detached from influences which, however ennobling in another domain, have always proved hindrances and delusions when introduced as factors into the domain of physics, the scientific mind never could have swerved from the search for a law of growth, or allowed itself to accept the anthropomorphism which regarded each successive stratum as a kind of mechanic's bench for the manufacture of new species out of all relation to the old.

Biassed, however, by their previous education, the great majority of naturalists invoked a special creative act to account for the appearance of each new group of organisms. Doubtless there were numbers who were clear-headed enough to see that this was no explanation at all, that in point of fact it was an attempt, by the introduction of a greater difficulty, to account for a less. But having nothing to offer in the way of explanation, they for the most part held their peace. Still the thoughts of reflecting men naturally and necessarily simmered round the question. De Maillet, a contemporary of Newton, has been brought into notice by Prof. Huxley as one who "had a notion of the modifiability of living forms." In my frequent conversations with him, the late Sir Benjamin Brodie, a man of highly philosophic mind, often drew my attention to the fact that, as early as 1794, Charles Darwin's grandfather was the pioneer of Charles Darwin. In 1801, and in subsequent years, the celebrated Lamarck, who produced so profound an impression on the public mind through the vigorous exposition of his views by the author of "Vestiges of Creation," endeavoured to show the development of species out of changes of habit and external condition. In 1813, Dr. Wells, the founder of our present theory of dew, read before the Royal Society a paper in which, to use the words of Mr. Darwin, "he distinctly recognises the principle of natural selection; and this is the first recognition that has been indicated." The thoroughness and skill with which Wells pursued his work, and the obvious independence of his character, rendered him long ago a favourite with me; and it gave me the liveliest pleasure to alight upon this additional testimony to his penetration. Prof. Grant, Mr. Patrick Matthew, Von Buch, the author of the "Vestiges," D'Halloy, and others,* by the enunciation of views more or less clear and correct, showed that the question had been fermenting long prior to the year 1858, when Mr. Darwin and Mr. Wallace simultaneously but independently placed their closely concurrent views upon the subject before the Linnean Society.

These papers were followed in 1859 by the publication of the first edition of "The Origin of Species." All great things come slowly to the birth. Copernicus, as I informed you, pondered his great work for thirty-three years. Newton for nearly twenty years kept the idea of Gravitation before his mind; for twenty years also he dwelt upon his discovery of Fluxions, and doubtless would have continued to make it the object of his private thought had he not found that Leibnitz was upon his track. Darwin for two-and-twenty years pondered the problem of the origin of species, and doubtless he would have continued to do so had he not found Wallace upon his track.† A concentrated but full and powerful epitome of his labours was the consequence. The book was by no means an easy one; and probably not one in every score of those who then attacked it had read its pages through, or were competent to grasp their significance if they had. I do not say this merely to discredit them; for there were in those days some really eminent scientific men, entirely raised above the heat of popular prejudice, willing to accept any conclusion that science had to offer, provided it was duly backed by fact and argument, and who entirely mistook Mr. Darwin's views. In fact the work needed an expounder; and it found one in Mr. Huxley. I know nothing more admirable in the way of scientific exposition than those early articles of his on the origin of species. He swept the curve of discussion through the really significant points of the subject, enriched his exposition with profound original remarks and reflections, often summing up in a single pithy sentence an argument which a less compact mind would have spread over pages. But there is one impression made by the book itself which no exposition of it, however luminous, can convey; and that is the impression of the vast amount of labour, both of observation and of thought, implied in its production. Let us glance at its principles.

It is conceded on all hands that what are called varieties are continually produced. The rule is probably without exception. No chick and no child is in all respects and particulars the counterpart of its brother or sister; and in such differences we have "variety" incipient. No naturalist could tell how far this vari-

* Only to some; for there are dignitaries who even now speak of the earth's rocky crust as so much building material prepared for man at the Creation. Surely it is time that this loose language should cease.

* In 1855 Mr. Herbert Spencer ("Principles of Psychology," 2nd edit. vol. i. p. 465) expressed "the belief that life under all its forms has arisen by an unbroken evolution, and through the instrumentality of what are called natural causes."

† The behaviour of Mr. Wallace in relation to this subject has been dignified in the highest degree.

ation could be carried; but the great mass of them held that never by any amount of internal or external change, nor by the mixture of both, could the offspring of the same progenitor so far deviate from each other as to constitute different species. The function of the experimental philosopher is to combine the conditions of nature and to produce her results; and this was the method of Darwin.* He made himself acquainted with what could, without any manner of doubt, be done in the way of producing variation. He associated himself with pigeon-fanciers—bought, begged, kept, and observed every breed that he could obtain. Though derived from a common stock, the diversities of these pigeons were such that "a score of them might be chosen which, if shown to an ornithologist, and he were told that they were wild birds, would certainly be ranked by him as well-defined species." The simple principle which guides the pigeon-fancier, as it does the cattle-breeder, is the selection of some variety that strikes his fancy, and the propagation of this variety by inheritance. With his eye still upon the particular appearance which he wishes to exaggerate, he selects it as it reappears in successive broods, and thus adds increment to increment until an astonishing amount of divergence from the parent type is effected. Man in this case does not produce the *elements* of the variation. He simply observes them, and by selection adds them together until the required result has been obtained. "No man," says Mr. Darwin, "would ever try to make a fantail till he saw a pigeon with a tail developed in some slight degree in an unusual manner, or a pouter until he saw a pigeon with a crop of unusual size." Thus nature gives the hint, man acts upon it, and by the law of inheritance exaggerates the deviation.

Having thus satisfied himself by indubitable facts that the organisation of an animal or of a plant (for precisely the same treatment applies to plants) is to some extent plastic, he passes from variation under domestication to variation under nature. Hitherto we have dealt with the adding together of small changes by the conscious selection of man. Can Nature, thus select? Mr. Darwin's answer is, "Assuredly she can." The number of living things produced is far in excess of the number that can be supported; hence at some period or other of their lives there must be a struggle for existence; and what is the infallible result? If one organism were a perfect copy of the other in regard to strength, skill, and agility, external conditions would decide. But this is not the case. Here we have the fact of variety offering itself to nature, as in the former instance it offered itself to man; and those varieties which are least competent to cope with surrounding conditions will infallibly give way to those that are competent. To use a familiar proverb, the weakest comes to the wall. But the triumphant fraction again breeds to over-production, transmitting the qualities which secured its maintenance, but transmitting them in different degrees. The struggle for food again supervenes, and those to whom the favourable quality has been transmitted in excess will assuredly triumph. It is easy to see that we have here the addition of increments favourable to the individual still more rigorously carried out than in the case of domestication; for not only are unfavourable specimens not selected by nature, but they are destroyed. This is what Mr. Darwin calls "natural selection," which "acts by the preservation and accumulation of small inherited modifications, each profitable to the preserved being." With this idea he interpenetrates and leavens the vast store of facts that he and others have collected. We cannot, without shutting our eyes through fear or prejudice, fail to see that Darwin is here dealing, not with imaginary, but with true causes; nor can we fail to discern what vast modifications may be produced by natural selection in periods sufficiently long. Each individual increment may resemble what mathematicians call a "differential" (a quantity indefinitely small); but definite and great changes may obviously be produced by the integration of these infinitesimal quantities through practically infinite time.

If Darwin, like Bruno, rejects the notion of creative power acting after human fashion, it certainly is not because he is unacquainted with the numberless exquisite adaptations on which this notion of a supernatural artificer has founded. His book is a repository of the most startling facts of this description. Take the marvellous observation which he cites from Dr. Crüger, where a bucket with an aperture, serving as a spout, is formed in an orchid. Bees visit the flower: in eager search of material for their combs they push each other into the bucket, the drenched ones escaping from their involuntary bath by the spout. Here they rub their backs against the viscid stigma of the flower and obtain glue; then against the pollen-masses, which are thus stuck to the back of the bee and carried away. "When the bee, thus provided, flies to another flower, or to the same flower a second time, and is pushed by its comrades into the bucket, and then crawls out by the passage, the pollen-mass upon its back necessarily comes first into contact with the viscid stigma," which takes up the pollen; and this is how that orchid is fertilised. Or take this other case of the *Catasetum*. "Bees visit these flowers in order to gnaw the labellum; on doing this they inevitably touch a long, tapering, sensitive projection. This, when touched, transmits a sensation or vibration to a certain membrane, which is instantly ruptured, setting free a spring, by which the pollen-mass is shot forth like an arrow in the right direction, and adheres by its viscid extremity to the back of the bee." In this way the fertilising pollen is spread abroad.

* The first step only towards experimental demonstration has been taken. Experiments now begun might, a couple of centuries hence, furnish data of incalculable value, which ought to be supplied to the science of the future.

It is the mind thus stored with the choicest materials of the teleologist that rejects teleology, seeking to refer these wonders to natural causes. They illustrate, according to him, the method of nature, not the "technic" of a man-like artificer. The beauty of flowers is due to natural selection. Those that distinguish themselves by vividly contrasting colours from the surrounding green leaves are most readily seen, most frequently visited by insects, most often fertilised, and hence most favoured by natural selection. Coloured berries also readily attract the attention of birds and beasts, which feed upon them, spread their manured seeds abroad, thus giving trees and shrubs possessing such berries a greater chance in the struggle for existence.

With profound analytic and synthetic skill, Mr. Darwin investigates the cell-making instinct of the hive-bee. His method of dealing with it is representative. He falls back from the more perfectly to the less perfectly developed instinct—from the hive-bee to the humble-bee, which uses its own cocoon as a comb, and to classes of bees of intermediate skill, endeavouring to show how the passage might be gradually made from the lowest to the highest. The saving of wax is the most important point in the economy of bees. Twelve to fifteen pounds of dry sugar are said to be needed for the secretion of a single pound of wax. The quantities of nectar necessary for the wax must therefore be vast; and every improvement of constructive instinct which results in the saving of wax is a direct profit to the insect's life. The time that would otherwise be devoted to the making of wax is now devoted to the gathering and storing of honey for winter food. He passes from the humble-bee with its rude cells, through the Melipona with its more artistic cells, to the hive-bee with its astonishing architecture. The bees place themselves at equal distances apart upon the wax, sweep and excavate squal spheres round the selected points. The spheres intersect, and the planes of intersection are built up with thin laminæ. Hexagonal cells are thus formed. This mode of treating such questions is, as I have said, representative. He habitually retires from the more perfect and complex, to the less perfect and simple, and carries you with him through stages of *perfecting*, adds increment to increment of infinitesimal change, and in this way gradually breaks down your reluctance to admit that the exquisite climax of the whole could be a result of natural selection.

Mr. Darwin shirks no difficulty; and, saturated as the subject was with his own thought, he must have known, better than his critics, the weakness as well as the strength of his theory. This of course would be of little avail were his object a temporary dialectic victory instead of the establishment of a truth which he means to be everlasting. But he takes no pains to disguise the weakness he has discerned; nay, he takes every pains to bring it into the strongest light. His vast resources enable him to cope with objections started by himself and others, so as to leave the final impression upon the reader's mind that if they be not completely answered they certainly are not fatal. Their negative force being thus destroyed, you are free to be influenced by the vast positive mass of evidence he is able to bring before you. This largeness of knowledge and readiness of resource render Mr. Darwin the most terrible of antagonists. Accomplished naturalists have levelled heavy and sustained criticisms against him—not always with the view of fairly weighing his theory, but with the express intention of exposing its weak points only. This does not irritate him. He treats every objection with a soberness and thoroughness which even Bishop Butler might be proud to imitate, surrounding each fact with its

appropriate detail, placing it in its proper relations, and usually giving it a significance which, as long as it was kept isolated, failed to appear. This is done without a trace of ill-temper. He moves over the subject with the passionless strength of a glacier; and the grinding of the rocks is not always without a counterpart in the logical pulverisation of the objector. But though in handling this mighty theme all passion has been stilled, there is an emotion of the intellect incident to the discernment of new truth which often colours and warms the pages of Mr. Darwin. His success has been great; and this implies not only the solidity of his work, but the preparedness of the public mind for such a revelation. On this head a remark of Agassiz impressed me more than anything else. Sprung from a race of theologians, this celebrated man combated to the last the theory of natural selection. One of the many times I had the pleasure of meeting him in the United States was at Mr. Winthrop's beautiful residence at Brookline, near Boston. Rising from luncheon, we all halted as if by a common impulse in front of a window, and continued there a discussion which had been started at table. The maple was in its autumn glory; and the exquisite beauty of the scene outside seemed, in my case, to interpenetrate without disturbance the intellectual action. Earnestly, almost sadly, Agassiz turned and said to the gentlemen standing round, "I confess that I was not prepared to see this theory received as it has been by the best intellects of our time. Its success is greater than I could have thought possible."

In our day great generalisations have been reached. The theory of the origin of species is but one of them. Another, of still wider grasp and more radical significance, is the doctrine of the Conservation of Energy, the ultimate philosophical issues of which are as yet but dimly seen—that doctrine which "binds nature fast in fate" to an extent not hitherto recognised, exacting from every antecedent its equivalent consequent, from every consequent its equivalent antecedent, and bringing vital as well as physical phenomena under the dominion of that law of causal connection which, as far as the human understanding has yet pierced, asserts itself everywhere in nature. Long in advance of all definite experiment upon the subject, the constancy and indestructibility of matter had been affirmed; and all subsequent experience justified the affirmation. Later researches extended the attribute of indestructibility to force. This idea, applied in the first instance to inorganic, rapidly embraced organic nature. The vegetable world, though drawing almost all its nutriment from invisible sources, was proved incompetent to generate anew either matter or force. Its matter is for the most part transmuted air; its force transformed solar force. The animal world was proved to be equally uncreative, all its motive energies being referred to the combustion of its food. The activity of each animal as a whole was proved to be the transferred activities of its molecules. The muscles were shown to be stores of mechanical force, potential until unlocked by the nerves, and then resulting in muscular contractions. The speed at which messages fly to and fro along the nerves was determined, and found to be, not as had been previously supposed, equal to that of light or electricity, but less than the speed of a flying eagle.

This was the work of the physicist: then came the conquests of the comparative anatomist and physiologist, revealing the structure of every animal, and the function of every organ in the whole biological series, from the lowest zoophyte up to man. The nervous system had been made the object of profound and continued study, the wonderful and, at bottom, entirely mysterious controlling power which it exercises over the whole organism, physical and mental, being recognised more and more. Thought could not be kept back from a subject so profoundly suggestive. Besides the physical life dealt with by Mr. Darwin, there is a psychical life presenting similar gradations, and asking equally for a solution. How are the different grades and orders of mind to be accounted for? What is the principle of growth of that mysterious power which on our planet culminates in Reason? These are questions which, though not thrusting themselves so forcibly upon the attention of the general public, had not only occupied many reflecting minds, but had been formally broached by one of them before the "Origin of Species" appeared.

With the mass of materials furnished by the physicist and physiologist in his hands, Mr. Herbert Spencer, twenty years ago, sought to graft upon this basis a system of psychology; and two years ago a second and greatly amplified edition of his work appeared. Those who have occupied themselves with the beautiful experiments of Plateau, will remember that when two spherules of olive-oil suspended in a mixture of alcohol and water of the same density as the oil, are brought together, they do not immediately unite. Something like a pellicle appears to be formed around the drops, the rupture of which is immediately followed by the coalescence of the globules into one. There are organisms whose vital actions are almost as purely physical as that of these drops of oil. They come into contact and fuse themselves thus together. From such organisms to others a shade higher, and from these to others a shade higher still, and on through an ever-ascending series, Mr. Spencer conducts his argument. There are two obvious factors to be here taken into account—the creature and the medium in which it lives, or, as it is often expressed, the organism and its environment. Mr. Spencer's fundamental principle is, that between these two factors there is incessant interaction. The organism is played upon by the environment, and is modified to meet the requirements of the environment. Life he defines to be "a continuous adjustment of internal relations to external relations.

In the lowest organisms we have a kind of tactual sense diffused over the entire body; then, through impressions from without and their corresponding adjustments, special portions of the surface become more responsive to stimuli than others. The senses are nascent, the basis of all of them being that simple tactual sense which the sage Democritus recognised 2,300 years ago as their common progenitor. The action of light, in the first instance, appears to be a mere disturbance of the chemical processes in the animal organism, similar to that which occurs in the leaves of plants. By degrees the action becomes localised in a few pigment-cells, more sensitive to light than the surrounding tissue. The eye is here incipient. At first it is merely capable of revealing differences of light and shade produced by bodies close at hand. Followed as the interception of the light is in almost all cases by the contact of the closely adjacent opaque body, sight in this condition becomes a kind of "anticipatory touch." The adjustment continues; a slight bulging out of the epidermis over the pigment-granules supervenes. A lens is incipient, and, through the operation of infinite adjustments, at length reaches the perfection that it displays in the hawk and the eagle. So of the other senses; they are special differentiations of a tissue which was originally vaguely sensitive all over.

With the development of the senses the adjustments between the organism and its environment gradually extend in *space*, a multiplication of experiences and a corresponding modification of conduct being the result. The adjustments also extend in *time*, covering continually greater intervals. Along with this extension in space and time, the adjustments also increase in speciality and complexity, passing through the various grades of brute life and prolonging themselves into the domain of reason. Very striking are Mr. Spencer's remarks regarding the influence of the sense of touch upon the development of intelligence. This is, so to say, the mother-tongue of all the senses, into which they must be translated to be of service to the organism. Hence its importance. The parrot is the most intelligent of birds, and its tactual power is also greatest. From this sense it gets knowledge unattainable by birds which cannot employ their feet as hands. The elephant is the most sagacious of quadrupeds—its tactual range and skill, and the consequent multiplication of experiences, which it owes to its wonderfully adaptable trunk, being the basis of its sagacity. Feline animals, for a similar cause, are more sagacious than hoofed animals—atonement being to some extent made, in the case of the horse, by the possession of sensitive prehensile lips. In the *Primates* the evolution of intellect and the evolution of tactual appendages go hand in hand. In the most intelligent anthropoid apes we find the tactual range and delicacy greatly augmented, new avenues of knowledge being thus opened to the animal. Man crowns the edifice here, not only in virtue of his own manipulatory power, but through the enormous extension of his range of experience, by the invention of instruments of precision, which serve as supplemental senses and supplemental limbs. The reciprocal action of these is finely described and illustrated. That chastened intellectual emotion to which I have referred in connection with Mr. Darwin is, I should say, not absent in Mr. Spencer. His illustrations possess at times exceeding vividness and force, and from his style on such occasions it is to be inferred that the ganglia of this apostle of the understanding are sometimes the seat of a nascent poetic thrill.

It is a fact of supreme importance that actions, the performance of which at first requires even painful effort and deliberation, may by habit be rendered automatic. Witness the slow learning of its letters by a child, and the subsequent facility of reading in a man, when each group of letters which forms a word is instantly

and without effort fused to a single perception. Instance the billiard-player, whose muscles of hand and eye, when he reaches the perfection of his art, are unconsciously co-ordinated. Instance the musician, who by practice is enabled to fuse a multitude of arrangements, auditory, tactual, and muscular, into a process of automatic manipulation. Combining such facts with the doctrine of hereditary transmission, we reach a theory of instinct. A chick, after coming out of the egg, balances itself correctly, runs about, picks up food, thus showing that it possesses a power of directing its movements to definite ends. How did the chick learn this very complex co-ordination of eye, muscles, and beak? It has not been individually taught; its personal experience is *nil:* but it has the benefit of ancestral experience. In its inherited organisation are registered all the powers which it displays at birth. So also as regards the instinct of the hive-bee, already referred to. The distance at which the insects stand apart when they sweep their hemispheres and build their cells is "organically remembered." Man also carries with him the physical texture of his ancestry, as well as the inherited intellect bound up with it. The defects of intelligence during infancy and youth are probably less due to a lack of individual experience than to the fact that in early life the cerebral organisation is still incomplete. The period necessary for completion varies with the race and with the individual. As a round shot outstrips a rifled one on quitting the muzzle of the gun, so the lower race in childhood may outstrip the higher. But the higher eventually overtakes the lower, and surpasses it in range. As regards individuals, we do not always find the precocity of youth prolonged to mental power in maturity, while the dulness of boyhood is sometimes strikingly contrasted with the intellectual energy of after years. Newton, when a boy, was weakly, and he showed no particular aptitude at school; but in his eighteenth year he went to Cambridge, and soon afterwards astonished his teachers by his power of dealing with geometrical problems. During his quiet youth his brain was slowly preparing itself to be the organ of those energies which he subsequently displayed.

By myriad blows (to use a Lucretian phrase) the image and superscription of the external world are stamped as states of consciousness upon the organism, the depth of the impression depending upon the number of the blows. When two or more phenomena occur in the environment invariably together, they are stamped to the same depth or to the same relief, and are indissolubly connected. And here we come to the threshold of a great question. Seeing that he could in no way rid himself of the consciousness of space and time, Kant assumed them to be necessary "forms of thought," the moulds and shapes into which our intuitions are thrown, belonging to ourselves solely and without objective existence. With unexpected power and success Mr. Spencer brings the hereditary experience theory, as he holds it, to bear upon this question. "If there exist certain external relations which are experienced by all organisms at all instants of their waking lives—relations which are absolutely constant and universal—there will be established answering internal relations that are absolutely constant and universal. Such relations we have in those of space and time. As the substratum of all other relations of the Non-Ego, they must be responded to by conceptions that are the substrata of all other relations in the Ego. Being the constant and infinitely repeated elements of thought, they must become the automatic elements of thought—the elements of thought which it is impossible to get rid of—the 'forms of intuition.'"

Throughout this application and extension of the "law of inseparable association," Mr. Spencer stands on totally different ground from Mr. John Stuart Mill, invoking the registered experiences of the race instead of the experiences of the individual. His overthrow of Mr. Mill's restriction of experience is, I think, complete. That restriction ignores the power of organising experience furnished at the outset to each individual; it ignores the different degrees of this power possessed by different races and by different individuals of the same race. Were there not in the human brain a potency antecedent to all experience, a dog or cat ought to be as capable of education as a man. These predetermined internal relations are independent of the experiences of the individual The human brain is the "organised register of infinitely numerous experiences received during the evolution of life, or rather during the evolution of that series of organisms through which the human organism has been reached. The effects of the most uniform and frequent of these experiences have been successively bequeathed, principal and interest, and have slowly mounted to that high intelligence which lies latent in the brain of the infant. Thus it happens that the European inherits from twenty to thirty cubic inches more of brain than the Papuan. Thus it happens that faculties, as of music, which scarcely exist in some inferior races, become congenital in superior ones. Thus it happens that out of savages unable to count up to the number of their fingers, and speaking a language containing only nouns and verbs, arise at length our Newtons and Shakespeares."

At the outset of this address it was stated that physical theories which lie beyond experience are derived by a process of abstraction from experience. It is instructive to note from this point of view the successive introduction of new conceptions. The idea of the attraction of gravitation was preceded by the observation of the attraction of iron by a magnet, and of light bodies by rubbed amber. The polarity of magnetism and electricity appealed to the senses; and thus became the substratum of the conception that atoms and molecules are endowed with definite, attractive, and repellent poles, by the play of which definite forms of crystalline architecture are produced. Thus molecular force becomes *structural.* It required no great boldness of thought to extend its play into organic nature, and to recognise in molecular force the agency by which both plants and animals are built up. In this way out of experience arise conceptions which are wholly ultra-experiential.

The *origination* of life is a point lightly touched upon, if at all, by Mr. Darwin and Mr. Spencer. Diminishing gradually the number of progenitors, Mr. Darwin comes at length to one "primordial form;" but he does not say, as far as I remember, how he supposes this form to have been introduced. He quotes with satisfaction the words of a celebrated author and divine who had "gradually learnt to see that it is just as noble a conception of the Deity to believe He created a few original forms, capable of self-development into other and needful forms, as to believe that He required a fresh act of creation to supply the voids caused by the action of His laws." What Mr. Darwin thinks of this view of the introduction of life I do not know. Whether he does or does not introduce his "primordial form" by a creative act, I do not know. But the question will inevitably be asked, "How came the form there?" With regard to the diminution of the number of created forms, one does not see that much advantage is gained by it. The anthropomorphism, which it seemed the object of Mr. Darwin to set aside, is as firmly associated with the creation of a few forms as with the creation of a multitude. We need clearness and thoroughness here. Two courses, and two only, are possible. Either let us open our doors freely to the conception of creative acts, or, abandoning them, let us radically change our notions of matter. If we look at matter as pictured by Democritus, and as defined for generations in our scientific text-books, the absolute impossibility of any form of life coming out of it would be sufficient to render any other hypothesis preferable; but the definitions of matter given in our text-books were intended to cover its purely physical and mechanical properties. And taught as we have been to regard these definitions as complete, we naturally and rightly reject the monstrous notion that out of *such* matter any form of life could possibly arise. But are the definitions complete? Everything depends on the answer to be given to this question. Trace the line of life backwards, and see it approaching more and more to what we call the purely physical condition. We reach at length those organisms which I have compared to drops of oil suspended in a mixture of alcohol and water. We reach the *protogenes* of Haeckel, in which we have "a type distinguishable from a fragment of albumen only by its finely granular character." Can we pause here? We break a magnet and find two poles in each of its fragments. We continue the process of breaking, but however small the parts, each carries with it, though enfeebled, the polarity of the whole. And when we can break no longer, we prolong the intellectual vision to the polar molecules. Are we not urged to do *something* similar in the case of life? Is there not a temptation to close to some extent with Lucretius, when he affirms that "Nature is seen to do all things spontaneously of herself without the meddling of the gods?" or with Bruno, when he declares that matter is not "that mere empty *capacity* which philosophers have pictured her to be, but the universal mother who brings forth all things as the fruit of her own womb?" The questions here raised are inevitable. They are approaching us with accelerated speed, and it is not a matter of indifference whether they are introduced with reverence or irreverence. Abandoning all disguise, the confession that I feel bound to make before you is that I prolong the vision backward across the boundary of the experimental evidence, and discern in that matter, which we in our ignorance, and notwithstanding our professed reverence for its Creator

have hitherto covered with opprobrium, the promise and potency of every form and quality of life.

The "materialism" here enunciated may be different from what you suppose, and I therefore crave your gracious patience to the end. "The question of an external world," says Mr. J. S. Mill, "is the great battle-ground of metaphysics." * Mr. Mill himself reduces external phenomena to "possibilities of sensation." Kant, as we have seen, made time and space "forms" of our own intuitions. Fichte, having first by the inexorable logic of his understanding proved himself to be a mere link in that chain of eternal causation which holds so rigidly in nature, violently broke the chain by making nature, and all that it inherits, an apparition of his own mind.† And it is by no means easy to combat such notions. For when I say I see you, and that I have not the least doubt about it, the reply is, that what I am really conscious of is an affection of my own retina. And if I urge that I can check my sight of you by touching you, the retort would be that I am equally trangressing the limits of fact; for what I am really conscious of is, not that you are there, but that the nerves of my hand have undergone a change. All we hear, and see, and touch, and taste, and smell, are, it would be urged, mere variations of our own condition, beyond which, even to the extent of a hair's breadth, we cannot go. That anything answering to our impressions exists outside of ourselves is not a *fact*, but an *inference*, to which all validity would be denied by an idealist like Berkeley, or by a sceptic like Hume. Mr. Spencer takes another line. With him, as with the uneducated man, there is no doubt or question as to the existence of an external world. But he differs from the uneducated, who think that the world really *is* what consciousness represents it to be. Our states of consciousness are mere *symbols* of an outside entity which produces them and determines the order of their succession, but the real nature of which we can never know.‡ In fact the whole process of evolution is the manifestation of a Power absolutely inscrutable to the intellect of man. As little in our day as in the days of Job can man by searching find this Power out. Considered fundamentally, it is by the operation of an insoluble mystery that life is evolved, species differentiated, and mind unfolded from their prepotent elements in the immeasurable past. There is, you will observe, no very rank materialism here.

The strength of the doctrine of evolution consists, not in an experimental demonstration (for the subject is hardly accessible to this mode of proof), but in its general harmony with the method of nature as hitherto known. From contrast, moreover, it derives enormous relative strength. On the one side we have a theory (if it could with any propriety be so called) derived, as were the theories referred to at the beginning of this address, not from the study of nature, but from the observation of men—a theory which converts the Power whose garment is seen in the visible universe into an Artificer, fashioned after the human model, and acting by broken efforts as man is seen to act. On the other side we have the conception that all we see around us, and all we feel within us—the phenomena of physical nature as well as those of the human mind—have their unsearchable roots in a cosmical life, if I dare apply the term, an infinitesimal span of which only is offered to the investigation of man. And even this span is only knowable in part. We can trace the development of a nervous system, and correlate with it the parallel phenomena of sensation and thought. We see with undoubting certainty that they go hand in hand. But we try to soar in a vacuum the moment we seek to comprehend the connection between them. An Archimedean fulcrum is here required which the human mind cannot command; and the effort to solve the problem, to borrow an illustration from an illustrious friend of mine, is like the effort of a man trying to lift himself by his own waistband. All that has been here said is to be taken in connection with this fundamental truth. When "nascent senses" are spoken of, when "the differentiation of a tissue at first vaguely sensitive all over" is spoken of, and when these processes are associated with "the modification of an organism by its environment," the same parallelism, without contact, or even approach to contact, is implied. There is no fusion possible between the two classes of facts—no motor energy in the intellect of man to carry it without logical rupture from the one to the other.

Further, the doctrine of evolution derives man, in his totality, from the interaction of organism and environment through countless ages past. The human understanding, for example—the faculty which Mr. Spencer has turned so skilfully round upon its own antecedents—is itself a result of the play between organism and environment through cosmic ranges of time. Never surely did prescription plead so irresistible a claim. But then it comes to pass that, over and above his understanding, there are many other things appertaining to man whose prescriptive rights are quite as strong as that of the understanding itself. It is a result, for example, of the play of organism and environment that sugar is sweet and that aloes are bitter, that the smell of henbane differs from the perfume of a rose. Such facts of consciousness (for which, by the way, no adequate reason has ever yet been rendered) are quite as old as the understanding itself; and many other things can boast an equally ancient origin. Mr. Spencer at one place refers to that most powerful of passions—the amatory passion—as one which, when it first occurs, is antecedent to all relative experience whatever; and we may pass its claim as being at least as ancient and as valid as that of the understanding itself. Then there are such things woven into the texture of man as the feeling of awe, reverence, wonder—and not alone the sexual love just referred to, but the love of the beautiful, physical and moral, in nature, poetry, and art. There is also that deep-set feeling which, since the earliest dawn of history, and probably for ages prior to all history, incorporated itself in the religions of the world. You who have escaped from these religions in the high-and-dry light of the understanding may deride them; but in so doing you deride accidents of form merely, and fail to touch the immovable basis of the religious sentiment in the emotional nature of man. To yield this sentiment reasonable satisfaction is the problem of problems at the present hour. And grotesque in relation to scientific culture as many of the religions of the world have been and are—dangerous, nay, destructive, to the dearest privileges of freemen as some of them undoubtedly have been, and would, if they could, be again—it will be wise to recognise them as the forms of force, mischievous, if permitted to intrude on the region of *knowledge*, over which it holds no command, but capable of being guided by liberal thought to noble issues in the region of *emotion*, which is its proper sphere. It is vain to oppose this force with a view to its extirpation. What we should oppose, to the death if necessary, is every attempt to found upon this elemental bias of man's nature a system which should exercise despotic sway over his intellect. I do not fear any such consummation. Science has already to some extent leavened the world, and it will leaven it more and more. I should look upon the mild light of science breaking in upon the minds of the youth of Ireland, and strengthening gradually to the perfect day, as a surer check to any intellectual or spiritual tyranny which might threaten this island, than the laws of princes or the swords of emperors. Where is the cause of fear? We fought and won our battle even in the Middle Ages: why should we doubt the issue of a conflict now?

The impregnable position of science may be described in a few words. All religious theories, schemes, and systems, which embrace notions of cosmogony, or which otherwise reach into its domain, must, in so far as they do this, submit to the control of science, and relinquish all thought of controlling it. Acting otherwise proved disastrous in the past, and it is simply fatuous to-day. Every system which would escape the fate of an organism too rigid to adjust itself to its environment, must be plastic to the extent that the growth of knowledge demands. When this truth has been thoroughly taken in, rigidity will be relaxed, exclusiveness diminished, things now deemed essential will be dropped, and elements now rejected will be assimilated. The lifting of the life is the essential point; and as long as dogmatism, fanaticism, and intolerance are kept out, various modes of leverage may be employed to raise life to a higher level. Science itself not unfrequently derives motive power from an ultra-scientific source. Whewell speaks of enthusiasm of temper as a hin-

* "Examination of Hamilton," p. 154.

† "Bestimmung des Menschen."

‡ In a paper, at once popular and profound, entitled "Recent Progress in the Theory of Vision," contained in the volume of lectures by Helmholtz, published by Longmans, this symbolism of our states of consciousness is also dwelt upon. The impressions of sense are the mere *signs* of external things. In this paper Helmholtz contends strongly against the view that the consciousness of space is inborn: and he evidently doubts the power of the chick to pick up grains of corn without some preliminary lessons. On this point, he says, further experiments are needed. Such experiments have been since made by Mr. Spalding, aided, I believe, in some of his observations by the accomplished and deeply lamented Lady Amberley: and they seem to prove conclusively that the chick does not need a single moment's tuition to teach it to stand, run, govern the muscles of its eyes, and peck. Helmholtz, however, is contending against the notion of pre-established harmony; and I am not aware of his views as to the organisation of experiences of race or breed.

drance to science; but he means the enthusiasm of weak heads. There is a strong and resolute enthusiasm in which science finds an ally; and it is to the lowering of this fire, rather than to a diminution of intellectual insight, that the lessening productiveness of men of science in their mature years is to be ascribed. Mr. Buckle sought to detach intellectual achievement from moral force. He gravely erred; for without moral force to whip it into action, the achievements of the intellect would be poor indeed.

It has been said that science divorces itself from literature: The statement, like so many others, arises from lack of knowledge. A glance at the less technical writings of its leaders—of its Helmholtz, its Huxley, and its Du Bois-Reymond—would show what breadth of literary culture they command. Where among modern writers can you find their superiors in clearness and vigour of literary style? Science desires no isolation, but freely combines with every effort towards the bettering of man's estate. Single-handed, and supported not by outward sympathy, but by inward force, it has built at least one great wing of the many-mansioned home which man in his totality demands. And if rough walls and protruding rafter-ends indicate that on one side the edifice is still incomplete, it is only by wise combination of the parts required with those already irrevocably built that we can hope for completeness. There is no necessary incongruity between what has been accomplished and what remains to be done. The moral glow of Socrates, which we all feel by ignition, has in it nothing incompatible with the physics of Anaxagoras which he so much scorned, but which he would hardly scorn to-day. And here I am reminded of one amongst us, hoary, but still strong, whose prophet-voice some thirty years ago, far more than any other of this age, unlocked whatever of life and nobleness lay latent in its most gifted minds—one fit to stand beside Socrates or the Maccabean Eleazar, and to dare and suffer all that they suffered and dared—fit, as he once said of Fichte, "to have been the teacher of the Stoa, and to have discoursed of beauty and virtue in the groves of Academe." With a capacity to grasp physical principles which his friend Goethe did not possess, and which even total lack of exercise has not been able to reduce to atrophy, it is the world's loss that he, in the vigour of his years, did not open his mind and sympathies to science, and make its conclusions a portion of his message to mankind. Marvellously endowed as he was—equally equipped on the side of the heart and of the understanding—he might have done much towards teaching us how to reconcile the claims of both, and to enable them in coming times to dwell together in unity of spirit and in the bond of peace.

And now the end is come. With more time, or greater strength and knowledge, what has been here said might have been better said, while worthy matters here omitted might have received fit expression. But there would have been no material deviation from the views set forth. As regards myself, they are not the growth of a day; and as regards you, I thought you ought to know the environment which, with or without your consent, is rapidly surrounding you, and in relation to which some adjustment on your part may be necessary. A hint of Hamlet's, however, teaches us all how the troubles of common life may be ended; and it is perfectly possible for you and me to purchase intellectual peace at the price of intellectual death. The world is not without refuges of this description; nor is it wanting in persons who seek their shelter and try to persuade others to do the same. I would exhort you to refuse such shelter, and to scorn such base repose—to accept, if the choice be forced upon you, commotion before stagnation, the leap of the torrent before the stillness of the swamp. In the one there is at all events life, and therefore hope; in the other, none. I have touched on debatable questions, and led you over dangerous ground—and this partly with the view of telling you, and through you the world, that as regards these questions science claims unrestricted right of search. It is not to the point to say that the views of Lucretius and Bruno, of Darwin and Spencer, may be wrong. Here I should agree with you, deeming it indeed certain that these views will undergo modification. But the point is, that, whether right or wrong, we claim the freedom to discuss them. The ground which they cover is scientific ground; and the right claimed is one made good through tribulation and anguish, inflicted and endured in darker times than ours, but resulting in the immortal victories which science has won for the human race. I would set forth equally the inexorable advance of man's understanding in the path of knowledge, and the unquenchable claims of his emotional nature which the understanding can never satisfy. The world embraces not only a Newton, but a Shakespeare—not only a Boyle, but a Raphael—not only a Kant, but a Beethoven—not only a Darwin, but a Carlyle. Not in each of these, but in all, is human nature whole. They are not opposed, but supplementary—not mutually exclusive, but reconcilable. And if, still unsatisfied, the human mind, with the yearning of a pilgrim for his distant home, will turn to the mystery from which it has emerged, seeking so to fashion it as to give unity to thought and faith, so long as this is done, not only without intolerance or bigotry of any kind, but with the enlightened recognition that ultimate fixity of conception is here unattainable, and that each succeeding age must be held free to fashion the mystery in accordance with its own needs—then, in opposition to all the restrictions of Materialism, I would affirm this to be a field for the noblest exercise of what, in contrast with the *knowing* faculties, may be called the *creative* faculties of man. Here, however, I must quit a theme too great for me to handle, but which will be handled by the loftiest minds ages after you and I, like streaks of morning cloud, shall have melted into the infinite azure of the past.

SECTION A

Mathematical and Physical

Opening Address by the President, the Rev. Prof. J. H. Jellett, M.A., M.R.I.A.

In opening the business of the Section, my first duty is, as you will naturally anticipate, to return my warmest thanks to the British Association for the honour which they have conferred upon me by inviting me to occupy this chair. I do it, I assure you, with all sincerity, fully sensible how high the compliment is; and if I do not dwell further upon the subject, it is, as I hope you will believe, because the president of a Section ought to occupy your time, not by speaking of himself or his own feelings, but by a review, more or less extensive, of those branches of science which form the proper business of the Section.

I say "more or less extensive;" for in determining what kind of review he will present to you, the president of this Section has a very wide range of choice. He may give you a rapid but (in its outline) complete sketch of the progress of mathematical science during the past year. He may select some one special subject, probably (and rightly) the subject with which he is himself especially conversant, giving of that a more detailed account; or he may take a middle course, neither so extensive as the first nor quite so limited as the second. It is this latter course which I wish now to take, proposing to direct your attention, during the short time which I can allow myself, to the relations, becoming every day more fully developed, not only among the branches of science which properly belong to us, but between our Section and the other Sections of the Association, or, in other words, between the sciences which we ordinarily call mathematical or physical and some of the other sciences to which the British Association is devoted. I am the more anxious to direct your attention to this class of subjects, because recent investigation has shown how fertile for discovery the "border land," if I may so call it, between sciences hitherto considered distinct has been found to be. Instances in proof of this will present themselves as we go on; some have no doubt suggested themselves to you already.

We are called, in ordinary language, the Mathematical Section. The adjective must indeed be understood in a very wide sense—too wide perhaps for strict propriety of language, if it be meant to include every thing to which our labours here are devoted; still the use of the term "mathematical" indicates, and truly indicates, the preponderance which in this Section we give to mathematics and to those sciences which are at present capable of mathematical treatment; and therefore the first question which in the consideration of our present subject naturally presents itself is, Does this list of sciences show any prospect of increase? Are we making, are we likely to make, an increased use of mathematics as an instrument of physical investigation? Are we trying to improve its use in those sciences which are already recognised as belonging to its legitimate province? Are we trying to perfect the mathematical treatment of such sciences as optics or electricity, which have been already brought under the sway of mathematics? Are we trying to extend its sway by bringing under it sciences (chemistry, for example, or biology) in which as yet its power has been but little felt? Or have we come to the conclusion, to which some writers would lead us, that we have already pushed the use of mathematics too far?

Is it true, for example, and do we feel it to be true, that in our anxiety to being physical optics completely under the power of mathematical science, we have abandoned the principles of the inductive philosophy, and substituted mere hypotheses for true knowledge? And are we convinced, at least, that every chemist is bound, as he values the truth and reality of his science, to resist the introduction into chemistry of the methods of mathematical analysis, if any such attempt should be made?

This latter is the opinion of Comte, whose severe strictures on the application of mathematical analysis to physical optics I shall have to consider further on; for the present I would confine your attention to the inquiry, What indications on this subject are presented by the actual progress of physical science? Does its history exhibit a tendency to widen or to contract the field of mathematical analysis?

In reviewing, with this purpose, the history of physical science, we may leave out of sight those sciences, or parts of a science, to which the methods and language of mathematics are applicable without the aid of hypotheses. No scientific man doubts the advantage of applying, as far as our analytic powers enable us so to do, the methods of mathematical analysis to such sciences as plain optics or plain astronomy. Even physical astronomy, although in strict logical precision not wholly independent of hypothesis, has been long recognised as, in the most proper sense of the word, a mathematical science. Wherever, in fact, the fundamental equations rest either on direct observation (as in plain optics) or (as in physical astronomy) upon an hypothesis, if we may venture to call it an hypothesis, so entirely accepted as universal gravitation, the extension of the methods of mathematics is only limited by the weakness of mathematical analysis itself. But there are other sciences, as, for example, physical optics, to which mathematical analysis cannot be applied without the intervention of hypotheses more or less uncertain. And if we would appreciate the true character of scientific progress, the question which we must put to scientific history is this, Is science becoming more or less tolerant of such hypotheses? A principle is assumed, possessing in itself a certain amount of plausibility, and capable of mathematical expression, from which we are able to deduce, as consequences and by mathematical reasoning, phenomena whose reality may afterwards be proved by direct experiment. And from this experimental verification we infer, with more or less probability, the truth of the original assumption. The question, then, which we have to put to scientific history is this, Do the records of science indicate a greater or a less tolerance of this kind of logic? Is the mode of physical investigation which I have shortly sketched gaining or losing the favour of scientific men?

Passing over sciences like astronomy, which, though not wholly free from hypothesis, do not give us very extended information on this point, I come to a part of scientific history to which we may put the question with every probability of obtaining (so far, at least, as one science is concerned) a decisive answer —I mean, the history of physical optics.

We have here a science whose basis is purely hypothetical. The definition of light is an hypothesis, the nature of the ethereal motion is an hypothesis, even the very existence of the ether is an hypothesis—hypotheses, indeed, which have led to conclusions amply verified by experiment, but hypotheses still. Does the history of optical science indicate a desire to discard this hypothetical base? Does the history of this science betray a tendency on the part of scientific men to abandon or neglect mechanical theories of light? Have physicists given up as hopeless, or perhaps unphilosophical, the attempt to reduce, by the intervention of a supposed ether, the phenomena of light under the mathematical laws which govern motion? Are they even abandoning the reasoning or the phraseology of the undulatory system? The answer to these questions is not doubtful. Commencing with Fresnel, more than half a century ago, the history of physical optics is a history of efforts, constantly repeated, to frame what M. de St. Venant has called "a really rational theory of light."

Take, for example, the repeated attempts to reconcile the mechanical principle of continuity with the optical phenomenon of double refraction. When the movement which we call light passes from one medium to another, if the molecular movement be continuous, it is hard to see how the elastic force of the ether can be different at different sides of the plane of separation. It would seem, then, that the principle requires that the elastic force of the ether should be the same in all media. But if it be the same in a crystalline as in an uncrystalline medium, it ought to be the same in every direction; and if it be the same in every direction, how are we to account for the phenomenon of double refraction? The effort to overcome this difficulty may be said to have engaged the attention of Cauchy during all the latter part of his life. The same question was taken up after his death by other writers, among whom I may mention M. Boussinesq as the most recent, and is to this day a question of great interest to mathematical physicists. I am not now inquiring whether the reasoning which I have just stated be valid, or whether the difficulty, which some writers do not appear to have felt, be real. I allude to it only as a proof of the anxiety felt by men who have borne the greatest names in optical science to have a complete mechanical theory of light. It would be easy to multiply instances, affecting all the great phenomena of optics, which evince the same anxiety.

Another and even stronger proof of the firm footing which the undulatory theory has obtained in the world of science, is the familiarity with which we use the terms of that theory, as if they denoted actual physical realities. When, not long since, much labour was expended in calculating the wave-lengths for the several rays of the spectrum, there does not appear to have been among physicists any consciousness that they were discussing, and even professing to measure, things which had no existence but in the fancy of mathematicians. On the contrary, we have come to speak of wave-lengths quite as freely and as familiarly as we speak of indices of refraction. Nor is this true only of detached memoirs, which might be supposed to represent only individual opinion. The language and the principles of the undulatory theory have found their way into our ordinary text-books—a sure proof that these principles have been generally accepted by the scientific world. I am not now discussing the question whether, regarded as an indication of scientific progress, this fact is favourable or unfavourable. I only say that it *is* a fact. M. Comte has done all that the hard words of a man of great genius could do to banish theories of light from the domain of science, but his greatest admirer will hardly say that he has been successful.

I pass to the consideration of another branch of science, closely connected with, and indeed including, physical optics, and exemplifying, even more strongly, the desire of scientific men to extend the sway of mathematics over physical science—I mean, Molecular Mechanics. This branch of mechanical science (if, indeed, it be not more correct to say, this science), is altogether modern. Fifty years ago it had hardly begun to exist, and even now it is in a very imperfect condition. Imperfect as it is, however, it has advanced far enough to mark the progress of science in the direction which I have indicated. And as it is a science more general than physical optics, the indications which we can gather from it are more important. Physical optics does not take us outside our own Section; molecular mechanics shows a marked tendency to carry mathematical analysis into the domain of chemistry. If it shall ever be possible to establish an intimate connection between this latter science and theoretical mechanics, it is probably here that we shall find the connecting link. In truth, it is impossible to contemplate the ever-growing tendency of science to see in so many natural phenomena varieties of motion, without anticipating a time when mathematical dynamics (the science which has already reduced so many of the phenomena of motion beneath the power of mathematical analysis) shall be admitted to be the universal interpreter of nature, as completely as it is now admitted to be the interpreter of the motions of the planets. I do not say that it will ever be. I do not even say that it is possible. It is no true philosophy which dogmatises on the future of science. But it is certain that the current of scientific thought is setting strongly in that direction. The constant tendency of scientific thought is, as I have said, to increase the number of those phenomena which are regarded as mere varieties of motion. Sound—that we have placed on the list long since. Light, though here our conclusions are more hypothetical, we have also long regarded as belonging to the same category; and heat may now be fairly added; and we have almost learned, under the guidance of Professor Williamson, to regard chemical combination as a phenomenon of the same kind. All these phenomena (of sound, of light, of heat, and perhaps even of chemical combination) we now regard as produced by the movements of systems of exceedingly small particles—whether of known particles, as in the case of sound, or of the hypothetical ether, as in the case of light; and a science which proposes to itself the mathematical discussion of the laws which govern the movements of such systems can hardly

fail to play an important part in the future history of physical science. I shall not then, I hope, be thought to misemploy the time of the Section by offering some observations on the science of molecular dynamics.

When we have to deal with a science which professes to be more than a mathematical abstraction—a science which assumes to itself the function of representing, with at least approximate truth, the realities of nature—our first question will naturally be, What is the basis on which it rests? Is it built upon a pure hypothesis, not derived from experiment, but seeking to justify its claim to reality by the truth of the results which may be deduced from it?

The word "molecule," as Prof. Maxwell has told us, is modern, embodying an idea derived from modern chemistry. It denotes a material particle so small as to be incapable of subdivision into parts similar in their nature to itself. Thus a drop of water may be divided into smaller drops, each of which is also water; but a *molecule* of water is regarded as incapable of such division. Not that we regard it as absolutely indivisible; but we assume that a further division, could it be effected, would produce molecules, not of water, but of its component gases, hydrogen and oxygen.

Now this conception of a molecule undoubtedly involves an hypothesis. Are there such ultimate particles of matter, not only resisting all the dividing forces which we can command, but absolutely indivisible, by *any force*, into particles similar to each other, or perhaps into particles of any kind? Or are we to suppose that, if we had instruments of sufficient delicacy, the process of division might be carried on without limit? Experiment gives us no means of deciding between these alternatives; and if the exigencies of our method of investigation force us to make a decision, we can make it only by an hypothesis. But we may fairly ask, Does the logic of molecular dynamics absolutely require this decision? And on this point I wish to offer one or two remarks. When we propose to determine the motion of a body, solid or fluid, we ought, as indeed in all scientific problems, to form in the first place a clear conception of the meaning of the question which we propose to ourselves. We wish to discover the laws which govern the motion—of what? Not certainly of the body taken as a whole. That is, no doubt, part of the information which we seek, but a very small part of it. When we have learned to determine by a fixed mathematical rule, or formula as we generally call it, the position occupied at any instant by the centre of gravity of the body and by its principal axes, we have learned something, but the investigation is far from being complete. There are, as you know, large classes of movements of which such knowledge would tell us nothing. Thus, to take a familiar instance, you see a man (to use our ordinary language) "sitting quiet." He is at rest, so far as the movement of the body, taken as a whole, is concerned. He is neither turning on his chair nor walking about the room; and yet there is probably not a single particle of his body which is absolutely quiescent. You see, then, how ignorant we are of the vital movements of the human body, if we know only that the individual is "sitting quiet."

But suppose that we push the inquiry a little further and propose to investigate the motion of the blood. We obtain an answer to this question in one sense by determining the rate at which the blood, taken as a whole, is moving—that is to say, suppose the number of ounces of blood which pass through the mitral valve in the space of one minute; but having learned this, we are still very far from knowing completely the motion of the blood. But suppose that we are able to assign at any instant the position of each one of the blood-globules considered as a unit —that is to say, suppose we could assign for each of these globules the position of its centre of gravity and the positions of its principal axes, we should then know the motion of the blood, not, indeed, perfectly (for we should still be ignorant of the motion of the *serum* as well as of the internal movements which take place in each globule), but very much more completely than before.

Further (and this is the point to which I wish especially to direct your attention), the results would be equally true, whether the globules were really units, incapable of further subdivision, or really aggregates of still smaller particles. In the former case we should know perfectly the motion of that part of the blood which consists of the red globules; in the latter, we should know the same motion, but not perfectly; that is to say, our results, though true as far as they go, would leave us still in ignorance of one or more classes of motions which are really exhibited by the globules of the blood. We should then be obliged to imagine a still further subdivision. If, for example, we divided, in imagination, each globule into a thousand parts, and could determine the motion of each part considered as a unit, our results would still further approximate to completeness; and so on for further subdivisions. The logic of molecular dynamics may then be shortly stated as follows:—

In seeking to form the equations of motion of a body, solid or fluid, we commence by an imaginary division of the body into elements of any arbitrary magnitude, and we form the equations of motion for each of these elements considered as a unit. The results so obtained are true, but, as long as the elements retain a finite magnitude, incomplete. They do not give us full information as to the movement of the system. But suppose now, adopting the spirit of the differential calculus, that the magnitude of these elements is constantly diminished; then it will be found that, as in the differential calculus, these equations tend towards a certain limiting form, constantly approaching it as the magnitude of the elements is continually diminished; and in this limiting form these equations are not only true but complete.

Stated in this general form, the principles of molecular dynamics are not only perfectly logical, but wholly free from hypothesis. Hypotheses have, no doubt, been freely introduced for the purpose of forming the actual equations in any given case; but molecular dynamics, as such, is not an hypothetical science. The word molecular is in some respects unfortunate, as tending to identify the science with a particular hypothesis as to the constitution of matter. But molecular dynamics as a science has no necessary connection with the molecular hypothesis. In truth, the methods of this science harmonise quite as readily with the supposition of the infinite divisibility of matter as with the supposition of ultimate molecules.

Molecular dynamics may fairly be called the differential calculus of physical science. It is, in its relation to physical science, what the differential calculus is in its relation to geometry. As in geometry, when we would pass from the small and exceptional class of rectilinear figures to the infinite varieties of curve-lines, we must invoke the aid of the differential calculus, so when we would pass from the abstractions of rigid solids and unbending surfaces to the contemplation of bodies as they really exist in nature, must we, if we would fully investigate their phenomena, invoke the aid of molecular dynamics. It is the science of that phenomenon which is gradually drawing all others within its sway; it is the science of that phenomenon which, "changed in all and yet in all the same," we have learned to see in every part of nature. Molecular dynamics is the science of Motion in its widest and truest sense—of the motion which passes along in the sweep of the tempest or the fierce throb of the earthquake—of the motion (no less real) which breathes in the gentlest whisper or thrills along the minutest nerve.

I have dealt thus long upon the subject of molecular dynamics because the amount of attention which in the present century it has commanded, and the great advance which it has made, mark most distinctly the tendency of scientific thought to the introduction of mathematical analysis into all parts of physical science; for molecular dynamics is the key to this introduction. It is to the perfection of this science that we must look for an increased use of the mathematical instrument; and when we combine the indications afforded by the history of this science with those which we may derive from the history of its principal application (Physical Optics), we have at least this partial answer to our question—Mathematical analysis shows no sign of relaxing its grasp upon any of the sciences which have been hitherto considered to belong to its domain; nay, more, the desire to extend that domain is indicated by the efforts to perfect the instrument by which that extension must be made. We may now ask, Is this indication confirmed by the history of any of those sciences which have been hitherto regarded as lying wholly without our Section?

And first, what shall we say of Section B? Does chemical science show any indications pointing to a future union with the group already collected under the *genus* (if I may so call it) Theoretical Mechanics? Take, for example, the great problem of chemical combination. Does the treatment of this problem now show any signs pointing in the direction of dynamical science? I desire here to speak with all reserve and even hesitation, being conscious that I am no longer on familiar ground. Still there are signs which even an outside spectator may read. And we may, I think, speak confidently of their direction, although the goal to which they point is far distant and may perhaps be unattainable.

One of these signs is the appearance of *time* as one of the elements of a chemical problem. And in recognising the necessity of a certain time for the production of a chemical effect, chemists are now pointing not obscurely to the analogy of mechanical science. "Time," says Berthelot, "is necessary for the accomplishment of chemical reactions, as it is for all the other mechanical phenomena." This might not in itself be very significant; but chemists have not merely recognised the necessity of time as a condition for the production of chemical phenomena, they have also undertaken to measure it; or rather, taking the converse problem, they have undertaken to measure the amount of chemical effect produced in the unit of time; and the law of this phenomenon announced by Berthelot takes (necessarily, indeed) a mathematical form quite analogous to equations which present themselves in dynamical science. The next step has followed as a matter of course, and chemists now speak as familiarly of the *velocity* of chemical reactions as engineers do of the velocity of a cannon-ball.

Still more important in its bearing on the future of chemistry, and tending distinctly in the same direction, is the theory of chemical combination, which science owes to Prof. Williamson, and according to which this phenomenon, like so many others, ought to be regarded as in great measure a mode of motion. We suppose the normal condition of the atomic constituents of a body to be *motion*, not rest; and when we say that a molecule of one substance enters into *combination* with a molecule of another substance, we do not mean that the same molecules constantly adhere together, but that the union between the molecules, whatever be its nature, is continually dissolved and as continually re-formed. According to this theory, chemical equilibrium does not denote molecular rest, but a system of molecular motion, in which these decompositions and recompositions balance each other.

If I may venture to add anything to that which comes from such an authority, I would say that this theory leads us naturally to regard the chemical properties of bodies as, if not wholly modes of motion, yet largely dependent upon the nature of the movements which take place among their constituent atoms. Hence, if two bodies incapable of chemical action are brought into chemical presence of each other, we may suppose that their atomic movements, and therefore their properties, remain unaltered. If, on the other hand, these bodies be capable of acting chemically on each other, their atomic movements are modified by their mutual chemical presence; and therefore the chemical properties of the compound, as we call it, may be wholly different from those of either of the bodies which have entered into combination.

Now we are not yet prepared to consider chemical combination as a problem of molecular dynamics. We have not sufficiently clear ideas (even hypothetical ideas) of these atomic movements, and of the modifications which are caused by the chemical presence of another body, to place the investigation of these phenomena in the same category with the investigation of the phenomena of physical optics; and I am sure that any attempt to hasten unduly the affiliation of chemistry to theoretical dynamics would be productive of serious mischief. The drift of the remarks which I have made has been only to show that the current of scientific thought is setting in that direction; and while we may not predict such an affiliation, still less should we be justified in pronouncing it to be beyond the possibilities or even the probabilities of science.

Time will only allow me to notice very briefly another important application of mathematics to a branch of science considered hitherto to be altogether beyond the limits of our Section,—I refer to the application of the methods of geometry and theoretical mechanics to biological science recently made by Prof. Haughton.

The first example which I shall notice is the establishment of a principle governing the animal frame, and quite analogous to the principle of "least action" in dynamics. This principle asserts that every muscle is so framed as to perform the greatest amount of work under the given external circumstances. If this principle be admitted as an *à priori* truth, the arrangement of any given muscle may be mathematically deduced from it; but many, no doubt, will prefer to regard it as an inductive truth established by the number of instances which Professor Haughton has adduced and discussed. Among these the work done by the human heart is considered; and in order more fully to exemplify the principle of the economy of work, Professor Haughton has imagined a very obvious construction of the heart in which the principle would be violated, contrasting this with the actual construction in which, as he has shown, the principle is preserved.

Prof. Haughton has also made much use of the geometry of curved surfaces in estimating the action of the non-plane muscles.

On the whole the work of Prof. Haughton is a remarkable example of the increasing use of mathematical methods in the investigation of physical problems.

We have put to scientific history the important question, Is it probable that the dominion of mathematics over physical science will be more widely extended than it is at present? Is it probable, not only that we shall improve the mathematical instrument as applied to those sciences which are already recognised as belonging to the legitimate province of mathematical analysis, but also that we shall learn to apply the same instrument to sciences which are now wholly or partially independent of its authority? And to this question I think that scientific history must answer, Yes, it *is* probable. It is probable, because physical science is learning more and more every day to see in the phenomena of nature modifications of that one phenomenon which is peculiarly under the power of mathematics. It is probable, because science already indicates the path by which that advance will be made, because we already possess in molecular dynamics a method (the creation, I may almost say, of our own age, and still very imperfect) whose proper subject is motion, not in any limited or abstract sense, but as widely as it really exists in nature. And it is probable, because we cannot look back on the history of science for the last fifty years without becoming conscious how large is the advance which has been already made.

I have thus far endeavoured to show to you the light which is thrown on the connection between physical science and mathematical analysis by actual scientific history; and I have given you some reasons for believing, so far as it is permitted to us to read the future, that this connection is likely to extend still more widely.

But before we pass from this part of the subject, we are bound to ask the question, Are we to regard this indication as being favourable to the cause of scientific progress? Shall we regard the tendency to use, as far as possible, the mathematical instrument in physical investigation as being likely to extend our real knowledge of nature? Or will its result be merely to encourage the formation of vain hypotheses, recommended only by their capability of mathematical expression, and deeply injuring the cause of science by means of the facility with which men accept such speculations as real knowledge? This latter opinion seems to be, on the whole, that of Comte, whose severe strictures upon physical theories of light I have noticed before.

Now, I believe that the advocate of the mathematical method of investigation might be, and would be, perfectly content to fight the battle of mathematical physics on the ground which Comte himself has chosen. We have put one important question to the history of science, let us put another.

Has the effect of theories of light upon the progress of real optical knowledge (knowledge which Comte himself would admit to be real) been beneficial or injurious?

This question belongs to a class to which the answer is never easy. It is never an easy task to abstract one from a group of causes which concur in the production of an effect, and then determine how the effect would have been changed by such removal. Still we may succeed in obtaining at least a partial answer to the question.

It has been frequently remarked as one of the benefits conferred upon physical science by theory, that it suggests experiment. Nowhere is this principle more strongly exemplified than in the history of perhaps the greatest name in optical science—I mean Fresnel. He is an experimentalist, certainly; but he is an experimentalist because he is a theorist. His most valuable experiments had their origin in the desire to test the truth of a theory. The experiment with the two mirrors were devised to test Young's principle of interference. His diffraction experiments were devised at first to test the truth of Young's theory; and when that had been found to be inconsistent with fact, then to test the truth of his own. And, not to multiply instances, the experiments by which he established the existence of circular polarisation, and ascertained the true nature of the light which passes along the axis of a quartz crystal, were suggested by theory.

Among the motives which induced Jamin to undertake the experimental researches which have given to science such valuable results, not the least was the desire to test the truth of an

hypothetical principle of Fresnel and of a theoretic formula of Cauchy. And quite recently M. Abria has made an elaborate examination of uniaxial refraction for the purpose of testing the truth of the construction of Huyghens. I may here remark that it is much to be desired that some competent observer would undertake the yet more difficult task of verifying experimentally the wave-surface of Fresnel.

But to revert to the general subject. If any physicist is inclined to agree with the views of Comte upon this subject, let me propose to him the following test:—Let him strike out of physical optics everything which that science owes to theories of light, and then let him try to write a treatise on the subject, excluding the language and the ideas of theory. Finally, let him compare his work with some treatise in which these aids have not been neglected, and judge himself of their relative value. Theoretic science need not be afraid of the result.

Naturally suggested by the subject which we have been considering, namely, the tendency of scientific progress to a reduction of all physical science under the power of mathematical analysis, is the gradual development of connections between the different members of that great group to which we give the name of physical science. And among the instances of such growing relationship I take, also suggested by the topics which have engaged us, the connection between optics and chemistry. I only say "suggested" by our former subject, for I do not desire to attach any undue significance to the fact that of these connected sciences one may already be called a mathematical science. As yet the connection between these sciences has consisted principally in the introduction into chemistry of an analysis in some respects more refined than any which has been hitherto known. And this fact does not in itself indicate the extension to chemistry of the mathematical character which belongs to physical optics. Still, if we hold the assumption of this character by any science to be the mark of perfection, we shall be inclined to regard every improvement in its instruments of research as tending in that direction.

In speaking of the connection between optics and chemistry, the topic which will occur first to everyone is the Spectroscope; but on this part of the subject it is not necessary that I should dwell. It has so largely occupied the attention of physicists, and has been so fully treated by those who have made it their special study, that I could not hope to add anything to what they have said. I would only observe that the spectroscope has enabled chemistry to overleap a barrier which Comte pronounced to be insurmountable, and which would have excluded from the objects of chemical research anything lying without the limits of our earth. Comte warned us that our knowledge of the planetary worlds was necessarily limited to their geometrical and mechanical properties—to the nature of their movements, and the forces by which they are produced,—and that all inquiry into the constituent elements of the planets or their atmospheres was for ever, and by the necessities of the case, interdicted to us. But the spectroscope has told quite another story.

But there is another point of contact between optics and chemistry,—another spot on the border-land between these two sciences which, I think, promises also to be fertile in discovery, —I mean the use of polarised light as an instrument of chemical analysis. It is true that the application of this instrument is limited in its extent. The physical property on which this application depends (namely, the power possessed by certain liquids to change the plane of polarisation of a transmitted ray, or, as it is commonly called, the rotatory power) is altogether confined to the organic world, and is not universal even there. Still, within this limited range, the application of polarised light is capable of solving, or aiding to solve, chemical problems which chemistry proper would probably find very difficult. Let me give you two examples.

1. Is it true that an acid salt is decomposed by solution? Or, taking the question in another form: If to a solution of a neutral salt there be added, atom for atom, a quantity of its own acid, does that additional atom of acid enter into combination, or does it remain free? It has been usually inferred from the thermic researches of Dr. Andrews, followed up by Favre, Silbermann, Berthelot, and others, that the second alternative is the true one, the solvent being water. Now, if the problem be varied a little by making the solvent spirit, the application of polarised light gives us this important information:—

If to an alcoholic solution of the ordinary nitrate of quinia there be added an additional equivalent of acid, this additional equivalent *does* enter into combination with the nitrate.

This information leaves to us the alternative of supposing that the ordinary nitrate, sulphate, &c., of quinia are not neutral but basic salts, or of admitting that an acid salt is not always decomposed by solution, at least in spirit.

2. When an acid is added to a solution containing two bases, the salts formed being also soluble, does the acid divide itself between the bases? and if so, what is the law which governs the division?

The application of polarised light enables us to solve this question for some of the organic bases, proving that there is a continuous partition of the acid, and enabling us in one case, and probably in many others, to assign the law according to which the partition is made.

One more instance may suffice to exemplify the advantage which chemistry proper has already derived from its union with optics. I take this instance from the general problem of saccharometry.

We have long known how to analyse, both optically and chemically, a solution which contains two kinds of sugar, one of which is sucrose? But as each of these methods gives but two equations, it is plain that neither is sufficient where the unknown quantities are more than two. If, then, as is very commonly the case, there are present in the solution three kinds of sugar, we cannot obtain a complete analysis, either from optics or from chemistry. But, as Dr. Apjohn has recently shown, this problem, insoluble by either method taken alone, is readily solved by a combination of both methods. An important step is thus made in the application of optics to chemistry. Instead of merely giving to chemistry a new solution of a problem which chemistry could solve without any assistance, optics has aided chemistry to solve a problem which chemistry unaided might have found very difficult.

But it is time that I should bring these remarks to a close, and I recur, in conclusion, to a thought which my subject has already suggested.

Let none presume to fix the bounds of Science. "Hitherto shalt thou come, but no further"—that sentence is not for man. Not by our own powers, not by the powers of our generation, not even by the conceptions of possibility, may we limit the march of scientific discovery. To us, labourers in that great field, it is given to see but a few steps in advance. And when at times a thicker darkness has seemed to gather before them, men have recoiled as from an impassable barrier, and for a while that path has been closed. But only for a while. Some happy accident some more daring adventurer, it may be time itself, has shown that the darkness was but a cloud. The light of Science has pierced it; the march of Science has left it behind; and the impossibility of one generation is for the next but the record of a new triumph.

If seeming plausibility could give to man the right to draw across any path of scientific discovery an impassable line, surely Comte might be justified in the line which he drew across the path of chemistry. Fifty years ago it might seem no unjust restriction to say to the chemist, Your field of discovery lies within the bounds of our own earth. You must not hope to place in your laboratory the distant planet or the scarce-visible nebula. You must not hope to determine the constituents of their atmospheres as you would analyse the air which is around your own door; and you will never do it. Fifty years ago no chemist would have complained that chemical discovery was unjustly limited by such a sentence; perhaps no chemist would have refused to join in the prediction. Yet even those who heard it uttered have lived to see the prediction falsified. They have seen the barrier of distance vanish before the chemist, as it has long since vanished before the astronomer. They have seen the chemist, like the astronomer, penetrate the vast abyss of space and bring back tidings from the worlds beyond. Comte might well think it impossible. We know is to be true.

We have learned from this episode of scientific history that the attempt to draw an impassable line between the domain of the chemist and the domain of the astronomer was not justified by the result. Another generation may learn to obliterate as completely the line between the domain of the chemist and the domain of the mathematician. When that shall be, when Science shall have subjected all natural phenomena to the laws of Theoretical Mechanics, when she shall be able to predict the result of every combination as unerringly as Hamilton predicted conical refraction or Adams revealed to us the existence of Neptune—that we cannot say. That day may never come, and it is certainly far in the dim future. We may not anticipate it—

we may not even call it possible. But not the less are we bound to look to that day, and to labour for it as a crowning triumph of Science, when Theoretical Mechanics shall be recognised as the key to every physical enigma—the chart for every traveller through the dark infinite of Nature.

SECTION C

GEOLOGY

OPENING ADDRESS OF THE PRESIDENT, PROF. EDWARD HULL, F.R.S.

On the Volcanic Phenomena of County Antrim and adjoining Districts.

FOLLOWING the example of several Presidents of the Geological Section of the British Association, I purpose commencing our proceedings by an address, selecting for my subject the volcanic phenomena of the district in which we are assembled. But before entering upon this subject, I am sure it will be equally in accordance with your feelings and my own if I give expression to the general and deep regret which is felt at the death (so little expected) of the late President of this Section, Prof. John Phillips, of Oxford, on April 24, in the 74th year of his age.

The late Prof. Phillips.—As the nephew and pupil of Mr. William Smith, "the Father of English Geology," Prof. Phillips was nurtured in an atmosphere of geological science which accorded well with his own tastes; and in his youth was the companion and assistant of his uncle in many a surveying-tour in the east and north of England. His subsequent appointment as Keeper of the Museum at York, and one of the secretaries of the Yorkshire Philosophical Society, gave him opportunities and scope for pursuing his inquiries—ultimately resulting in the publication of his laborious work on "The Geology of Yorkshire," a work not only abounding in local details, but containing the germs of several generalisations on questions relating to physical geology.

Of his connection with the Geological Survey of Great Britain, Prof. Phillips has left two enduring monuments in his work on "The Palæozoic Fossils of Cornwall, Devon, and West Somerset," and that on "The Malvern Hills and surrounding districts"*—one dealing with the organic structures, and the other more especially with the physical conditions of the south and west of England.

To his future career as Professor of Geology in the University of Dublin, afterwards, on the death of Dr. Buckland, in the University of Oxford, or as President of the Geological Society of London in 1859 and of the British Association at Birmingham in 1865, it is unnecessary for me in this brief notice to do more than allude. Through these years and down to the time of his decease his fertile brain and ready pen were ever at work. But the scope of his investigations was not limited to purely geological subjects; he was a man of many parts, and astronomical questions largely engaged his attention in his later years. In 1868 he visited Italy and Vesuvius, and subsequently published a little work on the history and structure of that mountain in a form very acceptable to that large portion of the travelling British public which at one time or another makes the delightful pilgrimage to the workshop of Vulcan and the Phlegræan Fields.

The loss of Prof. Phillips' presence at the meetings of the British Association, of which he was one of the founders, is irreparable. His genial face and lucid words brought sunshine wherever he appeared, and threw light on every topic he handled; to him might well be applied the words—"quidquid tetigit ornavit." While lamenting his loss, let us endeavour to imitate the example of his untiring industry, his patient pursuit of the beautiful and noble in nature, his honesty of character, his purity of life. †

The Volcanic District of the North-east of Ireland.—I have now to direct your attention to the district of County Antrim and its neighbourhood as one claiming our special investigation, and presenting a multitude of interesting problems connected with the volcanic phenomena of the Tertiary period. By the labours of Berger, Weaver, Portlock, Griffith, Bryce, Tate, Holden, and other geologists, many of these problems have received a solution; others remain for further discussion. It shall be my endeavour to give you a brief summary of the facts and inferences arrived at up to this time, and to present you with a connected history of the operations carried on by terrestrial agents in this island, from the commencement of the volcanic era to its close.

This era, though short as compared with the sum of geologic time, was in reality vastly extended, and comprised within its limits several stages or divisions characterised by special physical conditions. Speaking in geological terms, it probably included the latter part of the Eocene and the whole of the Miocene periods, interrupted by long pauses in the outburst of volcanic products.

But before entering upon the narrative of events which occupied this space of time, let us first endeavour to determine the physical limits of the theatre of these operations; for it may well be asked, considering the great extent to which the volcanic products have been cleared from off the surface of the country by denudation, with what degree of precision can we define the original limits of the volcanic area?

Let us for a moment, when replying to this question, turn to a still more recent volcanic district for an illustration. When we ascend the cone of Vesuvius, and from that commanding station sweep with our eyes the surrounding region, we find ourselves in the centre of a plain—the Campagna of Naples—formed of the products of volcanic eruptions, but limited through three quarters of a circle by calcareous hills of older date, and along the other portion by the sea.

I believe that similarly, but on a far more extended scale, we can trace out the original limits of the volcanic district of the north-east of Ireland, and that from some elevated stations rising from the central plateau of Antrim these limits may be almost descried by the uprising of ridges of more ancient rocks in several directions. Taking our stand on Tardree Hill, or Sleamish, we see to the southward the granitic and schistose ridge of Slieve Croob, projected against a background of the mountains of Mourne, culminating in Slieve Donard. Westward the eye rests on the rugged masses of Slieve Gullion and the Silurian hills of Newtown Hamilton. Towards the north, after passing the depression of the southern shore of Lough Neagh and the valley of the river Blackwater, the enclosing ridge of old rocks, forming from this distance an apparently unbroken line, ranges northward into Donegal and the northern shores of Lough Foyle. The ocean now intervenes; but a comparison of the physical characters of the Donegal mountains with those of Islay, Jura, Cantyre, and the Western Islands leaves the impression on my mind that the volcanic region of Antrim was limited northwards along the line of a submarine ridge, and that there is little reason for supposing that the volcanic rocks of Mull were superficially connected with those of this country,—on the contrary, the probability seems to be that the old crystalline rocks of the Western Highlands were interposed between the two regions.

Turning to the eastward, the sea overflows an area at one time occupied by volcanic products, but now only partially so, and we are unable strictly to define their easterly limits; but it is tolerably certain that the sheets of lava did not reach the shores of Galloway or those of the Isle of Man. Basaltic dykes, however, as is well known, traverse the north of England and the south of Scotland; but if referable, as Prof. Geikie concludes, to the Miocene period, they cannot be included in the volcanic region as here described and understood.

Thus the volcanic plateau of Antrim, like the Campagna of Naples, is washed on one side by the sea, and its limits become indefinable in consequence; but to the south, the west, and to some extent to the north, the limits of the region are marked out by mountains of considerable elevation. Within this region craters poured forth lavas or other volcanic products, which extended in great sheets until they were intercepted by the uprising of these natural barriers.

The floor of the area thus partially circumscribed was formed of various materials, as the accidents of denudation admitted. Over the central portions it was chiefly Cretaceous limestone (or Chalk), but to the southward it was New Red Sandstone and Lower Silurian, and to the north, Chalk, Lias, Carboniferous, and Lower Silurian beds in different directions. The whole region composed of rocks thus distributed was probably converted into dry land towards the close of the Eocene period—when, at various points, highly silicated felspathic lavas burst forth, consolidating into sheets of trachyte porphyry, rhyolite, and more rarely pitchstone, such as are found at Brown Dod Hill and Tardree, near Antrim, and west of Hillsborough. These trachytic lavas were therefore the oldest of the volcanic eruptions of the north of Ireland, and seem to have been represented by the newer granitoid rocks recently described by Zirkel, Geikie, and

* "The Malvern Hills compared with the Palæozoic districts of Abberley, Woolhope, May Hill, Tortworth, and Usk," Mem. Geol. Survey, 1849.

† An interesting memoir of the late Prof. Phillips will be found in the *Geological Magazine*, vol. vii. p. 301 (1870).

Judd in the Island of Mull on the one hand, and by the trachytes of Mont Dore in Central France on the other. They have been described in this district by Berger and Bryce; but it is only recently that their relations to the other lavas have been clearly determined; and as such rocks are exceedingly rare in the British Isles, I trust the members of the Association will take this opportunity of paying a visit to the quarries near Antrim, where they are fully opened to view. In composition, both at Hillsborough and at Antrim, they present a felspathic base, enclosing crystals of sanidine (or glassy felspar) and grains of quartz. At Brown Dod Hill they are disposed in sheets, showing lines of viscous flow and dipping beneath the overlying beds of basalt.

As I have already stated, the outpouring of these trachytic lavas may, with every probability, be referred back to the later Eocene period. At any rate, a considerable interval probably elapsed before the eruption of the next series of lavas of Miocene age, which are essentially augitic, and may be comprehended under the heads of basalt and dolerite with their amygdaloidal varieties. Sheets of these lavas were formed, from various vents, over the uneven surface of the older rocks, and to a far greater extent, both as to area and thickness, than in the case of the preceding eruptions of trachyte.* These beds, which are often vesicular, attain in some places a thickness of 600 feet, and are surmounted by decomposed lava and volcanic ashes, which mark the close of the second period of eruption.

The sheets of augitic lava which were poured forth during this stage are remarkable for their vesicular character and the numerous thin bands of red ochre (bole or laterite) which separate the different lava-flows, and which have been recognised by Sir C. Lyell as probably ancient soils formed by the decomposition of the beds of lava, similar to those in Madeira and the Canary Islands, resulting from streams of sub-aërial origin. Microscopic examination bears out this view; for a thin slice of one of the more compact beds of bole from the north coast showed that the felspar-prisms retained their form, while the augite and magnetite ingredients had passed into the state of an ochreous paste.

The vesicular and amygdaloidal character of these older beds of lava shows the probability that they have been poured forth under no greater pressure than that of the atmosphere, and together with the evidence derived from the bands of ochre leads to the conclusion that they have been erupted over land-surfaces. Some of the vents of eruption are now visible, either in the form of amorphous masses of trap protruded through the sheets, or of great funnels filled by bombs, broken pieces of rock, and ashes, such as the rock on which is perched the venerable ruin of Dunluce Castle (the ancient stronghold of the MacDonnells), or the neck erupted through the chalk in the coast-cliffs near Portrush.† One of these old funnels was found by the late Mr. Du Noyer near this place: it forms a portion of the crest of the ridge overlooking Belfast Lough, to the east of Cave Hill, and is within easy reach of members of the Association.

The period of the formation of the older sheets appears to have been brought to a close by the discharge of volcanic ashes and the formation of an extensive lake, or series of lakes, over the region extending at least from the shores of Belfast Lough to the northern coast of Antrim, in which the remarkable beds of pisolitic iron-ore were ultimately deposited. This is the only mode of origin of these ores which seems to me at all probable; and I am consequently unable to accept the views advanced by Messrs. Tate and Holden regarding their origin from basaltic lava by a process of metamorphism. That water was present, and that the beds of ash which underlie the pisolitic ore were stratified, at least in some instances, is abundantly evident upon an examination of the sections at Ballypalidy, Ballymena, and the northern coast. In some places they are seen to be perfectly laminated in a manner that could only take place by the agency of water.‡ It would seem, therefore, that by the combination of slight terrestrial movements, a shallow basin was formed over the area indicated, which received the streams charged with iron in solution, draining the upland margins, from the waters of

* In this respect they resemble the corresponding rocks in Central France, where, as Mr. Scrope has shown, the trachytes have a more restricted range than the basalts ("Volcanoes of Central France").

† A sketch of this old rock is given by Prof Geikie in Jukes's "Manual of Geology," 3rd edit. p. 271.

‡ The authors referred to, while admitting the stratified character of the beds at Ballipalidy and their formation in presence of water, consider that in all other cases the iron ore has been formed on a terrestrial surface; but sections seen at Ballymena and the north coast have led me to conclude that these beds are all more or less stratified, and due to aqueous deposition.

which were precipitated the iron, possibly by the agency of confervoid algæ, as in the case of the Swedish lakes of the present day (a view maintained by Mr. D. Forbes, F.R.S.), or by the escape of carbonic acid, owing to which the iron became oxidised and was precipitated.

Upon these uplands grew the plants whose remains occur amongst the ash-beds of Ballypalidy, the Causeway, and elsewhere, and which have enabled Mr. Baily to refer the strata in which they occur to the Miocene period.* In some places the vegetation crept over the surface of the former lake-bottom as it became shallower or was drying up, and gave rise to beds of lignite similar to those described by the Duke of Argyll as occurring at intervals amongst the basalts of Mull.† The beds of ore, wherever they are found, belong to one and the same geological horizon, and enable us to separate the basaltic series into two great divisions—one below and the other above the position of the pisolitic ore; and which, on maps of the Geological Survey, will for the future be represented by two different shades of colouring.

The ore itself is now laid open in numerous adits driven into the hill-sides, or in open works at Island Magee, Shane's Hill, Broughshane, Red Bay, Portfad, and other places,‡ whence it is transported to the furnaces of Scotland, Cumberland, Lancashire, and Wales. A new source of industry and wealth is rapidly springing up over the already prosperous county of Antrim, and ere many years are over we may expect to see furnaces established at several points for smelting the ores at the mines from which they are extracted.

The period of volcanic inaction just described was brought to a close by fresh eruptions of augitic lavas, which spread in massive sheets over the beds of ore, bole, and even lignite, without materially altering their constitution. Thus on the north coast a band of lignite is interposed between the pisolitic ore below and a massive bed of columnar basalt above, which can be followed and identified by the size and regularity of its columns for several square miles over that district. That this molten rock has not utterly reduced the lignite to ashes, or even entirely obliterated the impressions of the plant-remains, has been doubtless due to the rapidity with which a hard crust, of low conducting power, consolidates on the outside of a lava-stream, as has been frequently observed on Vesuvius and other active volcanoes.

Above this peculiarly massive bed were piled fresh sheets of basalt and dolerite to a total depth of at least 400 ft., each flow of lava being consolidated in a somewhat different manner from those above and below it, and probably separted from them by considerable intervals of time, as bands of ochre intervene in most instances between successive beds indicating subaërial soils of decomposed lava.

The maximum thickness of the basaltic sheets of Antrim has been estimated by Mr. Duffin and myself at 1,100 ft., to which must be added perhaps 200 ft. for the subordinate trachytic beds, giving a total of 1,300 ft. for the whole volcanic series. This is rather more than originally assigned by Dr. Berger, who places it at 900 ft.,§ but it falls far short of the enormous accumulations of Mull, estimated by Prof. Geikie at from 3,000 to 4,000 ft.; in neither district, however, have we the data for determining the original thickness of volcanic *ejecta*, as in both large masses of material have been wasted away by denudation, and not a single volcanic cone or crater remains behind out of all those which, probably in numbers corresponding to those of Central France, were planted over the entire volcanic region.

The basaltic dykes which traverse not only the geological formations subordinate to the bedded traps, but also the latter themselves, are, in some districts, both remarkable and exceedingly numerous. To the south of Belfast Lough we find at Scrabo Hill an outlying mass of bedded dolerite resting on New Red Sandstone, and far beyond the limits of the main masses which rise in a fine escarpment to the north of the Lough. There is every probability that Scrabo Hill is the site of a distinct focus of eruption; but it is also remarkable for the dykes of trap, as well as intrusive sheets, which have been squeezed in between the beds of sandstone themselves. Admirable and instructive sections are laid open in the freestone-quarries of this

* Quart. Jour. Geol. Soc, vol. xxv. p. 357, pls. 14 and 15. The plants determined by Mr. Baily, from Ballypalidy, belong to the genera *Sequoia*, *Cupressites*, *Rhamnus*, *Quercus*, *Pinus*, &c. They were originally detected by the late Mr. Du Noyer.

† Jukes's "Manual of Geology," 3rd edit. p. 690.

‡ At Pleaskin Head it was originally observed by the Rev. Dr. Hamilton (1790).

§ Trans. Geol. Soc., 1st Series, vol. iii.

hill, which will amply repay a visit. Another district remarkable for such intrusions is that of Ballycastle, where dykes and sheets are seen traversing the carboniferous rocks, as described by Sir R. Griffith in his admirable report on the geology of that coal-field;* while the well-known Giants' Causeway is itself a tessellated pavement of columnar basalt, traversing in the form of a dyke the horizontal sheets of older formation.

The intrusion of the thousands of dykes of the north-east of Ireland is unaccompanied by crumplings or contortions of the strata; and if it were possible to place the dykes side by side, their aggregate breadth would cover a space several thousand feet in breadth. How, then, has this additional space amongst strata of given horizontal dimensions been obtained? Has it been by lateral tension outwards owing to inflation by means of elastic gases or vapours, or by a general bulging of the surface consequent on lateral pressure? The former view, I am told by physicists, is untenable; the latter is one which will probably prove more consonant with modern views of terrestrial dynamics.

The results of the microscopic examination of a considerable number of specimens of augitic lavas from various parts of the volcanic district are of a generally uniform character. Whether we take specimens from the largely crystalline granular dolerites of Portrush or Fair Head, or the very dense micro-crystalline basalts of Shane's Castle, the structure and composition are found to be nearly uniform.

The lava is, with very few exceptions, an amorphous or sub-crystalline paste of augite, enclosing long prisms or plates of labradorite felspar, crystalline grains of titano-ferrite, and often of olivine. Chlorite is also sometimes present as a "secondary" mineral. It will be observed that this diagnosis differs essentially from that assigned by Dr. Zirkel as the normal structure of basalt, in which the base is "a glass," and the other minerals (the augite, felspar, and olivine) are individually crystallised out.† This, indeed, is the case with the carboniferous melaphyres of the south of Ireland,‡ and probably with all the rocks in which augite is deficient; but the basalts of Antrim contain augite so largely in excess of the felspar that it has, in nearly every case, formed the base of the rock.§

The basalt itself is often so rich in iron as to become an impure iron-ore. This is owing to the presence of the metal in the form of minute grains of titaniferous iron-ore, which is the principal cause of the black appearance of the rock and also as one of the components of the augite.

From the above general review of the volcanic history of Tertiary times in the north of Ireland it will be evident that it presents us with three distinct periods, similar to those which Mr. Judd has recognised in the succession of events in the Island of Mull:—

The earliest, possibly extending as far back as the later Eocene period, characterised by the trachytic lavas.

The middle, referable to the Miocene period, characterised by vesicular augitic lavas, tuffs, and plant-beds.

The latest, referable to a still later stage of the Miocene period, characterised by more solid sheets of basalt and numerous vertical dykes.

These three stages were probably separated from each other by long intervals of repose and the cessation of volcanic action. The succeeding Pliocene period seems to have been characterised by considerable terrestrial movements, resulting in the production of fractures in the earth's crust, and (as my colleague, Mr. Hardman, supposes) in the formation of that large depression which was filled with waters having a greater area than the Lough Neagh of the present day. Some of the faults which traverse the upper sheets of basalt, and are therefore of later date, have vertical dislocation amounting to 500 or 600 ft., as, for instance, that which runs along the valley under Shane's Hill near Larne. Such great fractures must necessarily have been accompanied by denudation, and it is probable that many of the present physical features had their origin at this (Pliocene) period. The extent to which the original plateau of volcanic rocks has been broken up and carried away within such comparatively recent times is vaster than is generally supposed. As there is evidence that the sheets of lava to the north of Belfast Lough were originally connected with those of Scrabo Hill to the south, we must suppose that this arm of the sea and the valley of the Lagan have been excavated since the Miocene period; while on the north-west the high elevation to which the escarpment of the basalt reaches, leads to the supposition that the basaltic sheets spread over the ground now occupied by Lough Foyle. Both along the west and along the eastern seaboard the sheets of lava are abruptly truncated, and must have extended far beyond their present bounds; while many deep valleys, such as those of Glenarm, Cushendall, and Red Bay, have been excavated.

But the most remarkable result of the denudation, as bearing upon the subject before us, is the complete obliteration of the volcanic cones which we may well suppose studded the plateau. Some of these cones, at least, were contemporaneous with those now standing upon the granitic plateau of Central France, and which are but little altered in elevation since the fires which once burst forth from them became extinct. But since then the north of Ireland has been subjected to vicissitudes from which Central France has been exempted. The surface of the country has been overspread by the great ice-sheet of the earliest stage of the Glacial period, which appears to have stretched across from the Argyleshire Highlands, if we are to judge by the direction of the glacial *striæ* at Fair Head.*

At a later stage the country was submerged beneath the waters of the Inter-glacial sea which deposited the sands and gravels which overlie the Lower Boulder-clay; and subsequent emergences during the stage of the Upper Boulder-clay, together with atmospheric agencies constantly at work, whenever land has been exposed, have moulded the surface into the form we now behold.

It will thus be seen that the physical geologist, whether a Vulcanist or a Neptunist, has in this region abundant materials on which to concentrate his attention.

Volcanic Energy.—In connection with this subject it may not unnaturally be expected that I should make some allusion to the views of Mr. Robert Mallet on "Volcanic Energy," which he has recently unfolded in the "Philosophical Transactions of the Royal Society."† My limits, however, forbid more than a cursory glance at this subject. Stated in a few words, volcanic energy, according to Mr. Mallet, has its origin primarily in the contraction of the earth's crust, due to secular cooling and the tendency of the interior molten matter to fall inwards and thus leave the exterior solid shell unsupported. The lateral pressure arising therefrom (which, as Mr. Mallet shows, is vastly greater than the vertical weight of the crust) is expended in crushing portions of the solid crust together, along lines of fracture which are supposed to correspond to those of the volcanic cones which are distributed over the earth's surface. Each successive crush produces an earthquake-shock, and is converted into heat sufficient to melt the rocks which line the walls of the fissure or lie beneath at high temperatures, and which, in presence of elastic steam and gases, are erupted at intervals both of time and place.

In the words of the author of these views, "The secular cooling of the globe is always going on, though in a very slowly descending ratio. Contraction is therefore constantly providing a store of energy to be expended in crushing parts of the crust, and through that providing for the volcanic heat. But the crushing itself does not take place with uniformity; it necessarily acts *per saltum* after accumulated pressure has reached the necessary amount at a given point, where some of the unequally pressed mass gives way, and is succeeded perhaps by a time of repose or by the transfer of the crushing action elsewhere to some weaker point."

It cannot be denied that Mr. Mallet's theory seems to be consistent with many observed facts connected with volcanic action. It has for its foundation an incontestable physical hypothesis, the secular cooling of the earth, and it seems to throw considerable light upon several observed phenomena of volcanic action—such as the distribution of cones and craters along great lines, the intermittent character of eruptions, and the connection of earthquake-shocks with volcanic outbursts. There are some statements in Mr. Mallet's paper which few physical geologists will be inclined to accept, such as the non-existence of true

* "Geological and Mining Survey of the Coal Districts of Tyrone and Antrim" (1829). Some of the sheets in this district may be of older date than the Miocene age.

† "Untersuchungen über d. mikrosk. Zusammensetzung und Structur der Basaltgesteine" (1870).

‡ E. Hull, "On the Microscopic Structure of the Limerick Carboniferous Melaphyres," Journ. Roy. Geol. Soc. Ireland, vol. iii. p. 112 (with plates).

§ Mr. Allport, F.G.S., states (Geol. Mag. 1873) that he has found the augite individually crystallised out in a specimen from near the Causeway. Such a case, however, must be exceptional; but the rule as stated above certainly holds good.

* A view also held by Mr. James Geikie and Mr. Campbell of Islay.

† [illegible] 3, vol. clxiii. p. 147.

volcanoes before the Secondary or Mesozoic period. The Silurian volcanic districts of North Wales and of the west of Ireland, and the Carboniferous volcanic districts of Limerick and Scotland, bear witness against the soundness of such a view. This statement, however, does not necessarily invalidate the general views of the author; and I cannot but think that the publication of Mr. Mallet's paper has enabled us to take a very long stride in the direction of a true theory of volcanic energy.

SECTION D

Biology

Opening Address by Prof. Peter Redfern, M.D., President

I consented to allow myself to be nominated President of this Section in compliance with the kindly-expressed wishes of scientific friends, notwithstanding that I felt that the duties of the Chair would have been more fitly discharged by many who have attended the meetings of the Association more regularly and laboured to promote its objects more continuously than I have been able to do.

Fortunately the increasing importance and the vast extent of the subjects comprised under the head of Biology have led to a division of the business of this Section into the separate departments of Anatomy and Physiology, Botany and Zoology, and Anthropology; and it is a great relief to me that the departments of Botany and Zoology, and of Anthropology, respectively, will be presided over by gentlemen of the highest eminence in those subjects, and that Anatomy and Physiology, in which I am more immediately interested, will alone come under my direct supervision. It has occurred to me that, in attempting to give a stronger impulse and a more systematic direction to scientific inquiry, the time ordinarily devoted to an introductory address could not be more profitably occupied than by bringing into as great prominence as possible some of the great revolutions in our knowledge of Anatomy and Physiology which have taken place in my own time and under my own immediate observation.

I remember, as if it were yesterday, the elucidation in the Museum of the Royal College of Surgeons of Edinburgh, of the newly discovered cell-theory by the late distinguished Professor of Anatomy in Edinburgh, John Goodsir—his account of the production of ulceration by cell-growth, of the characters of the corpuscles of bone, of the structure of lymphatic glands, and of the germinal centres of basement membranes as they were then understood. This was the time when the teaching of Histology was first established in Great Britain. Two students, of whom I was one, formed the first class under the most enthusiastic of teachers, my old friend, Dr. Hughes Bennett. The University of Edinburgh has just passed through what was probably the most brilliant period in its history. The race of the last of the Munros was well-nigh run; the great discoverer of the difference in the motor and sensory nerves, Sir Charles Bell, was still living; the aristocracy of Scotland had only just ceased to crowd the classroom and witness the brilliant and successful experiments of Dr. Hope. The day of Cullen, of Home, and Duncan, and Macintosh was over; but there still remained in the University the most loved and revered of teachers, the benevolent Dr. Alison, Sir Robert Christison, Sir George Ballinghall, and Mr. Syme, Dr. Abercrombie still practising his profession in the city.

At this period the great discoveries of Schleiden and Schwann seemed likely to upset all that had previously constituted Physiology. The idea that all tissues were either composed of cells or had been formed of cells—that nucleated cells elaborated all the secretions and formed the excretions—that their energy lay at the very root of the formation, the reproduction, and the function of every tissue and organ, was a revelation of such astounding simplicity as might well upset men's minds and prevent their seeing beyond.

No one, who did not live through that time, will, I believe, ever realise the eagerness and anxiety with which every new statement of the action of cells was received and added to the previous knowledge of their amazing power—or, on the other hand, be able to judge of the feeling, half akin to disappointment, which was experienced as each succeeding attack was made on this charming theory, showing it to be really human, very human indeed.

Cells were then understood to constitute the mass of all organs (the liver, spleen, kidney, and brain), and to be the main agents in the discharge of their functions—to exist and grow upon the definite membranous walls of the glandular vesicles and ducts—to be fed by blood brought to the attached surface of membranes which seemed almost everywhere to form an absolute separation of the cellular part (the potential gland) from the non-essential blood and lymph-vessels, the nerves, and framework of the organ. It seemed almost a pity that these little microscopic deities should be hampered by the necessities of their own existence, that they should need such base things as blood-vessels, nerves, and packing materials. Now how strangely are matters changed! What if it should turn out that these apparently independent little beings are not independent at all—that they are only the dilated ending of nerves? To this subject I shall refer again by and by.

This great cell-theory has now given place to what I think is certain knowledge, that living matter may move, perform all the functions of assimilation and nutrition, and reproduce its like without having any of the essential characters of a cell. A living mass of protoplasm may change its shape, alter its position, feed and nourish itself, and form other matter having the same properties as it has, and yet be perfectly devoid of any structure recognisable by the highest powers of the microscope.

Mr. Lister showed that the contraction of pigment-cells in the skin changes the position of the pigment-granules, driving them alternately into the processes and the body of the cell. Kühne, Golubew, and Stricker observed changes of form in amœbæ (white blood-corpuscles and embryonal capillaries, respectively) after the application of electrical stimuli; and Brücke observed contraction in the pigment-cells of the skin of the chameleon after excitation of the sensory nerves; whilst Kühne noticed contraction in corneal cells after excitation of the corneal nerves.

Thus obvious movements in fixed cells or masses of protoplasm are proved to result from the operation of various stimuli, including nervous stimuli.

But all cells are not fixed. The blood-cells, fixed, as cells of organs, at an early period, become free in the blood-fluid and are moved along by the forces which circulate it until a second time they enter into the composition of the solid tissues by penetrating the walls of the blood-vessels and moving along the substance of the tissues for purposes which are not yet wholly explicable.

What naturalist will not at once suggest how frequently this process of alternate fixation and movement of animal forms occurs low down in the scale? and yet how startling is it in man! how impossible to reconcile with our former ideas of the existence of membranous coverings, of cells, surfaces, and of gland-ducts! But, with or without explanation, the facts must be recognised; the floating blood-cells are really the very cells which once formed the substance of the lymphatic glands, the spleens, and other organs; and they do, in fact, move through the walls of the blood-passages, and wander about freely in what we call solid tissues.

Our knowledge of this circulating fluid has marvellously increased. The duration of the life of any of its particles is but short; they die and their places are occupied by others, as was the case with our forefathers, and will be the case with ourselves. It is now a matter of observation, which commenced with Hirt of Zittau, that after every meal an amazing number of white corpuscles are added to the blood: breakfast doubles their proportion to the coloured corpuscles in half an hour; supper increases their proportion three times; and dinner makes it four times as great. They come from such solid glands as the spleen. In the blood going to the spleen, their proportion is one to two thousand two hundred and sixty; in that returning from the spleen it is one to sixty. Every organ and every tissue changes this fluid; and, to my mind, perhaps the most stupendous miracle of organisation is the steady maintenance of but slightly variable characters in the living and moving blood which is every moment undergoing changes of different kinds as it circulates through each tissue and organ in the body.

Yet with all this change there is an invariable transmission of the parental characters by continual descent from particle to particle as each takes the place of a former one; and thus each organ continues to discharge the same function from year to year. Animals of the same kind retain the old number of organs the same shape of body, and similar modes of life. There is no sign of commencing life, no coining of new vital power, no production of living out of dead matter. The original life extends its limits; it operates in a more extended sphere; but it is the same life, it operates in the same way, it never fails to be recognisable in the individual by the same characters as it had when it was first known. Whatever other functions it discharges,

it acts continually in obedience to the first great law; it increases and multiplies, and replenishes the earth.

Let us now for a few moments compare our former views of the structure of animal membranes with the present ones. The skin (covering the outer surface of the body), the mucous membranes, the serous linings of the great internal cavities and of the blood- and lymph-vessels, and the lining membranes of joints were all alike viewed as if formed of a definite membrane covered on one side by cells, and on the other supplied by blood- and lymph-vessels and by nerves—the membrane covering in the latter parts and affecting an absolute separation of the cells from the vessels and nerves, which were universally believed never to penetrate into the cellular layer. The cells were regarded as the parts actively engaged in the performance of the functions, the vessels and nerves aiding thereto supplying materials to be acted on by the cells, and the nerves regulating the amount of action at particular times for special purposes. The diseased conditions, like the functions, were kept perfectly distinct; and we had one set of diseases of the epithelial or cellular parts, and another and a different set of diseases of the membranes and of the parts below.

I think the first occasion on which the public faith in these views was seriously shaken was when the late distinguished Professor of Medicine in St. Andrew's, Dr. John Reid, died of what was called an epithelial cancer of the tongue. Microscopical examinations showed that the disease existed in the cellular covering of the tongue. A sufficient cause for it was supposed to exist in the irritation caused by sharp points of the teeth, to cover which a protecting silver plate was constructed. The diseased parts were removed with the greatest skill and care by Sir William Fergusson, and subsequently by the late Dr. James Duncan, assisted by Mr. Goodsir and Mr. Spence, now Professor of Surgery in the University of Edinburgh. Every conceivable care was taken by these attached friends of the poor sufferer to remove every trace of the disease; but it progressed steadily and destroyed his valuable life.

At this period no one could understand the extension of an epithelial disease through a basement membrane; and therefore the affection of the adjacent lymphatic glands was explained by supposing the diseased action to have been propagated from cell to cell along the epithelial surface of the lymphatic vessels.

Not long afterwards the sternly truthful and accurate Sir James Paget declared, in terms of terrible significance, to the sufferers from this disease, that epithelial cancer takes a little longer time than ordinary cancer to do its fatal work.

And it soon became thoroughly well known that the glands of the skin, the hair-bulbs, and the teeth are produced by a local development of the deep cells of the cuticle, extending far below the line of the basement membrane or cutis, and through the position which it was supposed to occupy, as though no membrane were there to hinder them.

Thus the basement membrane, which was supposed so arbitrarily to separate the cells on one surface of membranes from the vessels and nerves on the other, gives way at once before an increased development of the cells, whether in the formation of new organs or the extension of disease. And the membranous walls of capillary blood-vessels allow the corpuscles of the blood to pass through them much in the same way as solid particles enter into and traverse the substance of the protoplasm of an amœba or other mass of sarcode.

Whilst physiologists were engaged in these observations, the late Master of the Mint, Mr. Graham, was conducting a series of experiments of the most remarkable kind, and of the utmost importance to physiology as well as to chemistry and physics. He found it necessary to separate the two sets of substances as crystalloids and colloids,—the colloids being penetrable by the crystalloids as readily as water, the crystalloids (such as hydrochloric acid and common salt) passing through organic membranes with great freedom, whilst many of the colloids, such as albumen and gum, will not penetrate them at all. This discovery has enabled the chemist to separate crystalloids from colloids by dialysis, even when they occur in the most minute proportions—for instance, to separate 80 or 90 per cent. of a ten-thousandth part of arsenious acid in twenty-four hours from porter, milk, or infusions of viscera, substances notoriously difficult to analyse. And it has enabled physiologists to explain how animal membranes are traversed by various substances which could not pass through them without being changed from the colloidal into the crystalloidal form. Thus the colloidal starch and albumen of our food scarcely admit of absorption until in the process of digestion the starch becomes sugar and the albumen albuminose, crystalloidal bodies which pass through animal membranes with great facility. And again, this crystalloidal albuminose, after having passed into the tissues through the membranous walls of the vessels, may become a second time a colloid, and be deposited and fixed as tissue-substance, ready in its turn to be permeated by crystalloids either for temporary or more durable purposes in the economy.

The effect of this great discovery of Mr. Graham's shows how impossible is the advance of physiology without a corresponding advance in our knowledge of chemistry and physics.

If basement membranes, the walls of blood-vessels, and of cells are made up of colloidal matter, we can easily understand how they are penetrated by crystalloids; and in like manner it is perfectly possible that they may be traversed by other substances in solid forms—as, for instance, the walls of blood-vessels by the corpuscles of the blood. No wonder that there is a continual deposition and removal of the constituents of the tissues, if so slight a change as that from the crystalloidal to the colloidal form, and the reverse, makes such perfectly marvellous differences in the relations of these substances to each other.

We must look upon the tissues of an animal body as we do upon the substance of an amœba, and recollect how penetrable the surfaces and tissues of animals are; then we shall cease to be startled when we see these parts become the seat of entirely new deposits, or find them traversed by migrating blood-corpuscles as freely as a colloid is penetrated by a crystalloid.

It is impossible to foresee what may be the result to physiology of this great advance in our knowledge of the varying relations of substances to each other according as they present themselves at different times in the opposite physical conditions which were described by Mr. Graham as crystalloidal and colloidal. But it is plain that we cannot continue to look upon animal membranes as forming such decided barriers against the penetration of one tissue by another, or by foreign matters, as was once supposed.

Let me now direct your attention to the present aspect of the question how far basement membranes limit the distribution of vessels and nerves, and separate them from the cells of glands and membranes.

Mr. Bowman, in his admirable researches into the anatomy of the organs of sense, discovered that the filaments of the nerves of smell have a remarkable structure—that they are nucleated, finely granular, contain no white substance of Schwann, and resemble the gelatinous nerve-fibres. The epithelial surface, too, of the olfactory region Mr. Bowman described as differing greatly from that of the adjacent parts of the nasal mucous membrane, and as being of a dark sepia tint. Subsequent examinations by Hoyer, Max Schultze, and Lockhart Clarke confirmed these statements; and those of Schultze demonstrated that the cells are of two kinds, one elongated and filled with yellowish granular protoplasm, exposed at the outer end of each cell and containing a clear oval nucleus in clear protoplasm in its deeper part, which is first attenuated and then expanded into a broad flattened process, apparently connected with the connective tissue; the other cell, the proper olfactory cell, a thin, fibrous, rod-like body, is moniliform or varicose, connected below with the out-runners of a nerve-cell, and in birds and amphibia furnished with one or more hair-like processes, which at the free end come directly into contact with odorous particles. Exner in 1872 denied the distinctness of these two forms of cells, stating that there are all intermediate forms, and that both forms are connected with a deep network continuous with filaments of the olfactory nerve. But Dr. Newell Martin, in a paper published in the November number of the *Journal of Anatomy and Physiology*, maintains that the two kinds of cell are distinct, though their characters approximate very closely in the instance of the frog. He inclines to the belief that, as both forms of cell are so distinct from ordinary epithelium, they are all olfactory cells.

The only conclusion which can be drawn from these observations is, that in this situation the olfactory nerves divide into myriads of small finger-like processes, which, exposed on the free surface of the membrane, are actually engaged in feeling at the odorous particles to inform us of their characters.

This single instance, so thoroughly proved, would be sufficient to destroy our former ideas that nerves are spread out under basement membranes and never penetrate an epithelial layer.

But this is not the only case of the kind. The general relations of the gustatory nerves to the epithelial cells of the tongue have been described by Axel Key as similar in the fungiform

papillæ of the frog, and by Schwalbe and Lovén in the gustatory cells of the circumvallate and of some of the fungiform papillæ in men and animals. On the protected sides of the circumvallate papillæ a peculiarity in the shape and arrangement of the epithelial cells produces a series of taste-cones, the central cells of which are furnished with hair-like prolongations similar to those of the olfactory cells.

In the otolith sacs and the ampullæ of the semicircular canals of the ear, the nerve-filaments, having lost their white substance, become connected with peculiar auditory cells and end in hair-like processes between the epithelial cells. In the cochlea, too, notwithstanding the complication of the examination produced by the rods of Corti, there is reason to believe that the cells supporting hairs which project beyond the epithelial surface are connected with the primitive nerve-fibrils of the plexus below.

Of the recorded instances in which nerves pass through basement membranes to get into direct contact or continuity with the superjacent epithelial cells, none is so striking as that of the salivary and other glands, if there be the least ground for the remarkably detailed observations and suggestions of Pflüger. They are of so much importance and interest in connection with the whole process of secretion, that I offer no excuse for directing your attention to them, even though it may be proved that the act of secretion is not attended with such marvellous and extensive changes of structure as Pflüger supposes. Up to a certain point his observations may be easily and abundantly confirmed; beyond that there is much greater difficulty; but this meeting offers one of the most favourable opportunities for extending our knowledge by bringing different observers into easy communication with each other, and enabling each to help the rest by stating the means by which he had overcome what seemed at first to be insuperable difficulties in the progress of an investigation.

Pflüger calls attention to the very variable characters of the alveoli, the secreting cells, and the excretory ducts of the salivary glands. These parts, which were believed to have very determinate sizes and characters, he declares to differ very greatly in different parts of the same gland. The alveoli, occupied by what we understand as secreting or glandular epithelial cells, and the excretory ducts, lined by columnar epithelium, he thinks he can prove to be but different stages of development of the same structures, produced on the ends of the myriad nervous filaments supplied to these glands.

On this view glandular epithelial cells must be regarded as special organs of termination of nerve-fibrils, like the auditory cells, touch-corpuscles, olfactory cells, muscular fibre-cells, and the like; the relation between such structures and the nerves becoming so close that it may be difficult, perhaps impossible, to define their respective limits. Pflüger has figured the nuclei of the cells of the alveoli of the salivary glands, the salivary cells, connected with a delicate fibre, which often pierces the surface of the cell in contact with the *membrana propria*, and gives the cell the appearance of being stalked. This appearance has also been seen by Schlüter, Otto Weber, Gianuzzi, Boll, and Kölliker; and indeed the appearance which Pflüger has figured may be seen by anyone who will take the trouble to examine the salivary glands of the common cockroach (*Blatta orientalis*). This process was shown to me by my friend and pupil, Mr. Charles Workman; and I have several preparations which show a similar process to that which Pflüger has observed and figured; but that it is as clearly connected with the nucleus of the cell as he describes it I am not prepared to affirm. Pflüger says it is hollow, and often discharges a large quantity of tenacious material which clearly proceeds from the nucleus.

In the interior of the gland there are ducts lined with a thick but single layer of columnar epithelium, the cells of which are clear and nucleated near their free end, but furnished with a large number of extremely fine varicose hairs at the end connected with the *membrana propria*. This epithelium becomes thicker as the ducts proceed towards their connection with the alveoli; and as transparent drops can be seen transuding from the ends of the cells when saliva has been made to flow by irritation of the gland, Pflüger concludes that they are important secretory organs. Such ducts frequently form loops, or bend suddenly, or possess diverticula. The epithelium of the ducts, which carry the secretion out of the gland, is of a different and apparently less important kind.

Pflüger directs special attention to the great number of nerves connected with the alveoli. He has identified them in fresh specimens by their investment here and there by an ordinary double-contoured medulla, by their being blackened by perosmic acid, by their varicosities, and by tracing them to large and more easily recognisable nerves. He finds them branching in great numbers amongst the cells of the alveoli, and traces their fibrils to the nuclei of the cells, sometimes after they have been connected with multipolar ganglion-cells. Or nerves covered by medulla and sheath, and containing numerous varicose axis cylinders, branch, enlarge, and become covered with protoplasm set with nuclei, forming what Pflüger calls a protoplasmic foot, and supposes to be a structure intermediate in character between nervous and glandular tissue. And on the surface of the ducts lined by columnar epithelium a nerve divides into a pencil-like tuft of varicose fibrils, each of which Pflüger says is directly continuous with one of the processes of a columnar epithelial cell. I have frequently seen the pencil-like tuft of varicose fibrils on the surface of the ducts lined by columnar epithelium; but it is not so easy to be sure that the fibrils are connected with the processes of the cells. However, the statement is made in the most positive way by Pflüger, who has made these glands the subjects of very special and lengthened investigation; and his drawings afford very strong corroborative testimony of the value of his statements. Moreover, in independent observations on the pancreas, he has also traced the nerves to endings in the secreting cells.

But Pflüger has gone greatly further than this. He has figured the hair-like processes at the attached end of the columnar cells in all stages of transition into salivary cells of new alveoli; and having previously found the nerves connected by varicose fibrils with protoplasmic masses set with nuclei, he concludes that it is possible that the salivary cells are developed on the ends of the nerves without interference of their own nuclei, and that, as a continual new formation of alveoli and salivary cells implies the atrophy and disintegration of corresponding older parts, the alveoli with pale offshoots of various forms which he has seen in moles are evidences of such atrophy.

With these numerous instances in which nerves are alleged to pass through membranes to be connected with the cells on their surfaces, as if these were their special modes of termination, we might well be content until there has been time for further investigation by independent observers. But there are yet other instances. Langerhans described, in 1868, a fine network of fibres in the skin, from the superficial part of which fine non-medullated fibres pass out of the cutis and end in the Malpighian layer of the epidermis. He saw in the epidermis also well-marked cells which gave off several processes towards the horny layer, and one long slender process which passed through the Malpighian layer into the cutis. He considers these cells to be nervous, and their peripheral processes to be the terminal parts of the nerves of the skin. C. J. Eberth agrees in the main with Langerhans, and recognises fine nerve-fibres passing from the nerves of the cutis into the deeper layer of cuticular cells, and also star-and-spindle-shaped cells in the cuticle, which he suggests may be nervous structures, though he has not traced them in connection with nerve-fibres.

On the surface of young fishes and Amphibia F. E. Schutze has described nerve-hairs arranged in the form of tufts or brushes very much as in the case in the organ of hearing; in this instance the brush-like endings of the nerves are probably connected with touch.

Cohnheim has described the corneal nerves as forming a superficial plexus under the anterior elastic lamina; from this perforating branches pass perpendicularly through the lamina, and then under the epithelium, break up into brush-like or star-shaped finer branches, which form a plexus giving off fine nerves at tolerably regular intervals between the deep columnar cells and the more superficial spheroidal ones, and dividing at length into their finest branches, which end by somewhat swollen extremities in the most superficial epithelial layers. Thus the exquisite sensibility of the front of the eye, like that of the olfactory or gustatory mucous membranes, may be accounted for.

When I look upon the vast amount of research which has been applied to this department of biology for some years past, and think that the instrument which has afforded the great means for it was only perfected so as to be capable of use for such purposes about 1820, I cannot but congratulate the Section on the abundant fruits we are reaping.

And when, in addition, I contemplate the amount of certainty which physical science has imparted to physiology by furnishing the means of examining and accurately measuring the rates of transmission of nerve-currents, of obtaining tracings of the respi-

ratory movements and of the arterial pulsations, of examining the retina in the living eye and the larynx of a living man almost as readily as if these parts were exposed in a dissection, I cannot but conclude that this nineteenth century has already been distinguished as a very notable one for biology, and especially for physiology.

Considering that so much time is required for making a single careful observation, it is very fortunate that so large an array of inquirers and so much talent are employed upon the subjects in which we are interested, and that once a year we have this admirable opportunity of listening to the results of inquiries instituted by the most eminent men in all parts of the world, and of hearing different views advocated with the greatest earnestness and yet with perfect good humour, and a rigorous determination to rest satisfied with nothing but the truth.

SCIENTIFIC SERIALS

Proceedings of the Berwickshire Naturalists' Club.—This is the first part of a new volume of the always welcome proceedings of this almost venerable club, which, although nominally a "Naturalists' Club," concerns itself not only with all departments of natural history, but also with subjects of antiquarian, archæological, and general historical nature. This part of the Proceedings especially contains a very large proportion of papers on the antiquities and history of the district worked by the club. As usual, the annual address of the president, Dr. Charles Stuart, consists of a summary of the proceedings of the club during the previous year, and as the proceedings take place mostly in the open air, in spring and summer, the president's address is almost always bracing and interesting, and full of information; it is so in the present case. One of the longest papers is by Dr. George Johnston, having a description of a visit to Holy Island in May 1854, and contains a great deal of interest on the history, natural history, and curiosities of that historical islet; appended is a list of the plants and animals which were seen during the visit. Mr. James Hardy has a large number of papers in this part; of his more strictly scientific contributions are the "History of some Bass Plants," "Arrival, Departure, and Local Migration of Birds near Old Cambus, 1873," "On Insects of East Berwickshire," "Contributions to the Entomology of Cheviot Hills, No. IV." Under the head of "Hawick and its Neighbourhood" we have the geology of the Hawick district by Prof. James Elliott, and its prehistoric antiquities by Dr. Bryden. Mr. John Anderson gives a list of Lepidoptera taken at various places in the south-east of Scotland in 1873, and Mr. A. Kelly the Habitats of some Berwickshire Birds. There are three contributions on *Poa Sudetica* by Mr. A. Brotherton, Mr. A. Kelly, and Mr. J. Hardy. Mr. Brotherton also contributes "Zoological Notes, 1873," and a "List of Tweedside Plants, mostly of recent introduction." Sir Walter Elliot has an interesting obituary of the late Dr. T. C. Jerdon, who wrote so largely on Indian natural history. We have not space to refer to the interesting historical and antiquarian papers.

SOCIETIES AND ACADEMIES

Göttingen

Royal Society of Sciences, March 7.—M. Wieseler read a paper On the Surname "Asphaleios" as applied to Poseidon.—Dr. Drude presented a note On the Systematic Position of Schizocodon, a genus created by Siebold, to which some plants found in the highlands of Japan are referred. The author regards Schizocodon as an anomalous Primulacea, allied to Soldanella, and clearing up the relationship between the Primulaceæ and the Polemionaceæ.—Dr. Carl Fromme made a communication On the magnetisation-function of a ball of soft iron, *i.e.* the magnetic moment obtained in a ball of unit volume by unit magnetising force.—M. Nöldeke communicated a note On the Greek Names of Susiana.—M. Bjerkesm gave a generalisation of the problem of motions produced in a still inelastic fluid by the motion of an ellipsoid.

Paris

Academy of Sciences, Aug. 10.—M. Bertrand in the chair. The following papers were read:—On a new memoir by M. Helmholtz, by M. Bertrand.—Studies on the fossil grain found in a silicified state in the coal formation of Saint Etienne, by M. Ad. Brongniart.—Note on the isthmus of Gabès and the eastern extremity of the Saharan depression, by M. Edm. Fuchs. The author speaks in unfavourable terms of the scheme for establishing a central sea in Algeria.—Fifth note on the conductivity of ligneous bodies, by M. Th. du Moncel.—Researches on explosive bodies; explosion of powder; by MM. Noble and F. A. Abel. Second memoir.—Actual state of the invasion of *Phylloxera* in the Charente provinces: extract from a letter from M. J. Girard to the perpetual secretary.—On the employment of flax waste against *Phylloxera*: a letter from M. La Perre de Roo to M. Dumas.—Vines attacked by *Phylloxera* treated by sand: extract from a letter from M. L. Faucon to M. Dumas.—Note on Coggia's comet, by MM. Wolf and Rayet. The authors made two determinations of the wave-length of the central and most brilliant band in the spectrum. The results are—July 1st, 5161; July 6th, 5165.—Observations of Coggia's comet (III. 1874) made with the Secrétan-Eichens equatoreal, by M. Baillaud.—Observations of Borrelly's comet (IV. 1874) made with the Secrétan-Eichens equatoreal, by M. Wolf.—On the application of gilding on glass to the construction of the camera lucida, by M. G. Govi.—Stratification of the electric light, by M. Bidaud.—On decolorising charcoals and their artificial production, by M. Melsens.—On the constitution of clays (second note), by M. Th. Schlœsing.—Estimation of tannin, by MM. A. Muntz and Ramspacher. The authors allow the tanning solution to pass through a piece of hide, and estimate the amount of matter removed by loss.—Note relating to the action of muscarine (toxic principle of *Agaricus muscarius*) on the pancreatic, biliary, and urinary secretions, by M. J. L. Prevost.—On an arrangement of apparatus permitting the recovery of the iodine which is disengaged during the manufacture of "superphosphate of lime," by M. P. Thibault.—On the etherification of glycol, by M. Lorin.—On a solid polymeride of the essence of terebenthene, tetraterebenthene, by M. J. Ribau. This substance is obtained by the action of antimonious chloride upon terebenthene.—On the albumens of the white of egg, *à propos* of a reclamation of M. Arm. Gautier, by M. A. Béchamp.—Analysis of different pieces of beef sold in the Paris market in 1873, by M. Ch. Mène.—On the Annelids of the Gulf of Marseilles, by M. A. F. Marion.—On the Echini from the environs of Marseilles, by M. V. Gauthier.—On the dressing of wounds with phenic acid (according to Dr. Leister's process), and on the development of vibrios in the wounds, by M. Demarquay.—On the scales of the lateral line in different percoid fish, by M. L. Vaillant.—On the influence of forests on the quantity of rain which a country receives, by MM. L. Fautrat and A. Sartiaux.—On the age and position of the white statuary marbles of the Pyrenees and Alps, by M. H. Coquand.

BOOKS RECEIVED

British.—British Wild Flowers, Part I.: Sowerby and Johnson (Van Voorst).—Reclamation and Protection of Agricultural Land: David Stevenson (Black).—Proceedings of the Manchester Literary and Philosophical Society, vols. viii. ix. x.—Memoirs of the Manchester Literary and Philosophical Society, vol. iv., 3rd series.—How I found Livingstone in Central Africa: H. M. Stanley. Cheap Edition (Low).—Twelfth Annual Report of the Birmingham Free Libraries Committees.—On the Modern Hypothesis of Atomic Matter and Luminiferous Ether: H. Deacon.—Proceedings of the Bristol Naturalists' Society, 1873.—Divine Revelation; or, Pseudo-Science: R. G. Suckling Browne (Longmans).—Tyer's Block Telegraph and Electric Locking Signals. 5th edit. (Tyer & Co.).—The Human Eye: W. Whalley (J. and A. Churchill).—Physiology of the Circulation: Dr. Bell Pettigrew (Macmillan & Co.).—Researches in the Life History of the Monads: W. H. Dallinger and J. Drysdale, M.D.—Journal of the Iron and Steel Institute, vol. i. (Newcastle).—Treasury of Natural History. New Edition (Longmans.)

CONTENTS

THURSDAY, AUGUST 27, 1874

FIFTH REPORT OF THE SCIENCE COMMISSION

THE Fifth Report of the Royal Commission on Scientific Instruction and the Advancement of Science, just issued, is a comparatively short one; but to many it will possess an unusual amount of interest, as showing how far private effort may be relied upon to supply the vast deficiency which at present exists in the means for affording a higher education accessible to all classes.

The Report is concerned with five institutions, each the result of private effort, and each having done much in its own way to raise the standard of the higher education, to place it within the reach of a wider circle, and to bring the physical and natural sciences to the front as indispensable branches of knowledge and an invaluable means of culture, without which all education must be radically incomplete. These institutions are—the two metropolitan Colleges (viz., University and King's Colleges), the Owens College, the Newcastle College of Physical Science, and the Catholic University of Ireland.

The Report gives an account of the origin and growth of each of these Colleges, founded on abundant data supplied by the authorities of the various institutions. Ample details are given as to the amount and sources of income of each of the five Colleges, the number and kinds of professorships, the income of each Chair, the number of students in each class during the last two years—in short, all information needed to form an opinion as to the kind and comprehensiveness of education which the Colleges aim to give, the means at their command to carry out their ideal aims, and the extent to which they have been successful.

The expenditure of University College, London, on capital account, for all purposes, up to the year 1870, amounted to 202,287*l.*, the whole having been defrayed out of the original share capital of the College, and out of the sums that have been either given or bequeathed to it for general purposes from time to time. In addition to the capital sum thus expended there are endowments arising out of various bequests which produced, in 1870, an annual income of 2,978*l.* Of this income, 2,276*l.* is appropriated to special purposes; no assistance has ever been received from any Government grant.

The School established in connection with the College is of unquestionable advantage to it, as a large and increasing proportion of well-prepared pupils pass from the former to the latter; and during the last few years the College has been slightly a gainer, in a pecuniary point of view, by the maintenance of the School. The scientific Chairs of the College are eleven in number. Of these eleven professorships, one only is endowed, Mr. T. J. Phillips Jodrell having lately presented to the College the sum of 7,500*l.* for a permanent endowment of the Chair of Physiology. With the exception of this recent benefaction, the College can hardly be said to possess any endowment whatever the revenue of which is properly applicable to the support of its Scientific Faculty. The Professor of Geology, however, receives 31*l.* per annum from the Goldsmid Fund.

The courses of study, as indicated in the programmes of the professorial lectures, appear to be carefully arranged with a view to the requirements both of elementary and of advanced students. Great importance is attached to the laboratory instruction in Physics, Chemistry, and Physiology. The College has but few scholarships or exhibitions, and of these, none are appropriated exclusively to scientific subjects.

The Report of the Council states that during the session 1873-74 the number of pupils was 1,542; of these, 893 were students in the College, and 649 pupils in the School. Of the students, 322 belonged to the Faculty of Medicine. In the Faculties of Arts and Laws and of Science there were 571. The fees received, exclusive of those for clinical instruction, amounted to 24,266*l.* 10*s.* 6*d.* The total payments out of these fees to the professors, teachers, and masters, amounted to 16,904*l.* 8*s.* 6*d.*, leaving 7,362*l.* 2*s.* for the College share of fees.

The evidence which has been laid before the Commission clearly shows that the usefulness of the College is greatly restricted by the insufficiency of funds. The difficulty is felt in two respects: first, in providing adequate payment for the professors and their assistants; and secondly, in providing laboratory accommodation upon a sufficient scale, together with the proper appliances for instruction and research. The Report gives a schedule of payments to the various scientific professors, followed by a schedule of the lectures given by each; and looked at merely from this point of view alone, the disproportion between the payment and the work done is very striking.

In the opinion of the secretary of the College, "the large deductions from the fees which the College is obliged to make in order to provide for the current expenses of the institution, have a twofold injurious effect. They materially diminish the remuneration of the professors, and so far tend to deprive the College of the services of able men, and by rendering it necessary to charge fees higher than might otherwise be requisite, they must have the indirect effect of keeping down the number of our students. The result is that our professors as a rule are very inadequately paid." The natural consequence of the inadequacy of the professorial stipends is, that in many cases the College has found it impossible to retain the services of some of its most distinguished professors. Some striking instances of very recent occurrence, which show the disadvantage at which the College is placed in this respect, are mentioned in the evidence.

The resources of the College have, moreover, been quite inadequate to provide suitable and sufficient laboratories, apparatus, and assistance for the practical departments of experimental science. The Council have done what they could with the means at their disposal, but these are so inadequate as seriously to cripple the efficiency of the scientific instruction given by the College. Proposals for the extension of the College buildings appear at various times to have come under the consideration of the Council, but no definite action has been taken with regard to them. One of the most important uses to which the additions would be put, were they made, would be laboratories for practical study and original research in connection with the various Science Chairs.

The history and constitution of King's College is in some respects similar to that of University College; by

its original charter, however, dated 1828, it is intimately associated with the Church of England. It started at first and has all along had to struggle with even greater difficulties than University College. For new buildings and other purposes it has had to incur debt from time to time, more especially to meet the increased demands of physical science, for which more accommodation is urgently needed.

The expenditure of the capital funds of the College from its foundation up to the present time amounts to 180,421*l*. 5*s*. 9*d*.

The schedule of payments shows that, as in the case of University College, the teaching staff is very inadequately paid.

The evening classes at King's College have been eminently successful, and provide a fairly complete course of scientific instruction for persons who are unable to attend the day classes. They were attended in 1873 by as many as 550 students, the majority of whom attended more than one class; about 300 out of the 550 attending Science Classes. The financial relations of the School, which is in a flourishing condition, to the College are substantially the same as at University College.

The same complaint is made in the case of King's as in the case of University College; the chief impediment to its further success is "that it is so extremely poor." The various scientific departments of the College do not pay, and were it not for the theological and literary departments, the College, we fear, would have to shut its doors. The professors ought to get three-fourths of the fees, but often a percentage for college expenses has to be deducted from the small sums thus yielded.

We quote in full the recommendations of the Commission with reference to the two Metropolitan Colleges, recommendations which, if carried out, would undoubtedly increase the efficiency of these Colleges, and from which the country would reap a rich return.

"After carefully reviewing the evidence laid before us with regard to University and King's Colleges, and especially taking into account the great public services which have been rendered by these two institutions to scientific education in the metropolis, we are of opinion that, subject to the reservations which we shall make hereafter, they have established a claim to the aid of Government which ought to be admitted. We think that such Government aid should be afforded, both in the form of a capital sum to enable the Colleges to extend their buildings where requisite, and to provide the additional appliances for teaching which the advance of scientific education has now rendered absolutely necessary; and also in the form of an annual grant in aid of the ordinary working expenses of the Colleges.

"With regard to the grant of a capital sum, we are of opinion that it should be appropriated to definite objects such as those above referred to; and we further think that the amount of such grants should be dependent upon the amounts raised by subscription.

"With regard to the annual grants in aid of the income of the Colleges, we think that they also should be appropriated to definite purposes, such, for instance, as the augmentation of the stipends of certain professorships, the payment of demonstrators and assistants, or payments in aid of the laboratory and establishment expenses. An account of the yearly expenditure of each institution receiving such assistance should be reported to Government. As the suspension or withdrawal of the annual grant would always remain in the power of Parliament, we do not think that it would be necessary or desirable to give the Crown a voice in the appointment of the professors, or any control over the management of the Colleges, other than such visitatorial jurisdiction as would be implied by an annual presentation of the accounts.

"As we do not consider that a day school in the metropolis ought to receive pecuniary assistance from an institution which is itself in receipt of such assistance from Government, our recommendation of Government aid to University College is subject to the reservation that its financial arrangements shall be such as, while enabling the College to do full justice to the School, may prevent the School from becoming a charge upon the funds of the College on an average of years. Our recommendation is also subject to the reservation that the finances of the Hospital, and of the purely medical departments, shall be kept distinct from those of the College generally. Our inquiry has not extended to Medical Schools, and it is not within our province to make any recommendation with respect to Government aid to such schools, whether associated with scientific colleges or not. In the case of University College, where such an association exists, we think it expedient that the annual outlay on the purely medical department should be kept distinct, in order to enable the Government to consider separately the question of aid to the scientific department. At the same time, we do not think that there is any reason why the Boys' School and the Hospital should not continue, as at present, under the management and control of the Council of the College.

"The same reservations apply to our recommendations with regard to King's College. Indeed, so far as King's College Hospital and the Medical School connected with it are concerned, the need of such a reservation is more obvious, because it is admitted that these institutions are a heavy burden upon the resources of the College.

"With regard to King's College, we would further suggest that the College should apply for a new Charter, or for an Act of Parliament, with the view of cancelling the proprietary rights of its shareholders, and of abolishing all religious restrictions (so far as any such exist) on the selection of professors of science, and on the privileges extended to students of science. We consider that any grant of public money which may be made to King's College should be conditional on such a reconstitution of the College as should effect these objects. And we suggest that advantage might be taken of the opportunity thus afforded to introduce into the government of the College such other modifications as the experience of the persons concerned in its management may have shown to be desirable." J. S. K.

(*To be continued.*)

THE INTERNATIONAL PREHISTORIC CONGRESS OF ANTHROPOLOGY AND ARCHÆOLOGY—STOCKHOLM MEETING

THIS Congress held its inaugural meeting on Aug. 7, and by acclamation elected Count Hamilton its, president, and the gentlemen already mentioned in NATURE (vol. x. p. 307) its acting office-bearers.

There was no further business that day; but the 300 foreign members present (the whole Congress amounts to over 1,400) were hospitably entertained in the evening by the town of Stockholm at Hasselbacken, which is to Stockholm what Richmond is to London. There were music, supper, and fireworks; and during the evening, in reply to a well-worded toast of welcome from the Mayor, several good speeches were delivered by members of the council representing the different nations present.

On Saturday the real work of the Congress began, and

the questions discussed were—What are the most ancient traces of man in Sweden? and Is it possible to indicate the routes, during antiquity, through which the commerce in yellow amber went?

Baron Kurck opened the discussion by stating that he believed that the most ancient traces of man were to be found in the southern parts of Sweden, and that during the Stone Age men had gradually and slowly travelled northwards, which he thought was sufficiently proved by the fact that the rudest constructed stone implements were found in the south, and that they became more and more mixed with polished ones as you proceeded in a northern direction. The question was entered into with liveleness, and, among others, three of our countrymen, Franks, Evans, and Howorth, took an active part and ably sustained the reputation of Anthropology among British *savans*.

At the Monday's sitting, when a point of great interest was discussed, namely, the characteristics of the polished stones in Sweden, and whether it was possible to attribute the antiquities of this age to one people or to the coexistence of several tribes inhabiting the different parts of Sweden, the King honoured the Congress with his presence. It would appear, too, that he was interested in the speeches, as on a subsequent day he not only himself returned, but brought the Queen with him. The discussion on that occasion was fortunately even more interesting than on the previous occasion, for it was on the Bronze Age, and what were the analogies in the manners and the industry of the Swedish people at that time when compared with those of the same period in the other countries of Europe: also on comparing the Bronze Age with those which preceded it. On Tuesday the Congress visited Upsala (the Oxford of Sweden), and were received and entertained by the professors and students in a most novel and interesting manner. They met us at the railway station, the students all with their white caps on, and carrying the twelve white silk banners, with the embroidered arms and devices of their respective provinces upon them, done in gold and silk thread in a manner which it would be hard to find female fingers at the present day, even when stimulated by Cupid's dart, capable or willing to execute. The choir of students, which I am told is the best in Europe, sang a song of welcome, and then marched before us to the principal points of interest in the town, several times giving us brilliant examples of their vocal powers, especially in the cathedral. Our visit to Upsala was, however, not one entirely for amusement, but for instruction, and a few miles from the town was one of the largest of the country's tumuli, opened for our inspection. It was nearly 40 ft. high, and composed chiefly of sand, covered over with grass, looking like a little hill, but one at whose height and steep sides you would look twice before attempting to ascend. In this were found human remains and the bones of animals (burned) supposed to have been offered in sacrifice. Fragments of gold and iron were also discovered, and a coin, all of which lead to the belief that this tumulus is not more ancient than the fourth century. Another excursion was made on Thursday to the Isle of Björkö, where there is an ancient cemetery of 2,000 tumuli, each about 4 ft. or 5 ft. high, and from 12 ft. to 18 ft. in diameter. Within a couple of hundred yards from this is the site of the ancient town; nothing remains to tell of its site but the souvenirs which lie hid in its soil, which is called the "Black Earth," and is famous for its potatoes. Several trenches, 3 ft. deep and nearly 4 ft. wide, were run through the site of this ancient town, and several of the members of the Congress were fortunate enough to pick up articles of interest—fragments of very rude pottery, needles of bone, glass beads, fragments of iron, and an immense number of the bones of domestic animals, including those of the horse, ox, sheep, dog, cat, pig, as well as of birds. From the remains found here it appears this town must have existed at least up to the eighth century. Before the visit of the Congress to it were found several iron keys, fish-hooks, and pincers: also a whole necklace of coloured glass beads, chiefly white and red; a great many fragments of hair combs, some very well engraved, with crossing straight lines, circles, and dots. They were all formed of bone.

On the following day was discussed the question of how the age of Iron was characterised in Sweden, and an attempt was made to establish the relations at that period which existed between the Swedes and the more southern nations; but, just as on some of the other occasions, no definite conclusion was arrived at, and this arose from the great tendency members showed for discussing the details instead of keeping to the main subject. The last question considered was, what were the anatomical and ethnical characters of the prehistoric men in Sweden? This afforded a second opportunity to the Congress of hearing an interesting passage of arms between Messrs. Virchow and Quatrefages, very similar in substance to what we had from them in print the year after the Franco-German war. They agreed to differ then, and they agree to differ still. It was interesting, but not to the point. However, all ended amicably, and the seventh session of the International Prehistoric Anthropological and Archæological Congress may be said to have terminated by an evening party given by the King of Sweden to all its members at his country palace of Drottningholm, on Saturday, August 15, 1874. Her Majesty and the Queen Dowager were both present. This evening party will long remain in the memory of the members of the Congress as a pleasant tribute of royalty to the shrine of science, reflecting as it does as much credit on the intellectual acumen of him who gave it as honour on those who received it.

The next meeting of the International Prehistoric Anthropological and Archæological Congress will be held at Pesth in 1876.

GEORGE HARLEY

ARMSTRONG'S "ORGANIC CHEMISTRY"

Introduction to the Study of Organic Chemistry. The Chemistry of Carbon and its Compounds. By Henry E. Armstrong, Ph.D., F.C.S. (London: Longmans and Co., 1874.)

To write a good introduction to any subject is sufficiently difficult, but if the subject be developing very rapidly and undergoing very marked changes, as is the case with organic chemistry, obviously the difficulty of presenting such a subject to a student in a satisfactory manner is vastly increased. Dr. Armstrong has devoted

himself heart and soul to his work: the requisite knowledge he evidently possesses, and he has shown good judgment in selecting from much new matter what to bring forward and what to withhold. Neither in arrangement nor in substance has he made direct use of previous treatises on the subject; he has written his own book on organic chemistry, and it certainly will prove to be a good and useful one.

No treatise of note on this subject had appeared of late years in our language, and this rapidly developing branch of science had outgrown the old form in which it had been cast. The change of name which has been suggested is really indicative of the change the science has undergone: formerly it was Organic Chemistry; now it is the Chemistry of the Carbon Compounds; in fact, formerly it was the properties of a few substances, the direct products from organised structures, which was studied, whereas now a very large portion of a treatise on organic chemistry is taken up with the exposition of the theoretical constitution of artificially prepared bodies. In few branches of science has theory been more useful and productive of more good than in this branch of chemistry; and certainly inorganic chemistry, although dealing with simpler bodies, owes much to lessons derived from the organic branch of the subject.

Dr. Armstrong has grouped his subjects in a simple, and, if in somewhat a summary, still in a philosophic way. He casts off and entirely ignores all bodies which at present refuse to fall into some established group. Thus, such bodies as the natural organic alkaloids, indigo, albumen, &c., find at present no place in his book; while we do not regret the exclusion of bodies of doubtful composition, unknown constitution, and but little special interest, still, to ignore the whole of the well-defined class of natural alkaloids was hardly necessary as a matter of principle, and certainly will prove inconvenient to the student.

Since this special property of carbon, this power which it has of combining with itself, appears capable of yielding an almost infinite number of compounds, the classification of this host of bodies becomes a matter of the first importance. So few were the number of organic bodies known only some forty years ago, that they could be classed according to their origin as vegetable or animal substances; afterwards there sprung up a multitude of bodies formed directly or indirectly from these, and we have the first indication of those series of bodies which are now so characteristic of organic chemistry. More or less of the old principle of grouping has lingered in the science until now, but in this book it gives way entirely to grouping dependent solely on constitution; some of the many series of organic bodies are now tolerably complete, and the discovery of new bodies, instead of as formerly tending to complicate the science, now tends to simplify it. In this arrangement of the compounds in series, Dr. Armstrong introduces a simplification which is important; he does away with the aromatic group of compounds as a distinct group, and merges them in the larger general groups. This aromatic group of compounds, as they have been designated, have undoubtedly very marked and specific properties, but Dr. Armstrong shall state for himself his reasons for giving up the exclusion of them from the general series to which they may be considered as belonging, and we think most chemists will be inclined to agree with him:—

"The division of carbon compounds into two great groups of fatty and aromatic substances, which has found favour of late years, has not been adopted. It appears to have arisen from the comparison of single substances, and cannot be sustained, I believe, if whole series are contrasted. It is now placed beyond doubt that in each homologous series of carbon compounds the properties (physical and chemical) of the successive terms undergo from first to last a progressive modification, and there is every reason to believe that in like manner the successive terms in each isologous series undergo a progressive modification. At present we are not acquainted with a single complete homologous or isologous series, so that it is difficult to draw conclusions; but to judge from the evidence at our disposal it appears highly probable that the modification in properties from term to term of each homologous and isologous series is of so gradual a character that continuity may be said to exist throughout. If so, it is as little possible to divide carbon compounds into two great groups as it is to draw a line which shall sharply divide so-called inorganic and organic compounds; that such a division appears possible at present is simply the consequence of the number of links which are still missing in the chain of facts."

While speaking of certain innovations which Dr. Armstrong has introduced into his book, the substitution of the term "unit weight" for combining or atomic weight should be noted: the term certainly has the advantage of being free from all theoretical significance; but if the term *atom* is objected to, the term *combining weight*, already in common use, would, we should have thought, so nearly have expressed Dr. Armstrong's meaning as to save the necessity of introducing a new term. The general arrangement of the book is clear and simple. The first chapter deals with the methods of organic analysis; and should any student be so unfortunate as not to have the opportunity of learning from experiment how organic bodies are analysed, certainly if he reads this chapter he will be well able to picture to himself the kind of way in which the determinations are made. The explanation of the use and meaning of formulæ naturally follow the determination of the data on which they rest. The following caution to students is not uncalled for, and cannot be too strongly impressed upon them. The author says, speaking of rational, constitutional, and structura formulæ: "The use of these terms seems to imply, however, that such formulæ express the constitution or structure of the bodies to which they refer; but we must guard ourselves most carefully against this impression, since, hypothesis aside, we possess no real knowledge as to the internal constitution of chemical compounds, or of the mode of arrangement of the atoms of which bodies are presumed to be made up; and although rational formulæ may represent the approximate constitution of chemical compounds, yet in the present state of our knowledge it is advisable to regard them simply as condensed symbolic expressions of the chemical nature and mode of formation of the compounds represented; they enable us, so to speak, to decipher at a glance the chemical history of compounds."

The second chapter is devoted to the classification of

organic compounds, and Dr. Armstrong arranges them all under the following nine heads :—Hydrocarbons, Alcohols, Ethers, Aldehydes, Ketones, Acids, Anhydrides, Amines, and Organio-Metallic Bodies. To each class he devotes a few lines of explanation ; in fact, the whole chapter is a general outline of what is to follow, and is very useful as giving a general and comprehensive view of the whole subject. The kind of action exerted by the most important reagents on organic bodies is next described, and will be useful to the student who already has some knowledge of the bodies acted on. After thus disposing of these introductory matters, the systematic study of the different classes of bodies above named is commenced and carried through, chapter by chapter, nearly in the above order, the study of Carbon itself forming the starting-point.

The book will certainly prove of great use in this country and do good service in extending a knowledge of organic chemistry. Students in general will hardly look upon it as an interesting text-book ; long lists of rare substances, whose only real interest at present is in their constitution, cannot be made very attractive. The descriptions, however, of important methods of preparation and of purification of different bodies are very well given, and there is a reality and freshness about them which is not generally met with in systematic works on organic chemistry. Dr. Armstrong has evidently not been content to obtain all his information second hand.

The book will probably become the standard text-book on organic chemistry in this country, and in future editions probably will develop into a larger work ; at present even it contains much detail, and is suited rather for the advanced student than for the mere beginner.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Mr. Herbert Spencer and Physical Axioms

In my letter, published in NATURE, vol. x. p. 104, I asked the following question—Does Mr. Spencer regard the second law of motion as an "unconsciously-formed preconception," or as a "corollary of a preconception," or as a "consciously-formed hypothesis"?

This led to a correspondence with Mr. Spencer, which he has thought well to publish, with comments, as part of a pamphlet containing appendices to his former pamphlet entitled "Mr. Herbert Spencer and the British Quarterly Reviewer." Consequently, I should be glad if you would allow me space for a few final words to state what now appears to be the result of the controversy.

By the fuller explanation with which Mr. Spencer has favoured me, it has now been made clear that, on his theory of the evolution of physical axioms, the second law of motion is not itself a "preconception," but a "corollary of a preconception," that is, a truth implied in, but only evolved by conscious mental processes from, the preconception ; though he afterwards somewhat qualifies this statement by admitting conscious *observation* to have its share in the result, when he says, "*Observation aids* in disentangling the truth that this relation between force and motion is more distinct where the actions are simplest—so leading to the intuition that the proportionality is absolute where the simplicity is absolute." I state this, in fairness to Mr. Spencer, because he lays stress on the distinction, and rightly so from the point of view of psychological theory ; though as regards my argument that the second law of motion is not to be regarded as in any sense an *à priori* cognition, it is a side issue of no importance.

But with respect to the main issue, I have at length obtained a definite reply in a passage which I proceed to quote from Mr. Spencer's comments on my last letter to him. I had said—"Various hypotheses as to the relation between force and change of motion may be made, all consistent with the general preconception of the proportionality of cause and effect, and between which the mind alone is unable to decide, until it calls to its aid conscious observation or experiment." To which Mr. Spencer rejoins—(the italics are mine)—"This is perfectly true. I have said nothing to the contrary. My argument implies nothing to the contrary. *I am not concerned with the question how impressed force is to be measured, or how alteration of motion is to be measured.* The second law of motion is a *purely abstract statement, and I hold it to be à priori only in its abstract form.* It asserts that the alteration of motion (a right mode of measurement being assumed) is proportional to the impressed force (a right mode of measurement being assumed). I do not affirm that we know, *à priori*, in what terms of space and time and mass change of motion is to be expressed. The law, as formulated, leaves this unspecified ; and all I hold to be *à priori* is that which is alone stated in the law."

To the mathematician and physicist, comment on this is hardly necessary. I was right when I said, in a former note, that there is little left to argue about. The osteologist may doubtless for his own purposes speak of the skeleton of a horse as a horse, though the dry bones would be a sorry substitute for the living animal to a man who wanted it to do his work. And so, too, Mr. Spencer, as a psychologist, might (if it did not lead to that disastrous confusion which we have complained that his use or misuse of the terms of physical science does lead to) speak of the second law of motion "in its abstract form" as the second law of motion ; but assuredly Newton, who had carefully defined quantity of motion and of motive force before enunciating his "Axiomata sive Leges Motûs," did not regard it as a "purely abstract statement ;" and every mathematician and physicist, who has to any extent followed in Newton's steps, knows that all that gives life and force—that is, power to generate new results and to co-ordinate and explain the external phenomena with which physics is concerned—to this or any other physical axiom is not its *à priori* basis or abstract form, but that element in it which has been derived from conscious observation or experiment.

The upshot of the whole controversy, then, is that the physical axioms of Mr. Spencer are not the living truths which form the basis of the physical sciences, but the bare abstract forms in which those truths may conveniently—possibly Mr. Spencer would say *must*—be expressed. I trust that the value of this result, to the readers of Mr. Spencer's first principles, may be some atonement for the space and time which the controversy has occupied. ROBERT B. HAYWARD

Harrow

Darwin on "The Origination of Life"

We are constantly meeting with an objection to Mr. Darwin's writings, urged alike by friends and foes, on the score of his not having published his views concerning the origin of life. As this objection refers to a matter of literary taste rather than to anything of substantial importance, in ordinary cases it is best met by silence ; but when a President of the British Association gives it a prominent position in his inaugural address, it is time that a dissentient view should be raised.

Towards the close of his discourse, Dr. Tyndall observes :—"The *origination* of life is a point lightly touched upon, if at all, by Mr. Darwin and Mr. Spencer. Diminishing gradually the number of progenitors, Mr. Darwin comes at length to one 'primordial form ;' but he does not say, as far as I remember, how he supposes this form to have been introduced. He quotes with satisfaction the words of a celebrated author and divine who had 'gradually learnt to see that it is just as noble a conception of the Deity to believe He created a few original forms capable of self-development into other and needful forms, as to believe that He required a fresh act of creation to supply the voids caused by the action of His laws.' What Mr. Darwin thinks of this view of the introduction of life I do not know. Whether he does or does not introduce his 'primordial form' by a creative act, I do not know. But the question will inevitably be asked, 'How came the form there?' . . . . We need clearness and thoroughness here," &c. Now, I submit that although this is a question which must "inevitably be asked," it is nevertheless a question with which Mr. Darwin has nothing whatever to do. The problem concerning the origin of life is as distinct from

that concerning the origin of species, as any two problems can well be; and it does not devolve upon a writer to speculate upon the one, merely because he has solved the other. Those who have taken the greatest interest in Mr. Darwin's illustrious career cannot have failed to appreciate the admirable forbearance he has always displayed in not allowing himself to digress into collateral topics, however great the temptation to digress may be. All his vast and numerous conquests of thought have been achieved by a rigid adherence to the philosophy of fact; there is a grand consistency in the maintaining of a method, according to which pure speculation is nowhere permitted to assert itself, excepting in so far as it is absolutely necessary. Surely it would be a deplorable thing were "the epoch-making book" allowed to present a gratuitous deviation from this method, merely in order to plunge into a sea of *à priori* conceptions where inductive verification is as yet impossible. The passage quoted by Prof. Tyndall is adduced by Mr. Darwin only in order to show that *so far as the doctrine of the transmutation of species is concerned*, the evolution theory supplies us with "just as noble a conception of the Deity" as does the theory of special creation. Regarding the more ultimate question, everyone must say with Dr. Tyndall, "What Mr. Darwin thinks of the introduction of life I do not know;" and this, I take it, is just the condition in which the author of the "Origin of Species" should allow his opinions to take their place in history. In short, those who censure Mr. Darwin for his praiseworthy reticence regarding "the far higher problem of the essence or origin of life, upon which science as yet throws no light," * would do well to consider the beautiful example of scientific caution that is afforded by the manner in which this very subject is treated of in the concluding pages of the last edition of the "Origin;" and I am sure that I am only expressing the opinion of the majority of Mr. Darwin's admirers when I say, that whatever our ontological views may happen to be, we all unite in sincerely hoping that, in subsequent editions, he will not spoil the splendour of his finished work by indulging in speculations as foreign to his subject as they must be unprofitable in themselves.

Aug. 21 A DISCIPLE OF DARWIN

Meteors

ON referring to my record of meteors for the 8th inst., I find two meteors nearly at the times mentioned by Prof. Tait (vol. x. p. 305), viz., 10.33 and 10.53. That at 10.33 was, from its position as seen here, unquestionably *not* identical with the one he saw. That at 10.53 may possibly be the same, if by Monoceros Prof. Tait means the constellation commonly marked at Equuleus. If such is the case, a calculation, rough as the data necessitates, would give for the meteor's height at the beginning 144 miles; at the end, 87 miles.

I have of course had to assume a path for the northern station, but as the radiant point was indicated, and one point of the meteor's course, I had not much choice in the matter.

Birmingham, Aug. 24 THOS. H. WALLER

ANOTHER NEW COMET

THE following communication, dated Mr. Bishop's Observatory, Twickenham, Aug. 20, has been sent to the *Times* by Mr. J. R. Hind, F.R.S.:—

"We have received to-day from M. Stephan, director of the Observatory at Marseilles, telegraphic notice of the discovery of a comet this morning by M. Coggia, in the constellation Taurus, the position of which is thus given:—

"August 19, at 14h. 33min. mean time at Marseilles.—Right ascension, 59° 29′; Polar distance, 62° 55′. Motion towards the south-east. The comet is faint.

"The comet discovered at the same observatory by M. Borrelly, on the 25th of July, I observed here last night as follows:—

"August 19, at 9h. 27min. 38sec. mean time at Twickenham.—Right ascension, 13h. 32min. 7·58sec.; Polar distance, 17° 21′ 42·3″.

"It does not appear, as yet, to have materially decreased in brightness."

* "Origin of Species," p. 421, 1874.

THE BRITISH ASSOCIATION AT BELFAST

BELFAST, *Tuesday Night.*

BELFAST is quite the centre of Irish industry, and one of the most progressive towns in the kingdom. People are living who remember it with less than 20,000 inhabitants; now it has near 200,000. As a proof of industry and thrift, it offers a good example to the rest of Ireland. The Association has not met under very favourable circumstances, for unfortunately at this moment no less than 20,000 men in the town are on strike, and somewhat less than 15,000*l.* a week is withdrawn from circulation. A smaller town with a less elastic population would be paralysed, and the influence of the strike is sufficiently felt as it is. The population of the town is very mixed; it is not true Irish. Belfast is less Irish either than Dublin, Cork, Galway, Derry, or Limerick. There is a large leaven of Scotch and Scoto-Irish, who have indeed the merit of a thrifty nature, but who lack many of the good qualities of the Irish; among others, their hospitality. The thrift of these people has caused the hotel and lodging arrangements to be carried out in an abominable manner. We have been shamefully fleeced. One hotel charges a sovereign a night for a bedroom, others half as much; in any case, members of the Association are charged at least double the ordinary prices. In final despair we were driven to inquire at a small coffee-shop whether they had a room; the people replied that they had; but that if we were a member of the Association we must pay ten shillings a night, the ordinary price in that house being about two shillings. When people travel from a distance, and sacrifice time, money, and rest, to do the work of the Association, and not as pleasure seekers, it is rather hard to be swindled because you happen to be a member of the Association.

The Sections have been well filled, and have had plenty of pabulum in the form of papers and verbal communications. Section A has been divided into two Departments, and it is probable that one or two of the Sections will have to sit on Wednesday. The addresses were quite up to the average. Among the more interesting papers were those of Mr. Huggins, On the Spectrum of Coggia's Comet; Prof. Wiedemann, On the Magnetisation of Chemical Compounds; Dr. Carpenter, On the *Challenger* Deep-sea Dredgings; and Mr. E. J. Harland, On a Screw-lowering Apparatus for Ships. The expected fight about the *Eozoön Canadense* did not come off. The specimen and apparatus room is well filled. Among the more interesting objects we observe Prof. Barrett's apparatus for showing the elongation of iron, cobalt, and nickel by magnetisation, Mr. Braham's heliostat and ruled glass used in experiments on light, and Mr. Roberts' illustrations of columnar structure, artificially produced. The Thursday *soirée*, on the other hand, was singularly devoid of exhibitions of any kind, and the Ulster Hall was extremely crowded, both causes tending to make the evening drag rather heavily. There were several excursions on Saturday, and there are many prepared for Thursday, the principal being to the Giants' Causeway. The Mayor, who has throughout been very active in forwarding the interests of the Association, has issued invitations for a trip round the coast on Thursday, for which purpose he has engaged one of the fine Fleetwood mail steamers.

The Association meets next year at Bristol, Sir John Hawkshaw, C.E., F.R.S., being President-elect; Glasgow is to be the place of meeting in 1876, an influential deputation having attended the Association to urge upon it the claims of that city to the honour of its presence. Plymouth will probably be the rendezvous for 1877.

The following is the financial statement of the Association for the past year:—

RECEIPTS.

	£	s.	d.
To balance brought from last account	£924	15	10
Life Compositions at Bradford Meeting, and since	358	0	0
Annual Subscriptions do. do.	646	0	0
Associates' Tickets do. do. ...	796	0	0
Ladies' Tickets do. do.	601	0	0
Dividends on Stock	237	10	0
Sale of Publications	21	18	1
Balance of Grant made at Brighton to the Sewage Committee	26	8	7
	£3,611	12	6

PAYMENTS.

				£	s.	d.
Expenses of Bradford Meeting, also sundry Printing, Binding, Advertising, and Incidental Expenses ...				£373	8	4
Printing, Engraving, &c., Report of 42nd Meeting (vol. 41), Brighton				696	13	10
Ditto on Account of Report of 43rd Meeting (vol. 42), Bradford				58	13	5
Salaries (one year)				462	6	0
Rent and Office Expenses (Albemarle Street) ...				104	5	0
Grants made at Bradford Meeting, viz. :—						
Zoological Record				100	0	0
Chemistry Record				100	0	0
Printing Mathematical Tables				100	0	0
For Committee on—						
Elliptic Functions				100	0	0
Lightning Conductors				10	0	0
Thermal Conductivity of Rocks				10	0	0
Anthropological Instructions, &c... ...				50	0	0
Kent's Cavern Explorations				150	0	0
Luminous Meteors				30	0	0
Intestinal Secretions				15	0	0
British Rainfall				100	0	0
Essential Oils				10	0	0
Sub-Wealden Exploration				25	0	0
Settle Cave Exploration				50	0	0
Mauritius Meteorological Researches ...				100	0	0
Magnetisation of Iron				20	0	0
Marine Organisms				30	0	0
Fossils, North-west of Scotland				2	10	0
Physiological Action of Light				20	0	0
Trades' Unions				25	0	0
Mountain Limestone Corals				25	0	0
Erratic Blocks				10	0	0
Dredging, Durham and Yorkshire ...				28	5	0
High Temperature of Bodies				30	0	0
Siemens's Pyrometer				3	6	0
Labyrinthodonts of Coal-Measures				7	15	0
Widow of W. J. Askham				50	0	0
Aug. 19, Balance at Bank ...	£698	10	5			
Ditto in hands of General Treasurer	15	19	6			
				714	9	11
				£3,611	12	6

SECTION B

CHEMICAL SCIENCE.

OPENING ADDRESS BY THE PRESIDENT, PROF. A. CRUM BROWN, M.D., F.R.S.E., F.C.S.

ONE hundred years have elapsed since the discovery of oxygen by Priestley. Perhaps we should say rediscovery, for there is no doubt that about one hundred years earlier Mayow prepared from nitre nearly pure oxygen, and observed and recorded some of its most marked properties. Mayow's discovery, however, led to nothing, while Priestley's was the most important step in that reconstruction of speculative chemistry which was commenced by Black and carried on with surprising energy and thoroughness by Lavoisier and his associates. I shall not detain you by enumerating the ways in which this discovery has affected chemistry both practical and speculative. The pre-eminent position to which oxygen was at once elevated, and which it so long retained, makes this altogether unnecessary. I wish, however, to point out one character of the phlogistic controversy which sharply distinguishes it from many others. The truth represented by the theory of Phlogiston was not recognised with sufficient distinctness by the supporters of that theory to give them any chance of success in opposition to a band of devoted adherents of a view which was clearly understood by all. The phlogistists were completed defeated, and the theory ceased to exist. It has been left for chemical antiquaries to pick out, with difficulty and uncertainty, a meaning from the ruins.

I have mentioned this character because I wish to draw your attention to another more recent controversy, the result of which was very different.

The questions as to chemical constitution raised about forty years ago by Dumas and the new French school, in opposition to Berzelius, may now be said to be practically settled. The great majority of chemists are agreed as to what is to be understood by chemical constitution, and also as to the nature and amount of evidence required in order to determine the constitution of a substance. How has this agreement been produced? Some historical writers seem to wish us to believe that it is the result of the triumph of the ideas of Dumas, Gerhardt, and Laurent, and the defeat of the dualistic radical theory of Berzelius; that the arguments of Berzelius and his followers were only useful as giving occasion for a more full and convincing proof of the unitary substitution theory than would otherwise have been called for; that, in fact, the adherents of dualism played the part (not unfrequently supposed to be that of the Conservative party in politics) of checking and criticising the successive developments of truth, and thus allowing them time to ripen.

In opposition to the view thus broadly stated, I would place another, and for the sake of contrast shall state it also in perhaps too broad a form :—That the two theories, the dualistic radical theory and the unitary substitution theory, were both true and both imperfect, that they underwent gradual development, scarcely influenced by each other, until they have come to be almost identical in reference to points where they at one time seemed most opposed.

I have said that the development of the one theory was scarcely influenced by that of the other. Of course the *facts* discovered by both parties were common property, and the development of both theories depended upon the discovery of these facts; but the explanations of facts and the reasoning from them given by each party seemed to the other scarcely worthy of serious consideration, and were treated as matter of ridicule. And the habit of mind created by this mode of viewing the opposed theory rendered it difficult for those who were engaged in the controversy on either side to see how nearly the two theories have now come to coincidence. Their language still remains different; but as the facts are the same for both, it is not difficult for a neutral critic to translate from the one to the other; and if we do so we shall see that there is much real agreement between the two modes of representing chemical ideas, historically derived, the one from Berzelius, the other from Dumas, Laurent, and Gerhardt.

In both, chemical constitution is regarded as *the order in which the constituents are united in the compound;* and the same fundamental notion is indicated in the one by reference to proximate constituents, in the other by the concatenation of atoms. To show that this is so, and that the fundamental notion can be arrived at from the dualistic as well as from the unitary starting point, I shall cite an illustrative case. Every student of chemical history will remember the view of the constitution of trichloracetic acid propounded by Berzelius, and afterwards supplemented by a similar view of the constitution of acetic acid and an explanation of the likeness of some of the properties of these two substances. This has sometimes been spoken of as a subterfuge of a not very creditable kind, by means of which Berzelius apparently saved his consistency while really yielding to the arguments of his opponents. But if, instead of looking at it in the light of the substitution controversy, we consider it in itself as a contribution to speculative chemistry, we at once recognise in it a statement, in Berzelian language, of the views we now hold as to the constitution of these acids. The view was that acetic acid is a compound of oxalic acid and methyl, trichloracetic acid a compound of oxalic acid and the sesquichloride of carbon. They differ considerably from each other, because the "copulæ" (methyl and sesquichloride of carbon respectively) are different; but their resemblance is strongly marked, because they contain the same active constituent, oxalic acid; and most of the prominent characters of the substances depend upon it, and not upon the copulæ. Let us first free this statement from what we may call archaisms of language. It will then assume something like the following form :—The carbon in acetic acid is equally divided between two proximate constituents, one of which is an oxide, the other a hydride of carbon. Trichloracetic acid similarly contains an oxide and a chloride of carbon, between which

the carbon is equally divided. The oxide is the same in both acids, and is that oxide which occurs in oxalic acid. The hydride and the chloride have the composition of the substances, the formulæ of which are C_2H_6 and C_2Cl_6 respectively. Oxalic acid undergoes chemical change much more readily than the corresponding hydride or chloride; and therefore the chemical character of acetic and of trichloracetic acids depends much more on the oxidised than on the other constituent, and they thus have a marked resemblance. The oxidised constituent is united to the other in a manner different from that in which oxalic acid is united to bases in the oxalates, inasmuch as, while the basic water of hydrated oxalic acid is displaced when oxalic acid unites with a base, in hydrated acetic and trichloracetic acids there is the same proportion between the basic water and the oxidised carbon as there is in oxalic acid.

Now, has not this a great resemblance to the view entertained by most modern chemists, that acetic acid is a compound of the radical carboxyl (half a molecule of oxalic acid) and the radical methyl (half a molecule of methyl gas), that trichloracetic acid similarly contains the same radical carboxyl and the radical CCl_3, and that the prominent chemical properties of these bodies depend upon their containing carboxyl, and that they therefore resemble each other?

The modern view contains nothing inconsistent with that of Berzelius; but it no doubt contains something more: it contains an explanation of the difference between the manner in which carboxyl is united to methyl in acetic acid, and the manner in which oxalic acid is united to bases in the oxalates. But it will surely be admitted that Berzelius was here far ahead of his opponents—so far ahead, that they altogether failed to see his meaning, and looked upon his argument as a clumsy device.

The treatment by Berzelius of the constitution of the sulpho-acids, furnishes a precisely similar case. These are now regarded as compounds of the radical SO_2OH (which we may call sulphoxyl). This radical is half a molecule of hyposulphuric acid; and Berzelius considered them coupled compounds of hyposulphuric acid, adopting at once the view first brought forward by Kolbe in his classical memoir on the sulphite of perchloride of carbon and the acids derived from it.

I might pursue the history of the carbon- and sulpho-acids further, and trace the development of the theory of their constitution through the discoveries of Kolbe, and his beautiful application to the cases of carbon and sulphur of Frankland's far-sighted speculation on the constitution of the organo-metallic bodies, pointing out the relation of Kolbe's views of the constitution of acids, alcohols, aldehydes, and ketones, to the Berzelian theory on the one hand, and to the opinions of modern chemists on the other; but the greater part of such an historical sketch has been given very recently by Kolbe himself in the *Journal für praktische Chemie*, and I may therefore omit it.

It would be easy to bring forward cases to show that our present views can be directly derived from the substitution theory and the types of Dumas and Gerhardt, through the complications of multiple and mixed types, and the labyrinthine formulæ to which these gave rise, to the wonderfully simple and comprehensive system of Kekulé; but that is unnecessary, as this development has been fully and ably described by more than one thoroughly competent writer.

We have been discussing a case in which Berzelius was right in considering a compound of carbon, oxygen, and chlorine as composed of two parts—an oxide and a chloride of carbon. It is only just that we should only take some notice of cases, at first sight similar, in which modern chemists would be inclined to think that he was wrong. This is the more necessary, as an examination of these cases will enable us to see what was the really valuable contribution made to speculative chemistry by the substitution theory.

Compounds containing three elements were formulated in two different ways by Berzelius:—

1. One of the elements was represented as combined with a radical composed of the other two, as—hydrocyanic acid, $H_2 \cdot C_2N_2$; ether, $C_4H_{10} \cdot O$.

2. The ternary compound was represented as composed of two binary compounds, having one element common, as—caustic potash, KO, H_2O; chromochloric acid, $2CrO_3, CrCl_6$.

Phosgene gas was at first formulated in the former of these ways as CO, Cl_2; but latterly he was forced, in consistency, to give up all radicals containing oxygen or other strongly electro-negative element,* and to write the formula of phosgene gas CO_2, CCl_4. Similarly, in every case where a positive element or radical is combined with two negative elements or radicals, he represented the compound as composed of two binary compounds, thus—chloride of acetyl, $2C_4H_6O_3, C_4H_6Cl_6$, as a compound of acetic acid and the corresponding terchloride.

This was in perfect consistency with the mode in which ternary compounds containing one negative and two positive elements or radicals were formulated, as caustic potash, KO, H_2O, sulphate of copper, CuO, SO_3, &c.; but it lacks the practical justification which can be given for the formula C_2H_6, C_2O_3 for acetic acid; for phosgene acts readily on water, forming carbonic and hydrochloric acids, an action which does not take place with perchloride of carbon; and it is not easy to see why the latter substance should be more readily attacked by water when combined with carbonic acid than when free. This difference did not escape the attention of Berzelius, and led him to distinguish two modes of chemical union: (1) where the constituents were held together by the electro-chemical force, and wholly or partially neutralised each other, as in the oxygen and sulphur salts; and (2) where a so-called "copula" was attached by an unknown force to a substance without greatly modifying its chemical activity. The distinction seems arbitrary; but it was not, as is usually supposed, a mere artificial bulwark to protect the electro-chemical theory; it has a real and very important meaning, a meaning which the development of the substitution theory enables us to explain.

The phenomena of electrolysis, upon which the Berzelian system is based, bring forward into great prominence *one* of the chemical units, viz. the *equivalent*; and the pre-eminent position of oxygen as the most electro-negative element made it most natural to select the atom of oxygen as the standard of equivalence, so that an equivalent of any element or radical was defined as that quantity of it which is equivalent to one atom of oxygen. Gay-Lussac's law of gaseous volumes, which was adopted by Berzelius, and which, by a curious accident, happens to be true for all elements gaseous at ordinary temperatures, led to the formulæ H_2 and Cl_2 for the *equivalents* of hydrogen and chlorine; but although these formulæ explicitly indicate the divisibility of the equivalents of these elements, this divisibility was not recognised, and integral numbers of equivalents were alone tolerated. Thus hydrochloric acid was written H_2Cl_2, ammonia N_2H_6, &c., and the etymological meaning of the word atom was soon lost. The use of barred letters to indicate two atoms or one equivalent of such elements as hydrogen and chlorine further contributed to hide the important fact of their divisibility.

The first great result of the substitution theory was to change the unit of equivalence, and to take as the standard the atom of hydrogen or of chlorine instead of that of oxygen; and although it would be most unjust to forget the services of Dumas, Gerhardt, Laurent, and Odling in this matter, the credit of removing the bars from H, Cl, and their comrades, and allowing the hitherto chained partners to walk at liberty, undoubtedly belongs mainly to our distinguished colleague and master, Prof. Williamson.

The establishment of the water type, or (to put it in another form) the proof that the atom of oxygen contains two units of oxygen, inseparably united but capable of separate action, led the way to the explanation of all the difficulties which beset the theory of radicals and copulæ. It at once explained how two oxides or two sulphides unite together;* and the idea of "polybasic," or, as we should now say, polyad atoms and radicals, was soon used to explain the existence of polybasic acids, double salts, acichlorides, and many other kinds of ternary compounds.

But a fact does not cease to exist because it is explained. Quicklime and water unite together, although we can now explain how they do so; and a useful purpose may still be served by the enumeration, as in the old dualistic formulæ, of the pairs of united equivalents. Although some of these equivalents belong to the same atoms, it is nevertheless true that they are united in pairs. Caustic potash might thus be formulated, $KO\frac{1}{2}, HO\frac{1}{2}$ or $\frac{1}{2}(K_2O, H_2O)$; phosgene gas, $\frac{1}{2}(CO_2, CCl_4)$; and chlorochromic acid, $\frac{1}{3}(2CrO_3, CrCl_6)$. These formulæ are not so well suited for general use as those now current; but the consideration of them as accurate representations of facts may enable us to see that the copulæ of Berzelius had a real and valuable meaning. Take, for instance, the formula of acetic acid, $H_3C—CO—OH$, or $\frac{3}{4}CH_4, \frac{3}{4}CO_2, \frac{1}{2}H_2O, \frac{1}{4}C_2$; it is this last term which indicates the coupled character of the compound. If we look upon acetic acid as a compound of carbon, it is a coupled compound because

* In 1838 Berzelius was inclined to regard C_2O_3, to which he gave the name "oxatyl," as the radical of oxalic acid and oxamide.

* It does not explain the existence of double chlorides, bromides, &c. These compounds, apparently so similar to the double oxides and sulphides, are still unexplained.

all the equivalents of carbon in it do not belong to the same atom, and the two atoms of carbon are directly united together, and replacement of the equivalents united to one of these atoms does not very greatly affect the function or chemical character of the equivalents united to the other.

I have perhaps spent too much of your time upon these historical questions. Let us now shortly consider what is the present state of our knowledge as to chemical constitution. This I have already defined as the order in which the constituents are united in the compound. We may indeed use metaphorical language, and speak of the relative position of atoms, perhaps deluding ourselves into the notion that such language is more than metaphorical; but the phenomena of combination and decomposition, although we cannot doubt that they depend solely upon the relative position and dynamical relations of the atoms, are not alone sufficient to prove even that atoms exist. Our knowledge of the intimate structure of matter comes from another source—from the study of the properties rather than of the changes of substances, and of the transformations of energy which accompany the transformations of matter.

This is strictly a branch of chemistry: the aim of chemistry is to connect the properties of substances and the changes they undergo with their composition, taking this word in its widest sense; and we must not allow our friends in Section A to cut our science in two and appropriate the half of it. We all frankly admit that chemistry is a branch of physics; but it is so as a whole—no section of it is more purely physical than all the rest. To accept a narrower definition of chemistry is to reduce ourselves to the position which the collector occupies among naturalists; it is to admit that it is our business to provide part of the materials out of which a science in which we have no share may be constructed by others. But we need not fear that this so-called physical side of chemistry will ever be divorced from the study of chemical change. The names of Faraday and Graham among those who have left us, of Andrews among those who are still at work, are sufficient proof of this; and a study of their researches will conclusively show that great results can be looked for in this direction only from a physicist who is also a chemist.

There are three special directions in which such investigations have already influenced chemical theory:—1. *Electrolysis*, which has confirmed the equivalent as a chemical unit, has proved that equivalents unite in pairs, thus forming the basis of electro-chemical theory, and has shown us how to estimate the amount of energy involved in the union of a given pair of equivalents. 2. *Vapour-density*, from which Avogadro inferred the law of molecular volumes (since proved by Clerk-Maxwell), which has given us the molecule as a chemical unit, and formed the basis of the unitary theory. 3. *Specific heat*, from which Dulong and Petit inferred their empirical law, which gives us the most satisfactory physical definition of the atom as a chemical unit.

We naturally turn to the future, and try to guess whence the next great revolution will come. For although periods of quiet have their use, as affording time for filling up the blank schedules furnished by the last speculative change, such periods have seldom been long, and each has been shorter than its predecessor.

But it is impossible to make a certain forecast: looking back, we see a logical sequence in the history of chemical speculation; and no doubt the next step will appear, after it has been taken, to follow as naturally from the present position. One thing we can distinctly see—we are struggling towards a theory of chemistry. Such a theory we do not possess. What we are sometimes pleased to dignify with that name is a collection of generalisations of various degrees of imperfection. We cannot attain to a real theory of chemistry until we are able to connect the science by some hypothesis with the general theory of dynamics. No attempt of this kind has hitherto been made; and it is difficult to see how any such attempt can be made until we know something in reference to the absolute size, mass, and shape of molecules and atoms, the position of the atoms in the molecule, and the nature of the forces acting upon them. Whence can we look for such knowledge?

The phenomena of gaseous diffusion, of gaseous friction, and of the propagation of heat through gases, have already given us an approximation to the size and mass of the molecules of gases. It is not unreasonable to suppose that a comparative study of the specific heat of gases and vapours may lead to some approximate knowledge as to the shape of their molecules; and a comparison of such approximate results with the chemical constitution of the substances may lead to an hypothesis which will lay the foundation of a real theory of chemistry.

Chemistry will then become a branch of applied mathematics; but it will not cease to be an experimental science. Mathematics may enable us retrospectively to justify results obtained by experiment, may point out useful lines of research, and even sometimes predict entirely novel discoveries, but will not revolutionise our laboratories. Mathematical will not replace Chemical analysis.

We do not know when the change will take place, or whether it will be gradual or sudden; but no one who believes in the progress of human knowledge and in the consistency of Nature can doubt that ultimately the theory of Chemistry and of all other physical sciences will be absorbed into the one theory of Dynamics.

SECTION E

Geography

Opening Address by the President, Major Wilson, R.E.

The President of the Royal Geographical Society has so recently delivered his anniversary address, that if I were to attempt to trace the progress of geographical discovery during the period that has elapsed since the meeting of the British Association at Bradford in September last, I could scarcely avoid repeating much that has already been said in far abler terms than I have it within my power to command. Still there are, at the present moment, certain subjects of such very general interest and of so much importance that they cannot well be passed over in any address to the Geographical Section of the British Association.

It has, I believe, been usual in the addresses to this Section to select some special subject for remark, and I will therefore, if you will allow me, before alluding to the geographical achievements of the year, draw your attention to the influence which the physical features of the earth's crust have on the course of military operations; to the consequent importance of the study of physical geography to all those who have to plan or take part in a campaign; and to the contributions to geographical science that are due, directly or indirectly, to war, and the necessity of preparing for war. To show how varied are the conditions under which war has to be carried on, and how much its successful issue may depend on a previous careful study of the physical character of the country in which it is waged, it is only necessary to remind you of the recent operations on the Gold Coast, brought to a successful issue in an unhealthy climate, and in the heart of a dense tropical forest, where an impenetrable undergrowth, pestilential swamps, and deep rivers obstructed the march of the troops; of the Abyssinian expedition, landing on the heated shores of the Red Sea, and thence, after climbing to the lofty frozen highlands of Abyssinia, working its way over stupendous ravines to the all but inaccessible rock, crowned by the fortress of Magdala; of the march of the Russian columns across the steppes and deserts of Central Asia to the Khivan oasis, one month wearily plodding through deep snow, the next sinking down in the burning sand, and saved from the most terrible of disasters by the timely discovery of a well; and, lastly, of the great struggle nearer home, the last echoes of which have hardly yet passed away, when the wave of German conquest, rolling over the Vosges and the Moselle, swept over the various provinces of France. The influence of the earth's crust on war may be regarded as twofold: first, that which it exerts on the general conduct of a campaign; and, second, that which it exerts on the disposition and movement of troops on the field of battle. Military geography treats of the one, military topography of the other; and it is well to keep this broad distinction in view, for, as with strategy and tactics, they stand in such close relation to each other that it is not always easy to say where geography ends and topography begins. Of special importance in the first case are great inequalities or obstacles that confine or obstruct the movement of large bodies of troops, and those features that retard or accelerate their march. The climate of the theatre of war must always have an important influence on military operations, and should be the subject of careful study. Our own experience in the Crimea shows how much suffering may be caused by want of forethought in this respect. General Verevkin's remarkable march of more than a thousand miles, from Orenburg to Khiva, with the thermometer ranging from 24° below zero to 100°, without the loss of a man, shows what may be accomplished with due preparation. Nor should the geological structure of a country be over-

looked in its influence on the varied forms which the earth's crust assumes, on the presence or otherwise of water, on the supply of metal for repairing roads, and, if we may trust somewhat similar appearances on the Gold Coast, at Hong Kong, and in the Seychelles, on the healthiness or unhealthiness of the climate. It is scarcely necessary to remind you that though mountain ranges and rivers materially affect the operations of war, they are by no means insurmountable obstacles. The Alps have been repeatedly crossed since the days of Hannibal; Wellington crossed the Pyrenees in spite of the opposition of Soult; Diebitsch the Balkan, though defended by the Turks; and Pollock forced his way through the dreaded Khyber; whilst there is hardly a river in the length and breadth of Europe that has not been crossed, even when the passage has been ably disputed. This is hardly the place to discuss the minuter details of military geography and topography: they will be found in the works specially devoted to the subject.

Queen Elizabeth's Minister was right when he said that "Knowledge is power;" and a knowledge of the physical features of a country, combined with a just appreciation of their influence on military operations, is a very great power in war. A commander entering upon a campaign without such knowledge may be likened to a man groping in darkness; with it he may act with a boldness and decision that will often ensure success. It was this class of knowledge, possessed in the highest degree by all great commanders, that enabled Jomini to foretell the collision of the French and Prussian armies at Jena in 1807, and in later years enabled a Prussian officer, when told that MacMahon had marched northwards from Chalons, to point unerringly to Sedan as the place where the decisive battle would be fought. As, then, all military operations must be based on a knowledge of the country in which they are to be carried on, it should never be forgotten that every country contiguous to our own—and the ocean brings us into contact with almost every country in the world—may be a possible theatre of war, and that it is equally the duty and policy of a good Government to obtain all possible information respecting it. Is it with much satisfaction that we can turn to the efforts made by this country to acquire that geographical knowledge which may be of so much importance in time of need? Though we had for years military establishments on the Gold Coast, and though we had more than once been engaged in hostilities with the Ashantees, and might reasonably have expected to be so again, no attempt appears to have been made to obtain information about the country north of the Prah, or even of the so-called protected territories. The result was that when the recent expedition was organised, the Government had to depend chiefly on the works of Bowdich, Dupuis, and Hutton, written some fifty years ago, and on a rough itinerary of the route afterwards followed by the troops, for their information relating to the country and its inhabitants. What advantage has been taken of the presence of the officers who have been in Persia during the last ten years to increase our knowledge of that country—knowledge which would be very useful at present in the unsettled state of the boundary questions on the northern and north-eastern frontiers? How little has been added to our knowledge of Afghanistan since the war in 1842? and what part did India take in Trans-Himalayan exploration before Messrs. Shaw and Hayward led the way to Yarkand and Kashgar? It was with feelings of no slight satisfaction that many of us heard last year that the policy of isolation and seclusion which India appears to have adopted as the last soldier of Pollock's relieving force recrossed the Indus was at last to be broken, and that an expedition well found in every respect was to be sent to Kashgar. It seemed an awakening from the long slumber of the last thirty years, during which we were content to stay at home in inglorious ease, resting under the shadow of the great mountain ranges of Northern India, whilst we sent out mirzas and pundits to gather the rich store of laurels that hung almost within our grasp. Far be it from me to depreciate the valuable services of those gentlemen—services frequently performed at great personal risk and discomfort; but who can compare the results they obtained with those that would have been brought back by English officers, or by travellers, such as Mr. Shaw, Mr. Ney Elias, and others? It has been said that if officers travelled in countries where Government could no longer protect them, they might be killed by the natives, and that then, if the murders were not punished, England would suffer loss of prestige. But is this the case? As a matter of fact, the number of travellers who lose their lives at the hands of the natives of the countries in which they are travelling is quite insignificant when compared with the number of those who return in safety. Let us, then, hope that the Kashgar mission may date the commencement of a new era, during which geographical enterprise may be encouraged, or at any rate not discouraged, amongst the officers of the army, and if few will now deny that a knowledge of Ashantee, of Yemen, of the northern and north-eastern frontiers of Persia, of Merv, Andkin, Maimana, Badakshan, and Wakhan, would have been of importance in the years just passed, it may not be forgotten that a knowledge of these countries may be of still more importance in a not far distant future. May we not take a hint in this respect from our now near neighbours in Central Asia, the Russians? No one who has followed their movements can fail to have been struck by the intense activity of their topographical staff—an activity that can only be compared to that of England at the period when Burnes, Eldred Pottinger, Wood, Abbott, Connolly, and others whose names are ever fresh in our memories, were penetrating into the wildest recesses of Central Asia. In alluding to the contributions of war to geographical science, it is perhaps hardly necessary to mention the very obvious manner in which military operations teach us geography by directing our attention for the time being to the country in which they are being carried on, or to the direct results that have followed many campaigns from the days of Alexander to our own. The Russians are indeed far in advance of us in all that relates to those survey operations and that geographical exploration which should always be carried on simultaneously with the advance of an expeditionary force into an unknown or but partially known country; they have long since realised the importance, almost necessity, of accurate geographical knowledge, based on sound systematic survey, and, having learned in time the lesson that opportunities once lost may never be recovered, make every effort to take advantage of those that are offered to them. In the expedition against Khiva each column had attached to it an astronomer and small topographical staff, whose duty it was to fix the geographical positions of all camps and map the route and adjacent country, whilst officers on detached duty were instructed to keep itineraries of their routes which might be fitted in to the more accurate survey. On the fall of Khiva an examination of the Khanate was at once commenced, and it was even thought necessary to send Col. Skobelof, disguised as a Turkoman, to survey the route by which Col. Markosof should have reached the oasis. It is much to be regretted in the interests of geography that some such system was not adopted during the recent operations on the Gold Coast, and that so little, comparatively speaking, has been added to our knowledge of Ashantee and the protectorate. The conclusion of peace with King Coffee, and the effect that must have been produced on the inland tribes by the destruction of Coomassie, appear to offer facilities for the examination of a new and interesting region which it is to be hoped will not be neglected by those who are able and willing to take part in the arduous task of African exploration.

The most important military contributions to geography have undoubtedly been those great topographical surveys which are either completed or in progress in every country in Europe except Spain, Turkey, and Greece. Frederick the Great was, I believe, the first to recognise that in planning or conducting operations on a large scale, as well as directing many movements on the field of battle, a commander should have before him a detailed delineation of the ground of a whole or part of the theatre of war. To supply this want, Frederick originated military topography, which, in its narrower sense, may be defined as the art of representing ground on a large scale in aid of military operations. It was found, however, that during war there was rarely sufficient time to construct maps giving the requisite information, and thus the necessity arose of collecting in peace such data as would enable maps to be prepared. In this necessity may be seen the origin of all national topographical surveys, including our own, which was commenced as a purely military survey in 1784 by General Roy, and transferred in 1791 to the old Board of Ordnance. The gradual development of these surveys, and the various stages through which they have passed before reaching their present state of excellence, need not be noticed here. Side by side with the large establishments engaged in the production of the topographical maps, there have grown up in most countries extensive departments, sometimes employing from fifty to sixty officers, whose duty it is to supplement the maps of their own and foreign countries by the collection of all information of whatever nature that may be useful in time of war. The brief interval that elapses between the declaration of war and the commencement of hostilities, the rapid movements of armies, and the short duration of campaigns at the present, have shown more clearly than ever the imperative necessity of previous preparation

for war; and the publication of the great surveys of most European countries has given an impetus heretofore unknown to the studies I have alluded to.

The progress of the European surveys, and especially of our own, has been marked by many results which have indirectly influenced the advancement of geographical science. Such are the improvements in instruments made during the progress of the triangulation; the introduction of the Drummond light, Colby's compensating bars, &c.; the connection of the English and Continental systems of triangulation; the pendulum observations at various places; the measurement of arcs of the meridian; the comparison of the standards of length of foreign countries, of India, Australia, and the Cape of Good Hope, with our standard yard, which has recently been completed at the Ordnance Survey Office, Southampton. In the same category may be placed the improvements in the art of map engraving, in the application of chromo-lithography to the production of maps as exemplified in the Dutch process of Col. Bessier and the Belgian maps; and the employment of electrotyping to obtain duplicates of the original plates. The method of copying maps by photography without any error in scale, or any distortion that can be detected by the most rigid examination, was first proved to be practicable and was adopted in the Ordnance Survey Department in 1854, by Major-General Sir Henry James, for the purpose of facilitating the publication of the Government maps of the United Kingdom on the various scales. Since that date the necessity of rapidly producing, multiplying, enlarging, and reducing maps has tended towards the development of the various photographic processes which have been brought to such a high state of perfection. During the last five years photographic negatives on glass covering an area of 10,071 square feet were produced at the Ordnance Survey Office for map-making purposes alone, and from these negatives 21,760 square feet of silver prints were prepared and used in the various stages of the Survey. An area of 959 square feet of the negatives was also used in producing 13,595 maps on various scales by the photosincographic process, which was also introduced by Major-General Sir Henry James. It was by similar processes that the Germans were enabled to provide the enormous number of copies of the various sheets of the map of France required during the war of 1870-1. Any comparison of the maps of various countries would necessarily occupy much time, so I will only add that as specimens of engraving the sheets of our one-inch map are unrivalled, and that no foreign maps can compare for accuracy of detail and beauty of execution with the sheets of our six-inch survey. Our great national Survey is the most mathematically accurate in Europe, and it speaks much for the ability of the officers who have brought it to its present state of perfection, that from the very first they recognised the necessity of extreme scientific accuracy in their work, and that they have never had to withdraw from the position they have taken up with regard to the many questions of detail that have arisen from time to time.

Before concluding this portion of my address I would draw your attention to the appliances used in the minor schools of this country for teaching geography, as they would seem to need some improvement. The appliances to which I allude are models or relief maps, wall maps, atlases, and globes. The use of models as a means of conveying geographical instruction has been too much neglected in our schools. If anyone considers the difficulty a pupil has in understanding the drawing of a steam-engine, and the ease with which he grasps the meaning of the working model, and how from studying the model and comparing it with the drawing he gradually learns to comprehend the latter, he will see that a model of ground may be used in a similar manner to teach the reading of a map of the same area. Relief maps of large areas on a small scale have their uses, but they are unsuitable for educational purposes on account of the manner in which heights must be exaggerated to make them appear at all; this objection, however, does not apply to models of limited areas on a sufficient scale, which always give a truthful and effective representation of the ground. One reason why models have not been more used has been their cost, but the means of constructing them with ease, rapidity, and at slight expense, are quickly accumulating as the six-inch contoured sheets of the Ordnance Survey are published. Instruction in geography should begin at home, and I would suggest that as the six-inch survey progresses each decent school throughout the country should be provided with a model and a map of the district in which it is situated. If this were done, the pupils would soon learn to read the model, and having once succeeded in doing this, it would not be long before they were able to understand the conventional manner in which topographical features are represented on a plane surface, and acquire the power of reading not only the map of their own neighbourhood, but any map which was placed before them. In our wall maps I think we have been too much inclined to pay attention to the boundaries of countries, and to neglect the general features of the ground. It is difficult to say whether the maps have followed the teachers or the teachers the maps, but I fear instruction in physical geography too often comes after that in political geography, instead of a knowledge of the latter being based on a knowledge of the physical features of the earth. My meaning may perhaps be explained by reference to a wall map probably well known to everyone, that of Palestine, which frequently disfigures rather than ornaments the walls of our schoolrooms. In this map there are usually deep shades of red, yellow, and green to distinguish the districts of Judea, Samaria, and Galilee, and perhaps another colour for the Trans-Jordanic region, with a number of Bible names inserted on the surface, whilst the natural features are quite subordinate, and sometimes not even indicated. There is perhaps no book that bears the impress of the country in which it was written so strongly as the Bible; but it is quite impossible for a teacher to enable his pupils to realise what that country is with the maps at present at his disposal. The first object of a wall map should be to show the geographical features of countries, not their boundaries, and for this purpose details should be omitted, and the grander features have special attention paid to them. In school atlases the same fault may be traced, physical features being too often made subordinate to political divisions; and there is also in many cases a tendency to overcrowd the maps with a multitude of names which only serve to confuse the pupil and divert his attention from the main points. The use of globes in our schools should be encouraged as much as possible, as there are many physical phenomena which cannot well be explained without them, and they offer far better means of conveying a knowledge of the relative positions of the various countries, seas, &c., than any maps. The great expense of globes has hitherto prevented their very general use, but some experiments are at present being made with a view to lessening the cost of the construction, which it is hoped may be successful. I cannot pass from this subject without alluding to that class of maps which gives life to the large volumes of statistics which are accumulating with such rapidity. On the Continent these maps are employed to an extent unknown in this country, both for purposes of reference and education, and they convey their information in a simple and effective manner.

I will only detain you to notice briefly a few of the most important geographical events of the year, and foremost amongst these ranks the publication of Dr. Schweinfurth's work which every one has recently been reading with so much interest and pleasure. Dr. Schweinfurth, who received the Founder's medal of the Royal Geographical Society this year, is, I am happy to say, amongst us at present, and has contributed a valuable paper on the oases of the Libyan Desert.

Lieut. Cameron, R.N., has reached Ujiji, and extracts from a journal which he has sent home will be read to you. The observations which he has made are of high value, and the presence of a trained surveyor on the shores of Lake Tanganyika cannot fail to be followed by great results. A short report of Dr. Nachtigall's travels has been prepared for this Section; and Dr. Rowe, who acted as Chief of the Staff to Sir John Glover during his recent operations on the Gold Coast, will read an interesting paper on the country passed through on the march to Coomassie and thence to the coast. Two Engineer officers, Lieuts. Watson and Chippendale, have recently left England to join Col. Gordon at Gondokoro, with the special object of surveying the territory over which Col. Gordon has been appointed Governor by the Khedive. In Algeria the French have been actively engaged on the survey of the country, and the exact level of the Choltmil-Rhir has been determined. Mr. Stanley's second expedition to the east coast of Africa, under the auspices of an English and American newspaper, should not remain unnoticed, and I cannot pass from Africa without expressing my deep regret at the death of Dr. Beke, whose travels in Abyssinia were rewarded by the gold medal of the society, and whose observations in that country were, for their great accuracy, of so much service during the Abyssinian war.

The survey of Palestine, a work which has been said by a distinguished German geographer to mark the commencement of a new era in geographical research, is progressing favourably, and has led to the formation of an American society for the exploration of the country east of Jordan, and of a German society for

the exploration of Phœnicia. The Rev. Dr. Porter, from whose labours in Palestine everyone who has visited or takes an interest in the country has derived so much profit and pleasure, will read a paper on the lesser known parts of Eastern Palestine, which he has recently visited; and a paper on the progress of the survey has been prepared by Lieut. Conder, R.E., the officer in charge. Our own survey is, I regret to say, languishing for want of funds, whilst that of the Americans is receiving that support from the people which it deserves; the serious loss which the fund has experienced in the death of Mr. Drake, who recently succumbed to an attack of fever at Jerusalem, and who had previously devoted his best energies to the work, must be still fresh in your memories. Lieut. Gill, R.E., who accompanied Col. V. Baker last year on a tour to Meshed, and the head waters of the Atrek, has prepared an account of their journey. Some most interesting particulars of the visit of a portion of Mr. Forsyth's mission to the Great Pamir and Wakham have been kindly supplied by Col. Biddulph, R.A., from letters received from his brother, Capt. Biddulph. The success of the party has, however, been purchased by the loss of Dr. Stoliczka, who died from the effects of fatigue and exposure within a few marches of Leh. Mr. Delmar Morgan has prepared a very valuable paper on Russian travels in Central Asia in the 15th century. Mr. MacGahan, the correspondent of the *New York Herald*, whose remarkable journey across the Desert to join General Kaufmann's column when marching on Khiva astonished the Russians, has forwarded some interesting notes on the Russian expedition against Khiva.

In Australia the great geographical event of the year has been Col. Warburton's journey from Alice Springs, near Mount Stuart, on the line of overland telegraph, to Roebourne, in Nichol Bay, for which he was awarded the Patron's gold medal of the Royal Geographical Society. Such particulars of the journey as have been forwarded to me through the courtesy of the Colonial Office and of Mr. Dutton, the Agent-General for South Australia, will be communicated to you.

In America, whilst the coast and inland surveys have been progressing, Dr. Haydon, who was the first to disclose to us the strange beauties of the Yellowstone region, has been engaged in exploring a country equally wild and picturesque, the eastern half of Colorado. Other exhibitions have been doing good service in the Yellowstone country, Arizona, Oregon, and the Aleutian Islands, amongst them one sent out by Yale College, which, besides exploring new country, brought back five tons of specimens from the great fossil beds of Oregon and other places for the college museum. I cannot help thinking that in sending out these expeditions—for this is only one of a series—for the examination of the geography, geology, botany, zoology, &c., of some special district, Yale College has set an example which might well be followed by our own universities, and that Dublin, Oxford, and Cambridge might take more part than they have hitherto done in what may be called scientific exploration in the field. My old friend and fellow-traveller, Capt. Anderson, R.E., has been engaged as chief astronomer of the International Boundary Commission in running the 49th parallel through the unknown country between the Missouri and Saskatchewan, and a short account of the demarcation of the parallel and the country it passes through will be read to you. In the south, Commanders Lull and Selfridge have found practicable routes for ship canals from Greytown, by Lake Nicaragua, to Brito, on the Pacific, and by way of the Atrato, from the Gulf of Darien, to a point near Cupica, on the Pacific; the cost of the latter is estimated at twelve million pounds. In South America Prof. Orton has been extending our knowledge of the Amazon country; and I may mention the activity which the Peruvian Government is showing in promoting the exploration of the little-known districts of Peru. Mr. Hutchinson, late her Majesty's Consul at Callao, has forwarded a paper on the commercial, industrial, and natural resources of Peru, which will be found to give much interesting information on that country.

Dr. Carpenter will, I hope, give us some account of the cruise of her Majesty's ship *Challenger*, which cannot fail to interest the people of this town, from Prof. Wyville Thomson's former connection with it. Capt. Warren, R.E., whose name is so well known from his work at Jerusalem, has forwarded a valuable paper on reconnaissance in unknown countries; and Capt. Abney, R.E., will read one on a subject which he has made peculiarly his own—the application of photography to military purposes. M. Mazznoir, the secretary of the French Geographical Society, has forwarded a paper on the objects sought to be obtained by the International Congress to be held at Paris in the spring of next year.

I regret that I am not able to give any definite information on the probability of Government assistance to Arctic exploration, but I understand that the impression produced on the members of the deputation which recently had an interview with the Prime Minister on the subject was that he was not unfavourable to such assistance. Admiral Sherard Osborn has kindly forwarded a paper on routes to the north pole, and Lieut. Chermside, R.E., who accompanied Mr. Leigh Smith on a very remarkable voyage last year to Spitzbergen, will read an account of the discoveries they were enabled to make. The reports of the officers of the *Polaris* have been published, expressing contradictory opinions as to the possibility of their having been able to reach a higher latitude. As regards the general subject of Arctic exploration, there can, I think, be no doubt that that by Smith's Sound would yield the most important scientific results, and would offer great facilities for reaching the Pole itself. It should not be forgotten that all recent Polar expeditions sent out from this country have been despatched with the special object of ascertaining the fate of Sir John Franklin, and that discovery was not a principal object. When, too, we consider that in these expeditions Arctic travel was reduced to a very perfect system, that the distance from the point reached by the *Polaris* to the Pole is less than has already been performed in some of the sledge journeys, and that no life has ever been lost on a sledge journey, it is impossible to doubt that a well-organised expedition would be able to reach the Polar area. In the words of a well-known Arctic explorer, "What remains to be done is a mere fleabite to what has already been accomplished." Morton, the second mate of the *Polaris*, says, as the result of his third voyage, that he is more than ever convinced of the practicability and possibility of reaching the Pole; and if I may express my own opinion, it would be in the words attached to a picture at the last exhibition of the Academy in London, "It is to be done, and England ought to do it."

Reports.

Report on the Rainfall of the British Isles for the years 1873–74.

We extract from the report the part relating to the rainfall of the British Isles during the years 1872–73. The very exceptional character of the rainfall of 1872 was mentioned in our last report, but in accordance with a custom which has now prevailed for twelve years, it was only incidentally referred to, the details being deferred until the two years 1872 and 1873 could be published together. This course, which was originally adopted with a view to economy in printing, has in the present instance had the fortunate result of bringing together two very remarkable features of each, of which we must speak separately.

Rainfall of 1872.—Records of rainfall have been collected and discussed in our previous reports, which enable us to compare the total fall in any year from 1726 to the present time with the mean fall. One of these tables (that facing p. 286 Brit. Ass. Report 1866) contains nine long registers, extending over 140 consecutive years, but the greatest excess even at a single station was only 58 per cent. (at Oxford in 1852). In 1872 this value was largely exceeded at a number of stations, as is shown by Tables I. and II., whence it appears that at fourteen stations out of 115, or 12 per cent., it exceeded this previously unparalleled value. At thirteen the excess was greater than 60 per cent., and it reached or exceeded 70 per cent. at the following stations:—

Shropshire, Shiffnall .	Rainfall	77	per cent. above average	1860–69.
,, Shrewsbury .	,,	75	,,	,,
,, Hengoed, Oswestry	,,	70	,,	,,
Northumberland, Bywell .	,,	77	,,	,,
Haddingtonshire, East Linton	,,	70	,,	,,
Aberdeenshire, Braemar .	,,	78	,,	,,

No similar falls have occurred since 1726, and there is no evidence of such a fall since rainfall observations were commenced, nearly two centuries ago. Full details respecting the monthly fall of rain in this very remarkable year are given in the appendix to this report, and we think it may be regarded as fortunate that so remarkable a fall has occurred at a period when, owing largely to the operation of this committee, the system of observation is in a state unprecedentedly near perfection.

The Rainfall of 1873.—If this year had stood by itself it would merely have been classed as a rather dry year, and would have soon passed into oblivion. Coming, however, immediately after such an exceptionally wet year, it has produced the unusual result of giving two consecutive years, one with twice the rainfall

of the other, and in many instances with much more than twice. How rare is this occurrence may be judged from the fact that there is no case in the 140 years' table just referred to. The nearest approaches are—Chatsworth, in 1788, 19·86 inches, in 1789, 36·31, the former being 55 per cent. of the latter. A still nearer approach occurred at Cobham, in Surrey, in 1851 and 1852, when the totals were 17·38 and 34·19 inches respectively, the former being 51 per cent. of the latter. In Table II. no cases are admitted unless much more striking than the above. The districts in which these exceptional ratios occur are (as might be expected) principally those in which the excess in 1872 was greatest, but there are also a few of which the explanation is not so obvious. It is very satisfactory to feel that these two exceptional years have found in the British Isles the most nearly perfect system of observation in the world.

Your committee cannot close their report without expressing as far as words can do so the loss which they have sustained in the death of Prof. Phillips, one of the original members appointed in 1865, who, notwithstanding the numerous other demands upon his time, was always as willing as he was able to assist the committee in any of the various difficulties which the extent of their operations inevitably involve.

Preliminary Report on Dredging on the Coast of Durham and North Yorkshire.

The dredging off the coasts of Durham and North Yorkshire, provided for by a grant from the British Association last year, was carried out during the week beginning on the 13th July. A suitable vessel was engaged, and being on the whole favoured by the weather, we dredged every day until the 18th inclusive. During two days the R.A. M. Marman accompanied us. We were indebted to him for valuable assistance in naming some of our specimens, as well as for kindly undertaking to report on some sections of the work.

On two days out of the six the sea was too rough to allow of the dredges being worked very successfully, and one dredge was unfortunately lost by getting fast on hard ground while a very strong tide was running, but with these exceptions the work was carried out satisfactorily. The dredging ranged from near Tynemouth, on the north, to Scarborough, on the south, the water varying in depth from 20 to 45 fathoms, the greater portion of the time being devoted to a belt known to fishermen as the "inner fishing bank," lying from four to eight miles from the shore. One day, however, was spent at the greater distance of thirty to forty miles from shore, and another day at a distance of about seventeen miles.

Time has not allowed of anything more than safely to preserve and arrange our captures. On a future occasion we hope to give a full account of the results obtained.

NOTES

The final programme of the Oriental Congress, to be held in London next month, was settled on Tuesday; we hope to be able to say something about it next week.

M. Alluard, director of the Meteorological Observatory which is being erected on the Puy-de-Dôme, regrets that, owing to the backward state of the works, the building cannot be opened in the end of September, as was expected. It is hoped, however, that the work of the Observatory will be commenced before winter. The construction of the telegraphic line which will connect the station on the plain at Clermont with the station on the summit of the Puy-de-Dôme has been completed. The formal inauguration will take place next summer. One main cause of the delay is owing to the fabulous prices demanded by the small proprietors through whose lands the approaches to the Observatory must be made; no blame whatever for the delay can be attached to the staff of the Observatory. The Government authorities, central and local, have shown the greatest zeal in forwarding the construction of the works.

The Emperor of Austria has conferred the decoration of Knight of the Order of the Iron Crown, with a patent of hereditary nobility, on Dr. Julius von Haast, director of the Museum of Canterbury, New Zealand, in recognition of his eminent scientific merits and attainments.

Sir William Fairbairn, Bart., F.R.S., died on the 18th inst., in his eighty-fifth year, having been born at Kelso, in Scotland, in 1789. What Sir William has done to improve the manufacture of iron is well known. He was one of the founders of the British Association, and was its president in 1861. Many papers by Sir William appeared in the Philosophical Transactions, in the Reports of the British Association, and in the Transactions of the Philosophical Society of Manchester. Some of his works, however, were also published separately. Among his chief productions may be specified treatises on "Canal Navigation," on "The Strength and other Properties of Hot and Cold Blast Iron," on "The Strength of Locomotive Boilers," on "The Strength of Iron at Different Temperatures," on "The Effect of Repeated Melting upon the Strength of Cast Iron," on "The Irons of Great Britain," on "The Strength of Iron Plates and Riveted Joints," on "The Application of Iron to Building Purposes in General," on "Useful Information for Engineers," &c.

It is stated that the Crown has appointed Mr. John Ferguson, M.A., to the chair of Chemistry in Glasgow University, vacant by the retirement of Dr. Thomas Anderson.

The subscriptions announced up to Saturday last on behalf of the University of Edinburgh Buildings Extension Scheme amount to 69,017*l*. The total sum required from the public is 100,000*l*.

The Council of the Ray Society, in presenting their Thirty-first Annual Report, congratulate the members on the continued prosperity of the Society. The arrears in the issue of the annual volumes, long a cause of much inconvenience, have been at length overcome. Since the last meeting, at Bradford, two volumes, those for the years 1872 and 1873, have been distributed; a third volume, that for the year 1874, is finished, and will be issued in October. The volumes for the years 1872 and 1873, consisting of the first part of the British Annelids, by Dr. McIntosh, although containing less text and fewer illustrations than in some of the previous memoirs, have been in the matter of production equally costly. The very beautiful plates, printed in colours by lithography, required many stones for their proper development, and necessitated a corresponding outlay. The volume for the present year, on the Spongiadæ, by Dr. Bowerbank, completing the series on that subject, and, illustrated by ninety-two plates, is also a most excellent example of work both on the part of the artist and the lithographer. As the cost of this volume has been in excess of the yearly income, it is hoped that a considerable addition of subscribers will justify the money expended. The proposition alluded to in the last Report, viz., that of reducing the price of certain of the earlier works of the Society, has been much appreciated by the members, and has proved a financial success. It has been suggested that the machinery of the Society might be more largely employed in the production of Monographs on the Fauna and Flora of Great Britain; the Council therefore solicit assistance from authors who possess the requisite knowledge and who may be willing to assist in the undertaking. In conclusion, the Council, in order to obtain funds sufficient to carry out the objects of the Society, urge upon members the necessity of gaining new subscribers.

In an address recently delivered before the Dublin Obstetrical Society, Dr. Evory Kennedy discussed the development and spread of scrofula from an evolutionary point of view. This is an aspect of hereditary disease which admits of much extension; one which requires a much larger accumulation of statistics than we yet possess, and a far deeper insight into the physiological basis of pathology than we can expect for some time to come. There is one argument brought forward by Dr. Kennedy that deserves especial attention, which is, that as scrofula tends to early death, or the production of a few early dying offspring, the fact that it is not diminishing in its ravages proves

that it is being continually developed *de novo* by surrounding circumstances. Is this not a sufficient stimulus for increased sanitary legislation?

THE Governor of Minnesota has called on the general Government for aid, as, owing to the ravages of grasshoppers for two years past, many thousands are suffering for want of food. The American naturalists suggest that the grasshopper should be eaten, just as it is in portions of Africa and Western Asia.

The new Minister of Public Instruction visited the Observatory of Paris last week, and expressed his satisfaction to M. Leverrier with what he had seen and with the explanations which had been given to him.

THE ownership of the grounds between the old Paris Observatory Gardens and the Boulevard Arago, more than two acres has been disputed between the Government and the city of Paris. The right of the city was acknowledged, but the Municipal Council have let it to the Observatory for the nominal rent of 20 francs a year. On these grounds a magnetic service is to be established.

TWO interesting balloon ascents have taken place in America lately, one at New York by Prof. Donaldson, with his large Transatlantic balloon, and a batch of reporters from several influential papers at New York. The trip, including four landings, lasted more than twenty-four hours, and ended in the vicinity of Saratoga, the balloon having run a distance of about eighty miles. A few days afterwards Prof. Wyse executed an ascent in Canada, in order to ascertain if a western current blows in the upper parts of the atmosphere when the lower stream of air is running in another direction. At a moderate height the western current was met with. Prof. Donaldson contends that it is a consequence of the revolution of the earth, and can be trusted to for crossing the Atlantic from America to Europe. But can these partial experiments be really relied upon? That remains to be demonstrated.

ONE of the very few scientific members of the Versailles Assembly has departed. M. Fland, an engineer, died at Dinan, where he was appointed Mayor seventeen years ago. He had an engine manufactory at Brest, and was appointed by contract the constructor of the celebrated Giffard injector. M. Fland was originally a pupil of the Ecole des Arts et Métiers d'Angers.

MR. THOMAS MUIR, M.A., F.R.S.E., Assistant Professor of Mathematics in the University of Glasgow, and author of some original investigations in Mathematics, has been appointed successor to Dr. Bryce in the Mathematical Mastership of the High School of Glasgow.

MR. CHARLES MOORE, the *Garden* states, who recently brought a good many valuable and very novel plants to this country from the South Sea Islands and Australia, returns to Sydney by the next mail, having visited many of the best botanic gardens and nurseries in Europe, and selected an immense collection of valuable and rare plants for the Sydney Botanic Garden, which is said to be one of the most beautiful in the world.

WE learn from *Iron* that the Academy of Sciences of Berlin offers a prize of 200 dols., payable in July 1876, for the best essay recording experiments as to whether changes in the hardness and friability of steel are due to chemical or physical causes, or to both. Papers in German, Latin, English, or French, are to be sent in before March 1876.

THE Report of the Council of the Leicester Literary and Philosophical Society, presented at the annual meeting of June 15 last, is on the whole very gratifying. The Society contains a large number of members, and is working in the right direction in trying to interest not only the members, but the inhabitants of Leicester generally, in science as well as literature. During last winter a very judiciously planned course of lectures was delivered in connection with the Society, which was fairly attended, and would, we believe, have been still better attended, had there been no free seats. The Society is divided into sections, three of which are scientific—(1) Meteorology and General Physics, (2) Geology and Palæontology, (3) Natural History. Satisfactory reports are given in Nos. 1 and 3, the latter having set itself to the collection of statistics of the natural history of the county, and the former, among other things, to a regular series of meteorological observations. We hope the Leicester Society will persevere in its work.

WE have received as No. 1 of the "Proceedings of the Chester Society of Natural Science," a very excellent list (with remarks) of birds observed in Werral, Cheshire, by J. F. Brockholes. The list contains 168 species.

THE Seventh Annual Report of the Trustees of the Peabody Museum of American Archæology and Ethnology (Harvard) contains some account of the valuable series of objects connected with South American and Pacific archæology and ethnology, which the late Prof. Agassiz acquired during his voyage in the *Hassler* in 1871-2, and which have been transferred to the Peabody Museum. The collection is very valuable and comprehensive; there are 330 specimens of Peruvian skulls alone. The Report contains a very ingenious paper, apparently by Mr. J. Wyman, the Curator, On the human remains in the shell heaps of the St. John's River, East Florida, in which the author argues, from the condition of the bones and other circumstances, that the Floridan aborigines were in all probability cannibals.

ONE of the many valuable results of the work of the U.S. Geological Survey of the Territories, is a "Synopsis of the Flora of Colorado," by T. C. Porter and J. M. Coulter. This work is intended to be a type of a series of handbooks of different branches of natural history, to be published from time to time as a part of a series of "Miscellaneous Publications" for the use of students. No. 3 of the series is nearly ready, and has been prepared by the eminent ornithologist, Dr. E. Coues. It will form an octavo volume of several hundred pages, bringing the whole subject of western ornithology up to date.

A PAPER by Dr. H. D. Schmidt, of New Orleans, U.S.A., On the construction of the dark or double-bordered nerve-fibre, occupies a large part of the last number of the *Microscopic Journal*, and is illustrated by three plates. In the same number is the first instalment of a communication by Rev. S. J. Brakey on the theory of immersion.

THE additions to the Zoological Society's Gardens during the past week include two Chukar Partridges (*Cacabis chukar*) from N. W. India, presented by the Hon. Justice Jackson; four Sandwich Terns (*Sterna cantiaca*), four Avocets (*Recurvirostra avocetta*), European, purchased; a Common Crowned Pigeon (*Goura coronata*), two Bronze-winged Pigeons (*Phaps chalcoptera*), hatched in the Gardens; a Black-eared Marmoset (*Hapale penicillata*) from Brazil; and two Suricates (*Suricata zenik*) from South America, deposited.

FRENCH ASSOCIATION FOR THE PROGRESS OF SCIENCE

THE Lille Session was opened on Aug. 20 by the address of M. Wurtz, of which you have received a copy, and which has been published in all the French papers. The *Débats*, by an extraordinary access of zeal, published it a day before it was delivered!

On Friday Colonel Laussedat read at a general session a report on the results of the last session.

On Saturday evening a lecture on the Transit of Venus was delivered by M. Faye, before a very large audience at the Cercle du Nord, a magnificent building, richly fitted up. The accomplished astronomer referred mostly to the arrangements at the French stations, deeply regretting that all civilised nations had not been united into a kind of federation for working in combination at a problem of such magnitude; he hopes that it will be so in 1882. He insisted upon the importance of photography, which has been used to such good purpose by the Americans, and he trusts that in future times photography will take the lead in such observations. He gave interesting details as to the Yokohama station, to which a Japanese prince educated in France will be attached as a photographer. The consequence will be that M. Jannsen and his associates will be admitted into the interior sea of Japan, where, up to the present moment, not a single foreign vessel has ever sailed.

Owing to the coincidence of the meeting of the British Association at Belfast, scarcely any English *savans* are present here. The only British member I have seen up to the present moment is Dr. Sylvester, the celebrated mathematician. He has been nominated the honorary president of his section, the acting president being M. Catalan, who, though a Frenchman, is regarded as a representative of Belgium. Ten years ago he settled in Liége, where he is a professor in the University.

The interest felt by the people generally is not nearly so great as in the case of the British Association in England. The inhabitants of the city do not appear to understand fully the extent of the honour conferred on them. A *train de plaisir* has been organised to visit distant workshops, but Lille workshops have not been opened for inspection.

Newspapers are glad to publish the transactions of the several sections, but the Association has not authorised any one of them to publish them at full length.

Last Saturday a most interesting experiment was tried with success on the Northern line. M. Giffard, the inventor of the injector, has constructed a new waggon which is suspended by powerful springs at both extremities, thus completely avoiding oscillation. It is very easy to read and even to write in these new carriages. The invention will be exhibited very shortly to the English public.

W. DE FONVIELLE

Lille, Aug. 23

OPENING ADDRESS BY THE PRESIDENT, M. WURTZ, AT THE MEETING OF THE FRENCH ASSOCIATION

The Theory of Atoms in the General Conception of the Universe

FRANCIS BACON conceived the idea of a society of men devoted to the culture of science. In his "New Atlantis," in which he describes the organisation of this society and its influence upon the destinies of a wisely governed people, he shows it rising to the dignity of a State institution. The progress of civilisation by the search for truth, and truth discovered in the order of nature by experiment and observation—such are the ends proposed and the means made use of. Thus, in an age when the syllogism was still supreme, and which was firmly held beneath the scholastic yoke, the English Chancellor assigned to science at once its true method and its mission in the world.

The plan of Bacon embraced all branches of human knowledge. The land was overrun by a multitude of observers, engaged, some in studying the monuments of the past, the language, the manners, the history of the nations; others in observing the configuration and the productions of the soil, noting the superficial structure of the globe and the traces of its revolutions, collecting all the data concerning nature, the organisation and distribution of plants and animals. Other men, located in various regions, cultivated the exact sciences. Towers were constructed for the observation of stars and meteors; vast edifices, arranged for the study of physical and mechanical laws, contained machines which supplied the deficiency of our forces, and instruments which added to the precision of the senses and rendered abstract demonstrations sensible. This immense labour was uninterrupted, co-ordinated, controlled; it had its origin in self-abnegation, it was regulated by precision, and had time for its sanction. Thus was it fruitful.

Such was the idea of Francis Bacon. To observe all things; by the rational comparison of these observations to disclose the hidden connections of phenomena, and to rise by induction to the discovery of their real nature and their causes, all with the view "of extending the empire of man over entire nature, and of executing everything possible for him to do;" such is the object which he has pointed out to us; such is the function of science.

This great exploration of the earth which he desired to institute, this patient and exact research of the laws of the universe, this deliberate intervention of science in the affairs of life and of the universe,—could all this be the work of his own time? He knew it too well to venture to hope it himself, and it is on this account, doubtless, that he placed the fortunate country which enjoyed so noble an institution in the solitude of the great ocean.

Two centuries and a half ago the conception of Bacon was regarded as a noble utopia; to-day it is a reality. That magnificent programme which he then drew out, is ours, gentlemen; ours, not in the narrow sense of the word, for I extend this programme to all who, in modern times and in all countries, give themselves to the search for truth, to all workers in science, humble or great, obscure or famous, who form in reality, in all parts of the globe and without distinction of nationality, that vast association which was the dream of Francis Bacon. Yes, science is now a neutral field, a commonwealth, placed in a serene region, far above the political arena, inaccessible, I wish I could say, to the strifes of parties and of peoples; in a word, this property is the patrimony of humanity. It is, too, the principal conquest of this century, which my illustrious predecessor characterised, with so much justice, as the century of science.

Modern generations are spectators, indeed, of a magnificent spectacle. For a century past the human mind has directed an immense effort to the study of the phenomena and the laws of the physical universe. Hence an astonishing development of all the sciences founded on observation and experiment. New ideas which have arisen in our days in the correlation and conservation of forces have been like a revelation to some of these sciences. Mechanics, physics, chemistry, physiology itself, have found at once a *point d'appui* and a bond of connection. And this powerful flight of ideas has been sustained by the progress of the methods, I should say by the more careful exactness of observations, the perfect delicacy of experiments, the more rigorous severity of deductions. These are the springs of this movement which hurry along the sciences, and of which we are the astonished and moved witnesses. It is to propagate it broadcast over our country that we hold, each year, this parliament, to which are invited all who take part or are interested in the war against the unknown. Science is indeed a war against the unknown; for, if in literature it is enough to give expression, and in art a body, to conceptions or beauties deposited either in the human mind or in nature, it is not so in science, where truth is deeply hidden. She must be conquered, she must be stolen, like the Promethean fire.

It is of some of these conquests that I wish to speak to-day, full of doubt and apprehension in presence of so great a task. To respond to the demands of his position and to follow noble examples, your president ought, at the beginning of this session and of the ceremonies which inaugurate our young association, to trace the progress accomplished in the sciences, mark by a few bold lines the various routes over which it has recently run, and the culminating points which it has attained. I shrink from such a programme: if it does not exceed the powers of some of my colleagues, and doubtless of some among you, it greatly surpasses mine. Less justified and less daring than was Condorcet at the end of last century, I only perceive the outlines and some bright patches of the sketch which he attempted to draw; and to see it accomplished, I shall call to my assistance these who will follow me in the honourable and perilous post I now occupy.

I shall confine myself, then, gentlemen, to speaking to you of what I know, or of what I think I know, by directing your attention to the science to which I have devoted my life.

Chemistry has not merely grown, it has been regenerated since Lavoisier. You know the work of that immortal master. His labours in connection with combustion gave to our science an immovable basis by fixing at once the notion of simple bodies

and the essential character of chemical combinations. In these latter we find in weight all that is ponderable in their elements. These, in uniting to form compound bodies, do not lose any of their proper substance; they lose only an imponderable thing, the heat disengaged at the moment of combination. Hence that conception of Lavoisier that a simple body such as oxygen is constituted, properly speaking, by the intimate union of the ponderable matter oxygen with the imponderable fluid which constitutes the principle of heat, and which he named caloric—a profound conception, which modern science has adopted, giving it a different form. It is, then, unjust that, in recent times, Lavoisier should be accused of having misconceived what is physical in the phenomenon of combustion, and that an attempt should be made to rehabilitate the doctrine of Phlogiston which he had the honour of overturning. It is true that in burning bodies lose something: "It is the combustible principle," said the partisans of Phlogiston; "It is caloric," said Lavoisier; and he adds, an essential thing, that they gain in oxygen.

Thus Lavoisier perceived completely the phenomenon, of which the great author of the phlogiston theory, G. E. Stahl, had only a glimpse of the external appearances, and of which he misconceived the characteristic feature. Such is, gentlemen, I maintain, the foundation and the origin of modern chemistry. Is that to say that the monument raised upon these bases by Lavoisier and his contemporaries subsists in all its parts, and that it was accomplished at the end of last century? It would not be from want of materials, and even in its outlines we may notice lines which have in time disappeared. It has then been added to and in part transformed; but it still rests upon the same foundations. Such has been in all sciences and in all times the lot of theoretical conceptions; the best of them contain obscurities and gaps which, on disappearing, become the occasion of important developments or of a new generalisation.

That of Lavoisier embraced especially the bodies best known in his time, *i.e.*, the compounds of oxygen, the true nature of which was discovered by him in his researches on combustion. All these bodies are formed of two elements; their constitution is binary, but it is more or less complicated. Some, oxides or acids, contain a simple body united to oxygen; others, more complex, are formed by the combination of acids and oxides among themselves, a combination which gives rise to salts. These last then are formed of two constituent parts, each of which contains oxygen united to a simple body. Such is the formula of Lavoisier on the constitution of salts; it is in harmony with the fundamental idea which he enounced on chemical combination, an idea according to which all compound bodies are formed of two immediate elements, which are either simple bodies or themselves compound bodies.

This dualistic hypothesis was embodied, in his time and with his consent, in French nomenclature, the work of Guyton de Morveau, the principle of which may be thus summarised: two words to designate each compound, one to mark the genus, the other the species. Thus, one of the fundamental conceptions of the system of Lavoisier—dualism in combinations—found a striking expression in the binary structure of the names, and is, as it were, insinuated into the mind by the very terms of chemical language; and we know what is, in such a case, the power of words.

The great successor of Lavoisier, Berzelius, extended to the whole of chemistry the dualistic hypothesis of Lavoisier on the constitution of salts. Wishing to give it a solid support, he added to it the electro-chemical hypothesis. All bodies are formed of two constituent parts, each of which possesses, and is, as it were, animated by, two electric fluids. And as the electro-positive fluid attracts the electro-negative, it is natural, it is necessary that in every chemical compound the two elements should reciprocally attract each other. Is not the one carried towards the other by electric fluids of opposite kinds? We see that the hypothesis of Berzelius gives at once a striking interpretation of the dualism in combinations and a simple and profound theory of chemical affinity. This elective attraction which the final particles of matter exercise upon each other was referred to electric attraction.

Another theoretic conception gave a body to the electro-chemical hypothesis, and has given since a solid basis to chemistry as a whole. We speak of the atomic theory, revived from the Greeks, but which took, at the commencement of this century, a new form and a precise expression. It is due to the penetration of an English thinker, Dalton, a teacher of chemistry in Manchester in the beginning of the century. It was less a pure speculation of the mind, as were the ideas of the ancient atomists and of the philosophers of the Castesian school, than a theoretical representation of well-established facts, viz., the parity of the proportions according to which bodies combine, and the simplicity of the relations which express the multiple combinations between two bodies.

Dalton found, in fact, that, in cases where two substances combine in several proportions, if the quantity of one of them remains constant, the quantities of the other vary according to very simple relations. The discovery of this fact was the starting-point of the atomic theory. Here is the substance of this theory:—That which fills space, viz. matter, is not infinitely divisible, but is composed of a universe of invisible, imperceptible particles, which, nevertheless, possess a real extension and a definite weight. These are atoms. In their infinitely attenuated dimensions, they offer points of application to the physical and chemical forces. They are not all like each other, and the diversity of matter is owing to inherent differences in their nature. Perfectly identical for the same simple body, they differ from one element to another in their relative weights, and perhaps by their form. Affinity sets them in motion, and when two bodies combine with each other, the atoms of the one are drawn towards the atoms of the other. As this approach always takes place in the same manner between a determinate number of atoms, which are in juxtaposition one to one, or one to two, or one to three, or two to three—in other words, according to very simple proportions, but invariable for a given combination—it results therefrom that the smallest particles of this combination present a fixed composition rigorously similar to that of the entire mass.

Thus the most important fact of chemistry, the immutability of the proportions according to which bodies combine, appears as a consequence of the fundamental hypothesis that chemical combinations result from the coming together of atoms possessing invariable weights. Berzelius compared these atoms to minute magnets. He imagined them to have two poles where the two electric fluids are separated but unequally distributed, so that one of them is in excess at one of the poles. "There exists," he said, "atoms with excess of positive fluid and others with excess of negative fluid; the first attract the second, and this attraction, the source of chemical affinity, preserve the atoms under all combinations. At the moment that these last are formed they are set in motion; in the completely formed compound they are at rest, and are divided as if into two camps, at once kept together and maintained in opposition by the two electric fluids of opposite kinds.

Thus the electro-chemical theory, ingeniously adapted to the hypothesis of atoms, raised the dualism of Lavoisier to the dignity of a system, which appeared solidly established during the first half of this century. The facts then known were included in it without difficulty, and the rich materials which the patience or the genius of experimenters amassed without ceasing were very soon co-ordinated.

Without attempting to enumerate the older works relating to the decomposition of alkalis, to the nature of chlorine recognised as a simple body, to various newly-discovered elements, such as selenium, tellurium, iodine, we shall mention in a special manner among so many discoveries, that of cyanogen, which we owe to our own Gay-Lussac. The demonstration of the chemical functions of this compound gas, which behaves like a simple body, which is capable of forming the most varied combinations with true elements, which finally, when it is engaged in such combinations lends itself to double decompositions, as does chlorine in the chlorides, was a great step in the progressive march of science. Hence the definition: cyanogen is a compound radical, and the triumphant appearance of the doctrine of radicals. It had been vaguely intimated by Lavoisier; it really dates from the discovery of cyanogen, and will make a rapid advance. Up to that time great efforts had been directed to the side of inorganic chemistry, and great ideas had arisen in this domain. The application of these ideas to organic chemistry, upon which attention then began to be directed, presented some difficulties.

We know that the innumerable bodies which nature has distributed in the organs of plants and animals contain a small number of elements—carbon, hydrogen, oxygen, and often nitrogen. It is then not in their general composition that they differ, but by the number and arrangement of the atoms which enter into their composition. By increasing more or less and grouping themselves in various manners, these atoms

give rise to an immense multitude of distinct compounds which are true chemical species. But what is the arrangement of these atoms? What is the structure of these organic molecules, so much alike in the nature of their elements, so wonderful in the infinite diversity of their properties? Berzelius solved this question without hesitation. Comparing organic compounds to the bodies of inorganic chemistry, he divided both classes of atoms into two lots, grouping on one side carbon and hydrogen, electro-positives, and on the other, oxygen, electro-negative. And when, at a later time, chlorine was artificially introduced into organic compounds, the atoms of this powerful element were ranged on the side of oxygen, both being invariably found in binary combinations of which they formed the electro-negative element, the atoms of carbon and hydrogen constituting the electro-positive radical.

Thus the great promoter of inorganic chemistry attempted to fashion organic molecules according to the image of those molecules of dead matter which he had studied so thoroughly. The paths which Lavoisier traced in this domain he wished to extend to the world of products formed under the influence of life; they resulted in a dead-lock. In proportion as the riches of science increased it was necessary, in order to uphold the system, to accumulate hypotheses, to invent radicals, to construct, with insufficient or imaginary data, formulæ more and more complicated—a thankless task, in which the feeling of experimental realities and sober appreciation of facts often gave place to outrageous reasonings and vague subtleties. These barren efforts of a great mind inaugurated the decline or marked the termination of the dualistic ideas which were at the foundation of what has been called, improperly perhaps, the old chemistry. The new began at that point. Great discoveries, cleverly and boldly interpreted, gave it an impulse which still endures.

There were then—I speak of forty years ago—a number of young men, with Dumas and Liebig at their head, in the opposite camp, who cultivated with ardour the investigation of organic compounds. Convinced that the constitution of these compounds could only be deduced from the attentive investigation of their properties and metamorphoses, they undertook to investigate these bodies themselves, to transform them, to torment them in some sort by the action of the most diverse reagents, in the hope of discovering their intimate structure. And this is, gentlemen, the true method in chemistry; to determine the composition of bodies, and by careful analysis of their properties to fix, as far as possible, the grouping of their ultimate particles. This, then, is the glory of our science, and the single but precious contribution which it is able to furnish for the solution of that eternal problem, the constitution of matter.

From the researches which were made at this epoch and in this spirit, an all-important fact issued; it relates to the action of chlorine on organic compounds. This simple body deprives them of hydrogen and may be substituted for that element, atom for atom, without affecting the molecular equilibrium and without, adds Dumas, modifying the fundamental properties. This proposition encountered at first the most violent contradiction. How could chlorine take the place of hydrogen and play its part in combinations? These two elements, said Berzelius, are endowed with opposite properties, and if the one is lacking the other cannot supply its place; for, in short, they are two inimical brothers, little disposed and by no means fit to be kept in the same house. These critics and many others have not prevailed against facts. The theory of substitutions has come triumphantly out of this great discussion, which marks a date in the history of our science. Its natural development has gradually introduced into it new ideas on the constitution of chemical compounds, on the mode of combination of the elements which they contain.

These ideas have come to light by various ingenious comparisons. Laurent considered organic compounds as formed of nuclei with appendages, both the one and the other admitting into their structures atoms grouped with a certain symmetry. Dumas compared them to edifices of which the atoms constitute, in a manner, the materials. Hence the graphic but frequently correct expression, of molecular edifices capable of being modified, in certain cases, by the substitution of one part for another, and which, in other cases, the shock of powerful reagents may shatter to pieces. In both conceptions the chemical molecules were regarded as forming a whole. A little later Dumas compared them to planetary systems; and here he veritably shot ahead of his time in giving us a glimpse of groups of atoms maintained in equilibrium by affinity, but carried along by movements, as the planets of a solar system are acted upon by gravitation and carried into space. It is in these movements of atoms and molecules that at a later period the source of the physical and chemical forces must be sought for; but I must not anticipate. I have attempted to show how the ideas on chemical combinations have been gradually modified under the double influence of the atomic hypotheses and of facts brought to light by the French school concerning their reciprocal replacement in combinations. Forming a whole, more or less complex, the molecules of organic substances may be modified by substitution and give rise to a multitude of derivatives which naturally attach themselves to the mother substance. The latter serves them as a model or type. The typical idea thus introduced into science very soon occupied a large place. It first brought to it important elements of classification. All the compounds derived by substitution from the same body were ranged in the same family, of which the latter was, so to speak, the chief. Hence arose groups of bodies perfectly distinct from each other, and the number of which were being constantly increased by daily discoveries. It was necessary not only to introduce order into all these tribes, but to connect them with each other by a common bond. The honour of having discovered the superior principle of classification belongs to Laurent and Gerhardt, valiant champions of French science, from whom premature death has snatched, if not victory, at least the gratification of victory. Laurent was the first to say that a certain number of mineral and organic compounds possessed the constitution of water, and this idea, brilliantly developed by Williamson, was generalised by Gerhardt. According to the last named, all inorganic and organic compounds may be connected with a small number of types, of which hydrochloric acid, water, and ammonia, are the chief. In these compounds, relatively simple, one element may be replaced by another element, or by a group of atoms performing the function of a radical, so that this substitution gives rise to a multitude of various compounds bound together by the analogy of their structure, if not by the harmony of their properties.

This last point was novel and important. Bodies belonging to one type and similar in their molecular structure may differ much in their properties: these depend not only on the arrangement of the atoms, but also on their nature. Thus the inorganic and organic bodies ranged under the type water, are, according to the nature of their elements or their radicals, powerful bases, energetic acids, or indifferent substances—a great and bold idea, which has established a connection between the most diverse bodies, and which has definitely overturned the barriers which use had raised, and which the weakness of theory had maintained, between inorganic and organic chemistry. And yet this was only a stage in the march of ideas. By what right and by what privilege, it was said, may the relatively simple compounds we have named serve as types for all others, and why should nature be restricted to make all bodies on the model of hydrochloric acid, water, and ammonia? This was a serious difficulty, but it has been removed; it became the occasion of a profound discussion and the germ of a real progress.

These typical compounds represent at bottom various forms of combination, the diversity of which it is necessary to refer to the nature of the elements themselves. The latter impress on each of these compound types a particular character and a special form. The atoms of chlorine are so formed that to one of them only a single atom of hydrogen needs to be added to form hydrochloric acid; then that an atom of oxygen takes two atoms of hydrogen to form water; that an atom of nitrogen requires three to constitute ammonium; and that an atom of carbon demands four to become marsh-gas. What a difference in the power of combination of these elements, and, so to speak, in their appetites for hydrogen! And will this difference not be connected with some peculiarities in their mode of existence, to some property inherent in matter itself, and which will impress on each of these hydrogenic compounds a special form? Such is the case.

It is now admitted that atoms are not motionless, even in bodies apparently the most fixed and in completely formed combinations. At the moment when these are being formed the atoms come into violent collision with each other. In this conflict a disengagement of heat is ordinarily observed, resulting from the expenditure of active energy which the atoms have lost in the *mêlée*, and the intensity of this heat-phenomenon gives the measure of the energy of the affinities which have presided at the combination. But there is another thing in chemical phenomena besides the intensity of the forces at work, and which are more or less exhausted by a disengagement of heat; I refer to their *mode*; it was of this elective attraction that Bergman spoke

a century ago, and which governs the form of the combinations. The atoms of the various simple bodies are not endowed with the same aptitude for combination with each other; they are not equivalent to each other. This is what is called atomicity, and the fundamental property of atoms is without doubt connected with the various modes of motion by which they are animated. When these atoms combine with each other, their movements require to be reciprocally co-ordinated, and this co-ordination determines the form of the new systems of equilibrium which will be formed; that is, the new combinations.

It is with atoms thus endowed that chemists now construct molecular edifices. Resting at once upon the data of analysis and on the investigation of reactions, they express the composition of bodies by formulæ which mark the nature, the number, and the arrangement of the atoms which each molecule of these bodies contains. But what! is this merely an ingenious exercise of the mind? and the construction of formulæ by means of these symbolic materials which are selected, which are arranged so as to give to the molecular edifice a determined form,—is this a mere matter of curiosity? By no means. These formulæ, by whose aid are expressed the composition of bodies and the constitution of their molecules, offer also a valuable aid for the interpretation of their properties, for the study of their metamorphoses, for the discovery of their reciprocal relations,—all things which are intimately connected in each body with the nature and arrangement of the atoms. Now, the investigation and comparison of these formulæ furnish to the inquiring spirit the elements of a powerful synthesis. What treasures have been acquired by science by this process, which consists in deducing the transformations of bodies from their molecular structure, and in creating, by a sort of intuition, new molecules by means of those already known! The artificial formation of a number of combinations, the syntheses of as many organic compounds as nature alone seemed to have the privilege of forming—in a word, the greater part of chemical discoveries which have enriched science and the world for twenty years—are founded on this inductive method, the only efficacious and the only rational one in the sciences. I shall cite only one example among many others.

A happy chance led to the discovery of that brilliant substance, of a bright purple, which is known under the name of fuchsine or rosaniline. Analysis determines its composition, skilled investigations find its molecular structure. Soon it is known how to modify it, to multiply the number of its derivatives, to vary the sources of their production, and from attentive study of all these reactions, issue a pleiad of analogous substances whose diverse colours rival in brilliancy the richest tints of the rainbow. A new and powerful industry has already resulted from all these investigations, which theory has followed step by step and guided the fertile evolution. In this order of investigation, science has recently gained one of her most striking triumphs. She has succeeded in forming at once the colouring matter of madder (alizarin). By an ingenious combination of reactions, and by theoretic reasonings still more ingenious, MM. Graebe and Liebermann have succeeded in obtaining this body synthetically, by means of anthracene, one of the numerous bodies which is now obtained from coal-tar, the impure source of so many wonders. Such is a discovery which has issued from the womb of science, and of science the most abstract; confirming preconceived ideas on the relations of composition and of atomic structure between anthracene, alizarin, and the intermediate terms. And this will not be the last product of this beautiful development of chemistry. Future conceptions on the intimate structure of complex organic compounds will be so many landmarks for new syntheses, and hypotheses rigorously deduced from acquired principles will be fruitful in the happiest applications.

Saccharine matters, alkaloids, other complex bodies whose properties and diverse transformations are actively investigated with a view of deducing their molecular constitution—all these substances may be artificially reproduced, as soon as this preparatory work, so difficult and often seemingly so useless, will have sufficiently advanced. So fine a programme justifies the great efforts which have been made, in our days, in this direction. To discover, to analyse, to study, to classify, to reproduce artificially so many diverse substances, to study their internal structure, to indicate their useful applications; to surprise, in a word, the secrets of Nature and to imitate her, if not in her processes, at least in some of her productions—such is the noble aim of contemporary science. She can only reach it by the sure but slow paths we have indicated; experiment guided by theory. In chemistry, at least, empiricism has had its day; problems, clearly stated, must be boldly faced, and henceforth the rational conquests of experiment will only leave a place more and more circumscribed for fortunate finds and the surprises of the crucible. Away, then, with the detractors of theory, who go in quest of discoveries which they can neither foresee nor prepare; they reap where they have not sown. But you, courageous workers, who trace methodically your furrows, I congratulate you. You may be sometimes deceived, but your work will be fruitful, and the goods which you amass will be the true treasure of science.

Will not this science be one day embarrassed and as if encumbered with so much riches, and will the strongest memory be able to support all the weight? If the danger exists, there is no need to fear it. The classification of all these materials will free us from embarrassment. In a well-arranged edifice, each stone requires to be prepared before taking its place; but the consruction accomplished, all do not strike the eye equally, though each has its use; only the strong courses, the corner-stones and the salient parts, are noticed. It will be thus with the monument of science. The details which have for their end to fill up gaps will disappear in the great whole, of which we only need consider the foundation, the principal lines, and the crowning of the edifice.

Gentlemen, chemistry thus constituted, and physics, have between them necessary connections. Both the one and the other investigate the properties of bodies, and it is evident that, so far as the ponderable bodies are concerned, these properties must be intimately connected with the constitution of matter. Hence the atomic hypothesis which suffices for the interpretation of chemical phenomena ought also to be adapted to physical theories. This is the case. It is in the movements of atoms and of molecules that we now seek, not only the source of the chemical forces, but the cause of the physical modifications of matter, changes of condition which it can undergo, phenomena of light, of heat, of electricity, of which it is the support.

Two French *savans*, Dulong and Petit, discovered some time ago a very simple law which connects the weights of atoms with their specific heats. It is known that the quantities of heat necessary to change by one degree the temperature of the unit of weight of bodies are very unequal. This is what we call specific heats; but the quantities of heat which bring about in simple bodies, taken under conditions in which they are rigorously comparable, the same variations of temperatures, are equal, if we apply these quantities of heat not to the unit of weight but to the atomic weight; in other words, the atoms of these elementary bodies possess the same specific heats, though their relative weights are very unequal.

But as to this heat which is thus communicated to them, and which raises their temperature equally, what is in reality its mode of action? It augments the intensity of their vibratory movements. Physicists recognise heat as a mode of motion, and that it comes under the cognisance of our perceptions by the vibrations of atomic matter or ether; of ether, that fluid material perfectly elastic, incoercible, imponderable, which fills all the immensity of space and the depth of all bodies. It is in this fluid that the stars describe their orbits; in this fluid atoms perform their movements and describe their trajectories. Thus the ether, the radiant messenger of heat and light, conveys and distributes their radiations through all the universe; and that which it loses in vibratory energy when it penetrates a cold body, which it warms, it communicates to the atoms of this body and augments the intensity of their movements; and that which it gains in energy by contact with a warm body, which it cools, it withdraws from this body and diminishes the intensity of their vibratory movements. And this kind of light and heat which come from material bodies is transmitted across space to other material bodies. You will remember in reference to this the words which Goethe put into the mouth of the Prince of Darkness in cursing the light—"It is born of bodies, it is brought forth and maintained by bodies, and it will perish with them."

But this exchange of forces which circulate from ether to atoms and from atoms to ether, must it manifest itself always in the phenomena of light or heat? This vibratory force which is transmitted by ether, can it not be preserved and stored up by matter, or appear under other forms?

It can be preserved as affinity, liberated as electricity, transformed into dynamic movements. It is this which is stored up in the innumerable compounds elaborated by the vegetable kingdom; it is this which provokes the decomposition of carbonic acid and of the vapour of water by the most delicate organs of plants which blossom in the sunlight. Originating

with the sun, luminous radiation becomes affinity in the immediate organic principles which are formed and accumulated in vegetable cellules. That mode of motion of ether which was "light" is become another mode of motion which is "affinity," and sways the atoms of an organic compound. In its turn this force thus stored up is expended again when the organic compounds are destroyed in the phenomena of combustion. Affinity, satisfied and as it were lost by the combination of combustible elements with oxygen, again becomes heat or electricity. Wood in burning, and carbon in becoming oxidised, produce sparks or flames: a metal which exhausts its affinities in decomposing an acid warms the liquid, or, under other conditions, produces an electric current, warming it less when the current is exterior. And in another order of phenomena, heat which distributes or propagates itself unequally between two surfaces, rubbing one against the other, or in a crystal that is warmed, or in two metals united by solder, disappears partially as such and manifests itself as static electricity or as an electric current. Thus all these forces are equivalent to one another and appear under diverse forms, whether they are passing from atoms to ether or from ether to atoms; but we never see them disappear or lose their force—only transform themselves and perpetually renew their youth.

And this is not all. These vibratory movements which sway atoms and which whirl about in ether can cause movements of the mass, displacement either of the bodies or of the molecules. Warm a bar of iron, it will dilate with a force almost irresistible; a part of the heat will be employed in producing a certain pulling asunder of the molecules. Warm a gas, it will in like way dilate, and a part of the heat disappearing as such, will produce a separation very considerable in this case between the gaseous molecules; and the proof of the consumption of heat in the work of dilation is not difficult to give, for if you warm the same gas to the same degree, but prevent it from dilating, less heat need be given to it than in the former case. The difference between the two quantities of heat corresponds exactly to the mechanical work performed by the molecules in dilatation. That is one of the most simple considerations, on which is founded the principle of the mechanical equivalent of heat so often now referred to in mechanics, in physics, and in physiology.

In physics it explains the mystery of latent heat, of fusion, and of volatilisation. But how is it that heat supplied continuously to a boiling liquid to maintain ebullition does not ever raise the temperature of the liquid above a point which under similar pressure remains fixed? The reason is that this heat is continually absorbed, and disappears as such to produce the mechanical work of driving apart the molecules. And so in the phenomena of fusion, the constancy of the temperature indicates the absorption of the heat consumed in molecular work. These conceptions have modified and thrown much light on the definitions which physicists have applied to different states of matter, and it is seen that they are in harmony with chemical theories of the constitution of bodies. These are formed of molecules which represent systems of atoms animated by harmonic movements, and whose equilibrium is exactly maintained and strengthened by these movements.

Applied to molecules thus constituted, heat can produce three different effects. In the first place, an elevation of temperature by the increase of vibratory energy; in the second place, an increase of volume by the driving apart of atoms and molecules, and this augmentation becoming very considerable, a change of condition, solid becoming liquid, and liquid becoming gas; in the last, the driving apart of the molecules is become immense in relation to their dimensions. Thus acting on the atoms which compose the molecule and amplifying their trajectories, heat can disturb the equilibrium which exists in the system, causing a conflict of these atoms with those of another molecule in such a way that this disturbance or this conflict leads to fresh systems of equilibrium, that is to new molecules. There commence the phenomena of decomposition and dissociation, or, inversely, of combination, which is the mainspring of chemistry, and it is seen they are but the continuation or consequence of the physical phenomena we have just analysed, the same hypothesis, that of atoms, applied to one and the other with an equal simplicity.

I ask, will it not be easy to conceive that the physical and chemical forces which act on ponderable bodies are applied also to diffuse continuous matter in some way, and is it not natural to suppose that there are limited and definite particles which represent the points of application of all these forces? And this view ought to apply to the two sorts of matter which form the universe, ether and atomic matter, the one infinitely rarefied but homogeneous, filling all space, and in consequence enormous in its mass, both unseizable and imponderable; the other non-continuous, heterogeneous, and only occupying a very limited portion of space, although it forms all worlds.

Yes, it forms all worlds, and the elements of ours have been discovered in the sun and in the stars. Yes, the radiations given off by incandescent atomic matter which forms these stars are also, for the most part, those which are produced by the simple bodies of our planet. Marvellous conquest of physics which reveals at once to us the abundance of forces which environ the sun and the simplicity of the constitution of the universe!

A solar ray falls upon a prism and is turned aside in its path and decomposed into an infinity of different radiations. These take each a particular direction, and all range themselves in bands in juxtaposition, and spread themselves out in the spectrum if the light thus received and decomposed is thrown on to a screen. The visible part of this spectrum shines with all the colours of the rainbow; but besides this, beyond both ends of the coloured bands the radiations are not absent. The heat-rays can be made to reveal themselves beyond the red; the chemical rays, more powerful than the others to make and destroy the chemical combinations, are known beyond the violet. All the forces which manifest themselves on the surface of our globe, as heat, light, and chemical energy, are sent to us in a ray of white light.

But this brilliant spectrum is not continuous. Fraunhofer has discovered in it an infinity of black lines cutting the shining band; these are the "dark lines" of the spectrum, and Kirchhoff has found that a certain number of them occupy the same position as the "bright lines" which occur in the spectra of metallic substances when in a state of incandescence. This last physicist, generalising an observation of Foucault, has seen, further, that under given circumstances these bright lines can be obscured and "reversed," coinciding then with the dark lines of the solar spectrum.

We have been able to conclude that these have an identical origin and are due to radiations given off by metallic substances spread in vapour over the solar globe, radiations which are obscured by these same vapours in the atmosphere of the sun. Thus the star which gives us heat, light, and life, is formed of elements like those which form our globe. These elements are hydrogen and metals in a state of vapour. They are not distributed equally in the mass of the sun and in his rarefied envelopes; the hydrogen and most volatile metals are raised to a greater height on the surface of the sun than are the other metals. They are never in repose; this ocean of incandescent gas is continually agitated by tremendous tempests. The *trombes* throw themselves out in immense columns to the height of 50,000 leagues above the gaseous sphere; these are the "protuberances," and they shine with a rose light peculiar to themselves; and they are formed according to Janssen and Lockyer by hydrogen, very rarefied, and also by an unknown substance—"helium." The luminous globe itself, the photosphere, gives the spectra of our ordinary metals, except gold, silver, platinum, and mercury; the precious metals, those which have little affinity for oxygen, being wanting. But, on the contrary, in the solar spectrum there are "lines" different from those which the metals of our earth give, but which are like them. The lines of the metalloids are wanting, as are the lines which are characteristic of compound bodies. The gaseous mass has such an incandescence that no chemical combination could withstand it.

The lines of Fraunhofer are dark, only the lines of the protuberances and those seen a moment after the disappearance of the sun in an eclipse, and a moment before its reappearance, are bright, like those which characterise the spectra of incandescent metallic vapours. Here we have a curious relationship which has furnished most important and precise indications on the physical constitution of the sun.

I have spoken of the chemistry of the sun, but the spectroscope has explored all the far-off space of heaven. The light of hundreds of stars has been analysed, and nebulæ, scarcely visible, have had the quality of their radiations revealed by its aid. The light, in some cases very feeble, with which a number of stars shine, gives a spectrum with dark lines like the solar spectrum, and this fact proves to us that the constitution of these stars is like that of our sun. Aldebaran sends us records of hydrogen, magnesium, and calcium, which abound in solar light, but also those of metals which are rare or absent, as tellurium, antimony, and mercury.

Nebulæ, twenty thousand times less brilliant than a candle a

a distance of 400 metres, have still given a spectrum, for their light, although feeble, is very simple in its constitution, and the spectrum which it gives consists only of two or three bright bands, one of hydrogen, the other of nitrogen. These nebulæ which give a spectrum of bright lines, are those which the most powerful telescopes cannot resolve: there is an "abyss" between them and resolvable nebulæ, which, like ordinary stars, give a spectrum with dark lines.

What an effort of the human mind! To discover the constitution of stars of which the distances even are unknown; of nebulæ which are not yet worlds; to establish a classification of all the stars, and still more to guess their ages—ah, tell me, is not this a triumph for science? Yes, we have classed them according to their ages. Stars coloured, stars yellow, stars white; the white are the hottest and the youngest; their spectrum is composed of a few lines only, and these lines are dark. Hydrogen predominates. Traces of magnesium are also met with, of iron, and perhaps of sodium, and if it is true that Sirius was a red star in the time of the ancients, it owed perhaps its tint to the greater abundance of hydrogen at that epoch. Our sun, Aldebaran, Arcturus, are among the yellow stars. In their spectra the hydrogen lines are less developed, but the metallic lines are fine and numerous. The coloured stars are not so hot, and are older. In consequence of their age they emit less vivid light. In them there is little or no hydrogen. Metallic lines abound, but one also finds channelled spaces like the lines of compounds. The temperature being lower, these latter can exist whether they consist of atoms joined to others of the same kind, or whether they contain groups of heterogeneous atoms. In referring recently to this classification of Father Secchi and the distribution of simple bodies in distant stars, Lockyer has observed that the elements the atoms of which are lightest are to be found in the hottest stars, and that the metals with high atomic weights are, on the contrary, met with in the colder stars; and he adds this—Are not the first elements the result of a decomposition brought about by the extreme temperatures to which the latter are exposed, and, taking them altogether, are they not the product of a condensation of very light atoms of an unknown primordial matter, which is perhaps ether?

Thus is brought forward afresh, from considerations taken from the constitution of the universe, this question of the unity of matter which chemistry has before raised from a consideration of the relative weight of atoms. It is not solved, and it is probable that it never will be in the sense here indicated. Everything leads to the belief in the diversity of matter, and the indestructible, irreducible nature of atoms. Does it not require, as M. Berthelot has pointed out, the same quantity of heat to put them in motion, whether they are heavy or light, and ought not the law of Petit and Dulong to prevail in its simplicity against the opposite hypothesis, however ingenious it may be?

I have endeavoured, gentlemen, to trace out for you the most recent progress accomplished in chemistry, in physics, and in physical astronomy, sciences so diverse in their object, but which have a basis in common—matter—and one supreme object—a knowledge of its constitution and of its properties and of its distribution in the universe. They teach us that the worlds which people infinite space are made like our own system, and that this great universe is all movement, co-ordinated movement. But new and marvellous fact, this harmony of the celestial spheres of which Pythagoras spoke, and which a modern poet has celebrated in immortal verse, is met with in the world of the infinitely little. There also all is co-ordinated movement, and these atoms, whose accumulation forms matter, have never any repose; a grain of dust is full of innumerable multitudes of material unities each of which is agitated by movements. All vibrates in the little world, and this universal restlessness of matter, this "atomic music," to continue the metaphor of the ancient philosopher, is like the harmony of worlds; and is it not true that the imagination is equally bewildered and the spirit equally troubled by the spectacle of the illimitable immensity of the universe and by the consideration of the millions of atoms which people a drop of water. Hear the words of Pascal: "I wish to picture not only the visible universe, but the immensity of nature that one can conceive within the limits of an atom; one may picture there an infinity of worlds, where each has its firmament, as in the visible universe."

As to matter, it is everywhere the same, and the hydrogen of water we meet with in our sun, in Sirius, and in the nebulæ, everywhere it moves, everywhere it vibrates, and these movements which appear to us inseparable from atoms, are also the origin of all physical and chemical force.

Such is the order of nature, and as science penetrates it further, she brings to light both the simplicity of the means set at work and the infinite variety of the results. Thus, through the corner of the veil we have been permitted to raise, she enables us to see both the harmony and the profundity of the plan of the universe. Then we enter on another domain which the human spirit will be always impelled to enter and explore. It is thus, and you cannot change it. It is in vain that science has revealed to it the structure of the world and the order of all the phenomena; it wishes to mount higher, and in the conviction that things have not in themselves their own *raison d'être*, their support and their origin, it is led to subject them to a first cause—unique, universal God.

SCIENTIFIC SERIALS

THE *Mittheilungen aus dem Göttingen Anthropologischen Vereine*, which are edited by Dr. Hermann von Jhering, promise to give important contributions to the department of anthropological science, and the appearance of these selections from the Transactions of the Society will be hailed with satisfaction. The first number contains an interesting paper on the origin of our knowledge of iron and bronze in Europe, by Prof. F. W. Unger, in which the author considers *seriatim* (1) the application of bronze for religious or sacrificial objects; (2) the linguistic affinity of the terms for ores, or metal generally, in different languages; (3-6) the mythical references to their use, seat of original works and the modes of employing bronze for and in connection with ceremonies of cremation. The section under which Prof. Unger treats of the myths and sagas connected with the history of the discovery and the first working of metals is especially interesting in regard to the early knowledge of iron possessed by the Tschudi, or primitive people of the Altai, through whom he believes that the Indo-Germanic races derived their acquaintance with its sources and modes of working.—A paper on skulls of extreme breadth, by Dr. von Jhering, which is rather a compendium of what has been done towards the definition of normal and abnormal types than a contribution of original matter, is aptly supplemented by the description of a new craniometer, given in the concluding extracts of the Transactions by Dr. W. Sprengel, who draws attention to the important direction taken by craniometrical inquiries in the course of the last year by the introduction of Dr. von Jhering's horizontal-plane apparatus, of which plates and detailed explanations are appended by the writer.—In a paper on the very widely-spread custom of tattooing the human body, in which some inquirers have believed they could trace the earliest origin of the art of using graved and written characters to express ideas, Herr Krause considers whether in this far-extending practice we have not an argument in favour of the unity of the human race. The author is not of opinion that we are justified in accepting this suggestion as capable of proof, but he thinks that this practice, against which Moses warned the Israelites, had a far higher significance than that of mere personal ornamentation, and was probably at one time or other associated with the religion of the several peoples who adopted it, while it also served as an emblematic emblasonment of the pretensions or calling of the wearer, a talismanic or hieroglyphic form of speech, and as a permanent pictorial exponent of facts in the absence of any other written language.

CONTENTS

THURSDAY, SEPTEMBER 3, 1874

FIFTH REPORT OF THE SCIENCE COMMISSION *

II.

SO much has been written recently here and elsewhere on the origin and growth of the admirable Owens College, Manchester, that we shall not repeat the details on these points furnished by the Report of the Commission. Since it was opened in 1851, it has held its way through many discouragements, and now, despite its comparatively narrow income, it is, at least from the point of view of scientific teaching and research, one of the most efficient institutions in the kingdom. Considering its comparatively recent origin and its provincial situation, the gifts bestowed upon it have been almost lavish; and yet the same complaint is made in the case of the Manchester College as is made by the two London institutions: the efficiency of the work of the College, and especially of its scientific side, is seriously crippled from want of adequate resources.

The whole endowments of the College, from its foundation till the present time, have amounted to 34,582*l.* In connection with the recent movement for the erection of new buildings, including various general and special endowments, an additional 168,300*l.* has been obtained; but even this is short by 60,200*l.* of the sum required to carry out the proposed extensions. With the prospect of this deficiency the Governors of the College cannot at present undertake the establishment of any new chairs. If, however, they had adequate resources, it has been stated that they would probably proceed to divide the professorship of English and its History, and to found new chairs of Mixed Mathematics, of Applied Geology and Mining, of Astronomy and Meteorology, and of Architecture.

The total number of students in Owens College in 1873-4 was 356, being an increase of 19 on the previous year, and excluding 140 students belonging to the Medical School.

The number of students entering the evening classes in 1872-3 was 557, which in 1874 rose to the very large number of 889.

With regard to the Owens College, the Commission makes the following recommendation:—

"Considering the strenuous and persevering efforts made by the great commercial community by which the Owens College is surrounded, and the cordial sympathy which these efforts have evoked, and which has manifested itself in the incorporation of other societies and schools with the College, and in the subscriptions and benefactions for special objects by which the exertions of the governing body have been seconded; we are of opinion that this institution has established a claim to aid from the national funds. We therefore recommend, in accordance with the views which we have expressed with regard to the two metropolitan colleges, that the Owens College should receive assistance from Government both in the form of a capital sum to be regarded as a contribution towards its building fund, and also in the form of an annual grant in aid of its working expenses, with the especial view of enabling it to complete the curriculum of studies by the establishment of new chairs."

* Continued from p. 332.

The Newcastle College of Physical Science originated in a feeling on the part of the authorities of the University of Durham, that that University did not completely meet the educational wants of the North. To render the University more generally useful, it was thought that the best step that could be taken would be to establish a School of Physical Science in connection with it. Newcastle, as the site of this school, was preferred to Durham, in deference to the wishes of all the eminent local employers of labour.

The College was founded in 1871 for the teaching of physical science, particularly in its practical application to engineering, mining, manufactures, and agriculture. The funds necessary for its endowment were provided in part by the University of Durham, which gave, in the first instance, 1,000*l.* a year in perpetuity, which has since been increased; and, in part, by a subscription raised in the north of England.

From local sources, and by amalgamating with the College the other scientific institutions of Newcastle, 117,000*l.* may be obtained.

The amount originally subscribed was of course insufficient to provide buildings for the new institution, and the College has at present to pay rent for the premises which it occupies. It is the opinion of the witnesses that it is extremely desirable that the College should be provided with buildings of its own. Sir William Armstrong says: "We consider the present accommodation as a makeshift, but without Government assistance it would be scarcely possible to undertake" to provide separate buildings appropriated solely to the College.

It was proposed, in the first instance, to provide four professorships, viz., of Pure and Applied Mathematics, of Chemistry, of Experimental Physics, and of Geology. To these professorships, lecturers have been added in literary subjects, in Greek and Latin, in English History and Literature, in French, and in German, besides a lectureship in Mechanical Drawing. It is thought very desirable by the founders of the College that other professorships of Science should be added to those already founded; indeed, a professorship of Biology has been recently established.

The number of students in 1873-4 was 78. The course of study is one of two years, there being two examinations, one at the end of each year; the candidates who pass the formal examination in Physical Science at the end of the second year to receive the title of Associate in Science of the University of Durham.

"There appears," the Report states, "to be every reason to think that the Newcastle College of Science is serving a most useful purpose in its own neighbourhood. There can be no doubt that local colleges in the great centres of manufacturing industry are in a position to meet local requirements which central institutions in London or the national universities are unable to do.

"According to Sir Wm. Armstrong the character of the instruction should be mainly, or almost entirely, of a purely scientific character, because at present there is no difficulty as regards practical knowledge, while on the other hand there is no means of acquiring scientific knowledge.

"The claims which the promoters of the College consider themselves to have upon the Government for assistance are founded upon the national usefulness of the institution, and on the amount of local support which it

has received. Sir William Armstrong's view is that the promoters 'have a very sound claim upon the Government, considering how liberally the scheme has been supported locally. I think it would be a very fair thing if the Government, considering how much the nation benefits from the establishment of such colleges, in every case were to contribute a sum proportional to what has been raised in the locality towards the attainment of the object.' . . . .

"We concur to a considerable extent in the opinions expressed by these witnesses. The degree of success which has attended the College of Physical Science at Newcastle-upon-Tyne, both in the collection of local subscriptions and in the organisation of its system of instruction, leads us to express with confidence the hope that by further efforts of the same kind it will before long be placed in a position to establish its claim to assistance from the State."

With regard to the Catholic University of Ireland, while the Commission believes that it is calculated to do much good to the cause of scientific education, it cannot recommend Government to grant it any endowment.

"On a review of the evidence," the Report states, "we are satisfied that the establishment of the Scientific Faculty of the Catholic University has not been without advantage to the instruction of the Irish people, an advantage which might be considerably increased if this faculty could be more completely organised, and its professors increased in number and supplied with adequate means for practical teaching. And we have not failed to observe that at the present time fresh efforts are being made by the persons interested in this institution, to improve and to render more widely available the instruction afforded by it.

"It is also indisputable that the Catholic University has received, and still continues to receive, a large amount of pecuniary support. The permanency, however, of this support, which proceeds, to a large extent at all events, from annnal subscriptions levied by clerical agency, cannot be predicted with any certainty.

"The peculiar organisation of this institution," the Report concludes, "the religious restrictions imposed upon the selection of scientific professors and lecturers—restrictions the removal of which it would be idle to anticipate; the incompleteness of a large portion of its arrangements for the teaching of science, and the uncertainty of its income, preclude us from recommending that it should receive a grant from public funds."

The general outcome, then, of the Fifth Report of the Science Commission is, that University and King's Colleges, London, and Owens College, Manchester, ought certainly to receive assistance from Government, that the Newcastle College is in a fair way to prove that it deserves such assistance, and that it would not be advisable to subsidise the Catholic University of Ireland, as it is at present constituted. J. S. K.

THE APPLICATION OF THE LAWS OF SELECTION TO AGRICULTURE

IN every phase of life the law of selection comes into play. At one time it is natural, at another time it is more or less artificial. At every time, and in every place, we see evidence of the plastic character of the materials on which the vital principle operates.

In devoting my holidays to an agricultural tour in England this season, I have visited several seed-growers who are conferring great advantages on the public by careful selection of parent plants. I can speak on this point with the experience which a wide range of observation gives. I have myself, by selection, doubled the quantity of solid matter in turnips, and nearly doubled the number of seeds in ears of wheat.

If the principle of selection were universally applied with skill and care in the raising of our seed corn, what an enormous increase would thereby be made to the wealth of the agricultural classes of Great Britain and Ireland!

In our agricultural live stock a series of results, which are truly marvellous, have been accomplished by selection. And yet the principle is understood or practised only by a very small percentage of our farmers.

If any reader wishes to understand in a general way the change that has been made within the last quarter of a century, which is the measure of the life-time of the Royal Agricultural Society of England, let him take the Society's prize lists of 1839 and 1874. In the interval, several new breeds of sheep and cattle have come to be recognised as having distinct types. Nature has had her share in the work. The soil and climate of every district impress certain characters and qualities on the animal; and, in his artificial selection, the farmer preserves these in whole or part. In studying, some years ago, the origin of the older breeds, I was much struck with the extent to which their distinctive characters were due to the natural conditions under which they rose. And in a recent inquiry into the history of the newly-established breeds, the same leading truth has become still plainer.

To give point to this short paper I derive an illustration from the influence exercised on the art of sheep-breeding by the remarkable change which, common observation tells us, has taken place in the material of garments in common use. I refer to the well-known fact that tweeds and coarse cloths are now much more commonly used than in the last generation. To meet the demand thus created the farmer has produced sheep which carry wool of longer staple than the old breeds.

My argument is well illustrated in the great plains in the west of Ireland, where the flock-owners have established a splendid new breed, called the Roscommon Sheep. In the production of this variety the breeder has of course exercised his skill in selection. He crossed Leicester tups of the very best English strains of blood with the native ewe; and he repeated this over and over again until he obtained an animal of the type which suited him. Nature aided him in his art. It may be safely asserted that some of the peculiarities of the wool, as well as some of the peculiar conformations of the body, have been the work of Nature. And it is in retaining what was so well done by Nature that the highest skill is manifested. In England the best example of the argument is possibly afforded by the Lincoln breed of sheep, which stands so deservedly high in public estimation, affording as it does great weight of carcase with a remarkably heavy fleece of lustrous wool. Then, again, let us take the dark-shaded breeds—South Down, Shropshire Down, Oxford Down, and Hampshire Down. The South Down used to be more popular than it is now. It has been giving way in many places to an animal with a larger frame and with a fleece longer in the staple. The first that arose to displace it was the Shropshire, which has been followed by the Oxford Down. Each of these breeds

pays best under a given set of circumstances; and this only shows the wide field open to British farmers for profiting by the laws of selection.

I look to the development of this great principle as one of the soundest and surest means of promoting the interests of the agricultural classes.

THOMAS BALDWIN

DARWIN'S "CORAL REEFS"

The Structure and Distribution of Coral Reefs. By Charles Darwin, M.A., F.R.S., &c. Second edition, revised. 1874; pp. 268. (Smith, Elder, and Co.)

THE rising generation of naturalists and geologists has not had, and most probably will never have, such feelings of intellectual pleasure as fell to the lot of the first readers of Charles Darwin's book on Coral Reefs, which was offered to science more than thirty years since. The recent researches into the nature of the deposits of the deep sea, and the discoveries of the bathymetrical zones of water of very different temperatures, are certainly full of vast interest, and will afford the data for the development of many a theory; but the clear exposition of facts, and the bold theory which characterised the book on Coral Reefs, came unexpectedly and with overpowering force of conviction. The natural history of a zoophyte was brought into connection with the grandest phenomena of the globe—with the progressive subsidence of more or less submerged mountains, and with the distribution of volcanic foci. The forces of the organic and inorganic kingdoms were shown to unite in the production of those circular growths of coral which appeared to rise from profound oceanic depths; and it was made evident that the existence and persistent growth of fragile Porites and *Madreporæ* were dependent upon movements of the crust of the globe, the result of forces acting almost from the beginning—upon movements so vast, equable and slow, that over thousands of square miles the coral grew upwards, whilst the supporting rock, its base, and the mother crust subsided in a wonderful unison. The pristine condition of the globe was in fact brought in relation with the formation of those beautiful islands, the theme of romance and poesy, the delight of the missionary, the dread of the navigator, and which should be, according to Dana, the luxurious home of enervated and used-up investigators.

The theory of the formation of barrier reefs and atolls is stated with Darwin's usual lucidity:—"From the limited depths at which reef-building polypifers can flourish, taken into consideration with certain other circumstances, we are compelled to conclude that both in atolls and barrier reefs the foundation to which the coral was primarily attached has subsided; and that during this downward movement the reefs have grown upwards." "There is not one point of essential difference between encircling barrier reefs and atolls; the latter enclose a simple sheet of water; the former encircle an expanse with one or more islands rising from it. Remove the central land, and an annular reef like that of an atoll in an early stage of formation is left." It was necessary, in order that this theory should be valid, that the depth at which reef-building corals can exist below the surface should be ascertained, and also that direct or indirect proofs of subsidence over a vast area should be offered. The nature of the bottom of the sea immediately surrounding Keeling atoll was carefully examined, and moreover soundings with the wide bell-shaped lead, with tallow armings, were carefully taken, off the fringing reefs of Mauritius. In Keeling atoll outside the reef it was found, "to the depth of ten or twelve fathoms the bottom is exceedingly rugged and seems formed of great masses of living coral, similar to those on the margin. The arming of the lead here invariably came up quite clean, but deeply indented, and chains and anchors which were lowered in the hopes of tearing up the coral were broken." "Between 12 and 20 fathoms the arming came up an equal number of times smoothed with sand and indented with coral; an anchor and lead were lost at the respective depths of 13 and 16 fathoms. Out of twenty-five soundings taken at a greater depth than 20 fathoms, every one showed that the bottom was covered with sand." Off the reef at Mauritius, "from 15 to 20 fathoms, the bottom was with few exceptions either formed of sand or thickly coated with Seriatopora (one of the Tabulata). At 20 fathoms one sounding brought up a fragment of Madrepora which I believe to be the same species as that which mainly forms the upper margin of the reef; if so, it grows in depths varying from 0 to 20 fathoms. Between 20 and 23 fathoms I obtained several soundings, and they all showed a sandy bottom with one exception at 30 fathoms, when the arming came up scooped out as if by the margin of a large Caryophyllia." "The circumstance of the arming having invariably come up quite clean when sounding within a certain number of fathoms off the reef of Mauritius and Keeling atoll (8 fathoms in the former case and 12 in the latter), and of its having always come up (with one exception) smoothed and covered with sand when the depth exceeded 20 fathoms, probably indicate a criterion by which the limiting of the vigorous growth of coral might in all cases be ascertained.'" Darwin admits that this limit might be exceptionally transgressed, but insists upon the importance of the gradual change, as depth progresses, from living clean coral to a smooth sandy bottom, in endeavouring to fix the depth at which the reef-builders can grow.

Even at this period of Darwin's life, the importance of the struggle for existence had been recognised by him, and had influenced his thoughts. He remarks that "we can understand the gradation only as a prolonged struggle against unfavourable conditions." All subsequent investigations by many independent observers have proved the correctness of this bathymetrical limit of the flourishing of reef-builders, and of late years the general characters of the coral which can exist at a greater depth and even on oceanic floors have been shown to differ essentially from those of the forms which live and flourish amidst the rush of the wave and surf. Darwin notices that where the sea is very shallow, as in the Persian Gulf and in parts of the East Indian Archipelago, the reefs lose their fringing character and appear as separate and irregularly scattered patches, often of considerable area. Around the Philippines the bottom of the sea is "entirely coated by irregular masses of coral, which, although often of large size, do not reach the surface and form reefs." There are huge clumps of Porites and many sponges on the floor of the sea off Cuba, but although

these corals belong to reef-building genera, still as species they are not those which grow on flourishing reefs. The reef-builders evidently grow with great rapidity, and their struggle against the tide and currents and waves necessitates a constant process of reparation or of growth to replace fractured branches. They flourish in the warm, highly aërated, rushing water, which is full of living things —their proper food. Beyond the reach and influence of these conditions other species and genera exist, which add to the bulk of the coral mass, but which of themselves would never build up a reef, and it is some of these which have been dredged up from considerable depths. The simple corals and the branching forms without a cellular exotheca to hold them together have an enormous bathymetrical range, and can live in water of 76° F. close to the surface, and also at a depth of more than 1,000 fathoms in a temperature of less than 32°. But the true reef-builder requires a high temperature, and it therefore becomes very important to discover, as has been suggested by Dr. Carpenter, whether the vast sub-zone of cold water which underlies the superficial and heated water has not much to do with this restriction of certain species to definite depths. We must wait for the results of systematic dredging at great depths in the Pacific before this question can be for ever settled, but at present all our knowledge tends to prove that this deep stratum of cold water would prevent reef-builders from living at any considerable depth, and therefore that they never could have risen by growth from the ocean floor itself. Growing, therefore, on submerged rocks, the reef-builders must have their foundation slowly subsiding, if they are to attain a great thickness and to assume the bulk and the characters of atolls. The direct proofs of subsidence advanced by Mr. Darwin were noticed especially in Keeling atoll. "Appearances indicating a slight encroachment of the water on the level are plainer within the lagoon : I noticed in several places, both on its windward and leeward shores, old cocoa-nut trees falling with their roots undermined and the rotten stumps of others on the beach, where the inhabitants assured us the cocoa-nut would not grow. Capt. Fitzroy pointed out to me near the settlement the foundation-posts of a shed, now washed by every tide, but which the inhabitants stated had seven years ago stood above high-water mark." "From these considerations I inferred that probably the atoll had subsided to a small amount : and this inference was strengthened by the circumstance that in 1834, two years before our visit, the island had been shaken by a severe earthquake, and by two slighter ones during the ten previous years." The observations of such authorities as Williams, Kotzebue, and Stutchbury, respecting the encroachment of the sea on, and the destruction of parts or the whole of islands, were noticed by Darwin in his early edition, and comparisons were made, as in the case of Whitsunday Island, between old and new charts, in support of the evidence of subsidence. The existence of submerged or dead reefs is very properly advanced as an indirect proof of subsidence, and the condition of the Great Chagos bank was considered to explain the effects of a rapid subsidence which killed the corals. But the principal and most interesting evidence is afforded by the relative positions of active volcanic vents and barrier reefs and atolls. Darwin noticed the absence of active volcanoes in the presumed areas of subsidence, and their frequent presence in areas of elevation, the exceptions being very few. In acknowledging Dana's suggestive criticism that he had not laid sufficient weight on the mean temperature of the sea in determining the distribution of coral reefs, Darwin very properly urges that some other cause must account for the absence of coral growth in localities where the surface temperature of the sea is sufficient, and he refers especially to the islands which rise up from the abyssal sea in the Atlantic ; but he indicates that temperature evidently has much to do with the absence of reefs on the west coast of Tropical America, the cold current reducing the mean emperature of the sea there below 68°.

Although investigations made subsequently to those of Darwin add almost invariably to the proofs of his theory of atoll formation, and it is received as correct by every teacher, still there have been one or two able criticisms of its general applicability. For instance, Semper, in his description of the Pelew Islands, doubted the evidence of subsidence. His opponent, with his usual justice and candour, gives Semper's objections the most careful consideration, and indeed they deserved this treatment. "He (Semper) states that the southern islands consist of coral rock upraised to the height of from 400 to 500 feet ; and some of them before their upheaval appear to have existed as atolls. They are now merely fringed by living reefs. The northern islands are volcanic, deeply indented by bays, and are fronted by barrier reefs. To the north there are three true atolls. Prof. Semper doubts whether the whole group has subsided, partly from the fact of the southern islands being formed of upraised coral rock ; but there seems to me no improbability in their having originally subsided, then having been upraised (probably at the time when the volcanic rocks to the north were emptied), and again having subsided. The existence of atolls and barrier reefs in close proximity is manifestly not opposed to my views. On the other hand, the presence of reefs fringing the southern islands is opposed to my views, as such reefs generally indicate that the land has either remained stationary or has been upraised. It must, however, be borne in mind that when the land is prolonged beneath the sea in an extremely steep slope, reefs formed there during subsidence will remain closely attached to the shore and will be undistinguishable from fringing reefs. Now, the submarine flanks of most atolls are very steep; and if an atoll after upheaval and before the sea had eaten deeply into the land and had formed a broad flat surface, were again to subside, the reefs which grew to the surface during the subsiding movement would still closely skirt the coast." The appendix, which contains a detailed description of the reefs and islands in the well-known coloured map, is of the greatest value to the physical geographer, and it includes notices of nearly every known coral tract.

After reading and pondering over this long-prized work, there comes the feeling that Mr. Darwin should at some future time enlarge its scope and deal with the distribution of coral species, and trace back in time the reefs of old. Who would not be glad to be taught from the vigorous pen of the man whose theory has lasted more than thirty years, and will last as long as science, what was the condition of the vast Pacific area prior to the age of reefs

and atolls? Mountains of different heights are now more or less submerged, and either capped with vast thicknesses of coral, or their tops are girt with barrier and fringing reefs. Take away the sea and the coral growth, and imagine the conditions which prevailed during the slow piling up of these volcanic rocks, their denudation and final overwhelming by the inrush of the ocean incident to the first phase of subsidence. Little is known concerning the age of the raised reefs of the Pacific, and therefore of the duration of the existing state of things; but in the Caribbean there have been reefs in consecutive ages since the early Cretaceous period, and in that area there have been during past ages subsidences and upheavals with contemporaneous volcanic action, following the same laws as those so elaborately described by Darwin as influencing coral growth in the Pacific.

P. M. D.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

The Long Peruvian Skull

It was not my intention to have replied to Dr. J. B. Davis's letter on "The Long Peruvian Skull" in NATURE, vol. x. p. 123, as I shall have an opportunity before long of presenting the subject in detail before scientific readers. I find, however, by letters from England that an answer is expected from me. To me, it seemed little more than a reiteration of his disbelief in the existence of such a type; while it leaves unnoticed what I specified as the main point in the discussion.

Dr. Davis demands the production of "half a score of ancient Peruvian dolichocephalic skulls, the appearance of which totally precludes the possibility of interference by art, or other deforming process." Had an anonymous correspondent so stated the issue, I should have supposed that the writer had never seen half a score of Peruvian skulls in his life. The collection presented by Mr. Hutchinson to Prof. Agassiz numbered 368; and out of this Prof. Wyman reports only *eleven* not flattened or distorted. Is Dr. Davis prepared to rule the remaining 357 out of court as of no value in relation to his brachycephalic type? This question of Peruvian long and short heads must be settled in connection with a deforming element affecting both types, or it cannot be settled at all. Hence my specification of the real issue. Keeping this in view, I must beg leave meanwhile to refer, for the sake of brevity, to my statements in NATURE, vol. x. p. 48, in reference to examples previously adduced; while I now point out others easily accessible to Dr. Davis.

The large collection furnished to Prof. Agassiz was obtained, apparently at one time, from a single locality, "Ancona and its neighbourhood." Hence no doubt the uniformity of type. Doubling this number of skulls from the same locality would add nothing to the evidence. It is otherwise with the London Anthropological Institute. Its collection was obtained at different times, partly from the same accessible locality; but also from Santos, Ica, Passamayo, and Cerro del Oro. These include places hundreds of miles apart; and Prof. Busk, after minute study, reports that the evidence of the existence of a dolichocephalic type afforded by the collection, though "not very abundant, *is nevertheless decisive.*"

It is a case precisely analogous to the remarkable dolichocephalic British type recognised by the acute sagacity of the late lamented Dr. Thurnam, in the Uley, Kennet, Littleton Drew, Rodmarten, and other long barrows in Wiltshire, &c., as illustrated in the *Crania Britannica*, for which so great a debt of gratitude is due to Dr. Davis and his gifted colleague. Those dolichocephalic skulls are exceedingly rare; they are found along with brachycephalic skulls; but, as Dr. Thurnam showed, accompanying elements suggestive of the latter as an inferior or servile class. Long ago, in a paper in the *Canadian Journal* of September 1862, I referred to the analogy this presents to the long Peruvian skull mingling in the ancient Inca cemeteries with crania of a markedly diverse type.

No multiplication of specimens of the less rare brachycephalic skull of the British cist or round barrow will invalidate this exceedingly rare but valuable dolichocephalic British type produced by Dr. Thurnam; and the exhibition of a whole ship's cargo of brachycephalic skulls from the accessible coast cemetery of Ancona is equally ineffective in disproof of the rare Peruvian dolichocephalic skull of Titicaca and other ancient burial-grounds.

Dr. Davis refers to an error in one of the woodcuts of my first edition of "Prehistoric Man." To anyone conversant with the difficulties of a Canadian author correcting proof-sheets for the London press, the chances of error, with proofs passing while the woodcut swere in the engraver's hands, and their mere titles or blank spaces in lieu of them, must be obvious enough. Dr. Davis will find the error pointed out in the preface to the second edition.

University College, Toronto, Aug. 6 DANIEL WILSON

Pollen-grains in the Air

I AM very sorry to find that, owing to my absence from home at the time, a question addressed to me by Mr. A. W. Bennett, in NATURE, vol. ix. p. 485, has escaped my notice hitherto and remained unanswered. Mr. Bennett, alluding to my letter on "Microscopic Examination of Air" (NATURE, vol. ix. p. 439), asks on what ground I refer the "triangular pollen" captured on my slide to the birch and hazel. The identification resulted from comparison under the microscope. The pollen-grains which I obtained from catkins of birch and hazel exhibited three conspicuous equidistant prominences (pores) giving each grain a triangular appearance. I cannot now remember if this appearance was equally distinct before and after immersion in glycerine: probably there was a change of shape due to osmosis. I confess that I used the word "triangular" not in its strict geometrical meaning, but in order to mark a feature which distinguished the pollen-grains of birch and hazel from those of poplar. Referring to my notes, I must admit that the shape of the grains which I identified with birch pollen would have been more accurately described as "spherical with three large protuberances." HUBERT AIRY

Blackheath, S.E., Aug. 31

Chrysomela Banksii

I SHOULD be much obliged if you would allow me to ask the following question of Coleopterists in the columns of NATURE:—

Does *Chrysomela Banksii* possess any quality, such as that of exuding an acrid liquid or the like, which would be likely to make it distasteful to spiders or other animals? I have seen it first taken and then rejected unharmed by a Trap-door Spider, and as these spiders feed largely on beetles, I am led to suppose that this particular beetle has some special protection.

J. TRAHERNE MOGGRIDGE

2, Foxton Villas, Richmond, Surrey, Aug. 27

The Aurora Borealis

MAY I ask the readers of NATURE for information on the following points:—

1. Where can I find references to any observations on the polarisation or otherwise of auroral light?

2. Are there any published lists of auroræ arranged with a view to determine the periodicity of its recurrence; or, if not so arranged, sufficiently extended for such an investigation?

3. Has any observer besides Mr. Backhouse noted the relative proportion between eastward and westward movement of auroral rays? HENRY R. PROCTER

North Shields, Aug. 29

ROBERT EDMOND GRANT, M.D., F.R.S.

ON Sunday, August 23, after an illness of about a fortnight, died Dr. R. E. Grant, for many years Professor of Zoology and Comparative Anatomy at University College, London. The family from which Dr. Grant was descended had its head-quarters in the county of Elgin, whence his father removed to Edinburgh, settling as an accountant and a writer to the signet in Argyll Square. He was one of fourteen children, twelve brothers and two sisters, being the seventh son, and the

longest surviving of them all. Neither he nor any of his brothers were married; one sister was, but she left no children. He was born in 1793. Between 1803 and 1808 he was a pupil at the High School, Edinburgh, after leaving which he entered the University of that city as a medical student, attending the lectures of Drs. Monro, Hope, Gregory, Duncan, and others. He took his doctor's degree in 1814, for five years after which he devoted his time to travelling on the Continent, visiting Paris, Rome, Florence, as well as Germany, Bohemia, Hungary, and Austria. In 1822 he settled in Edinburgh, and from then till 1828 contributed several zoological papers to different Scotch scientific societies and journals, including one to the Wernerian Natural History Society, in 1827, on the circulation of fluids through the structure of sponges, in which attention was first drawn to the function of the ossicula and pores of those animals, and which led Mr. Fleming to give the generic name *Grantia* to one member of the family.

In June 1827, whilst still in Edinburgh, Dr. Grant was elected Professor of Zoology and Comparative Anatomy in the new University of London, then being formed; his first lecture was not however delivered until October 1828. For the first few years after he settled in London he communicated several papers on zoological subjects to the Scientific Committee of the Zoological Society, some of which, on points in the anatomy of *Sepiola*, *Loligopsis*, and *Beroë*, read in 1833, are to be found in the first volume of their Transactions. From that time Dr. Grant published no papers of importance.

In 1836 Dr. Grant was elected a Fellow of the Royal Society, and in 1837 he was appointed to the triennial Fullerian Professorship of Physiology at the Royal Institution in Albemarle Street.

At his classes, during one session, it is said that Dr. Grant had only two attendants, these being Mr. Hallam, the illustrious historian, and a young boy; it was always a matter of surprise to the other students of the college how he managed to adapt his lectures to the mental capacity of this trying audience.

During the forty-six years that he held his professorship, he never missed a single lecture. It was his determination, if he had lived, to resign his appointment during the present year.

In disposition Dr. Grant was very retiring and seclusive, and a great reader. He travelled much and was an excellent linguist; so fond of languages was he, that only two years ago he attended lectures on Anglo-Saxon in University College. By his will Dr. Grant leaves his extensive library and all his private collection to University College, together with a sum of money to be employed in maintaining and extending the zoological and zootomical department of the library of the college.

CONFERENCE FOR MARITIME METEOROLOGY

A GENERAL wish having of late been expressed that the measures for the prosecution of Maritime Meteorology, proposed at the International Conference at Brussels in 1853, should be reconsidered, now that the experience of more than twenty years of the operation of these measures has enabled meteorologists to form opinions as to their utility, a conference is now being held at the Meteorological Office, 116, Victoria-street, consisting of the following gentlemen:—Austria—R. Müller, K. K. Hydrographic Office, Pola. *Belgium—Van Rysselberghe, Navigation School, Ostend. Bengal—H. F. Blanford, Meteorological Office, Calcutta. China—J. D. Campbell, Secretary Commissioners of Maritime Customs. Denmark—Capt. N. Hoffmeyer, Meteorological Institute, Copenhagen. France—C. Sainte-Claire Deville, Inspector of Meteorological Stations; A. Delamarche, Ministry of Marine, Paris. Germany—W. H. von Freeden, Deutsche Seewarte, Hamburg; G. Neumayer, Hydrographer, Berlin; Capt. Stempel, Imperial Navy; H. A. Meyer, Commissioner for Investigating German Seas, Kiel. Great Britain—(Board of Trade), Capt. Toynbee; R. H. Scott, Director Meteorological Office, Hon. Sec.; *(Admiralty), Rear-Admiral Nolloth; R. J. Mann, M.D., President Meteorological Society. Holland—Buys Ballot, Royal Meteorological Institute, Utrecht, President; Lieut. J. E. Cornelissen, R.N. Italy—Capt. N. Canevaro, R.N. Norway—H. Mohn, Meteorological Institute, Christiana. Portugal—J. C. de Brito Capello, Observatory, Lisbon. Russia—Capt. M. Rikatcheff, I.R.N., Central Physical Observatory, St. Petersburg; *A. Movitz, Observatory, Tiflis. Spain—C. Pujazon, Marine Observatory, San Fernando; Captain Montijo, S.N. *Turkey—Admiral Hobart Pacha. The basis of discussion will be the Report of the Brussels Conference above referred to, with some other heads relating to instructions, instruments, &c. The Conference will be divided into two sub-committees:—1. Instruments; 2. Observations. A Report of the proceedings will be published by the Meteorological Committee. A programme has already appeared in NATURE, vol. x. p. 152.

* Not present at the meeting on Aug. 31.

DEEP-SEA SOUNDINGS IN THE PACIFIC OCEAN

WE take the following extracts on this subject from a report made to the United States Secretary of the Navy by Commander George E. Belknap, dated United States Steamer *Tuscarora*, Hakodadi, Japan, June 26:—

"I left Yokohama on the 8th inst., and at dawn the next morning began the work of sounding homeward on a great circle passing through the island of Tawaga, of the Aleutian group, and towards Puget's Sound. When about 100 miles east by south from Kinghasan or Sendai Bay, on the east coast of Japan, the lead sank to a depth of 3,427 fathoms, showing a descent of 1,594 fathoms in a run of 30 miles. The result seems extraordinary at so short a distance from the land, but the next coast revealed a depth still more astonishing, the sinker carrying the wire down 4,643 fathoms without reaching the bottom.

"On this occasion, when some 500 fathoms of wire had run out, the sinker was suddenly swept under the ship's bottom by the strong undercurrent, and all efforts to get the wire clear and keep it from tending underneath were unavailing, the difficulty being increased by a fresh breeze and a moderately heavy sea. Finally, when 4,643 fathoms of wire had run out, and only 150 fathoms of wire were left on the reel, it broke close to the surface, and about five miles were lost.

"The strain on the reel was very great, and notwithstanding a weight of 130 lb. on the pulley line, it took three men to check and hold the drum, and the wonder was that the wire had not parted sooner. This great strain must have been due to the action of the strong undercurrent upon the sinker, sweeping it with great force from the ship, as since that cast we have sounded repeatedly in depths of more than 4,000 fathoms, and had no trouble in reaching the bottom.

"The position of the cast, as shown by observation was about 45 miles distant from the previous one, the strong current having carried the ship beyond the position where it was intended to sound. . . . .

"I determined to run back inshore and skirt the stream, beginning a new great circle off Point Komoto, in latitude 40° north. I also concluded to increase the weight of the sinker some 20 lb. . . . .

"It will be seen, by an inspection of the track chart of sounding, that the moment the second line diverges from the coast of Niphon and enters the edge of the Japan

stream, but yet runs parallel to the island of Yesso, the water begins to deepen rapidly, and at the cast No. 24, or the third cast from the initial point of curve, a depth of 3,493 fathoms is found. Forty and eighty miles further on depths of 3,587 fathoms and 3,307 fathoms are reached; then the ocean bed or trough of the stream drops nearly a statute mile in the run to the next position, where the sinker is not detached until it has descended to the extraordinary depth of 4,340 fathoms.

"A good specimen of bottom soil was brought up from that great depth, and the Miller's Casella thermometer, No. 18,136, came up a perfect wreck. . . . .

"The next six casts were made in over 4,000 fathoms water, the last two revealing depths of 4,411 fathoms and 4,655 fathoms respectively, and on both occasions the wire was lost. . . . .

"Sometimes the wire comes in much easier than at others, and cast No. 31, made in 4,120 fathoms, occupied only 1h. 47m. 42s.

"The difference must be due to the varying action of the undercurrents upon the rod, specimen cup, and small lead, increasing or diminishing the resistance in hauling in, according to the extent of curve from the perpendicular. . . . .

"The conditions under which all these deep casts were made were eminently favourable. Believing that such deep water would be impracticable for cable purposes, I resolved to run inshore and sound back along the coast of the Kurile Islands to the position of cast No. 22, then to return and skirt those islands and the coast of Kamschatka as far as Cape Chipounsky, then passing over to the Alutian group. . . . .

"If the time on the great circle route for the proposed cable has failed, at least for the present, the results of these soundings will be of interest and value to hydrographic science, as establishing the fact of depths in the sea hardly to be expected, in view of the numerous soundings made by her Majesty's steamship *Challenger* and this ship, over wide expanses of the Atlantic, Pacific, and Indian Oceans, and confirming the existence of a very deep trough under the Japan stream, similar to that cut by the Gulf Stream on our own coast. . . . .

"As we passed by Sturup, of the Kurile group, dense volumes of smoke were seen rising out of a crater on the east end of the island."

PROCEEDINGS OF THE FRENCH ASSOCIATION

ON Sunday the 23rd there was an excursion to Boulogne, to visit the steel-pen factory established by the Blanzy Company, and the Laboratory of Zoology, which Prof. Giard of Lille has organised by the seaside. On Monday many members paid a visit to Turcoing and Roubaix, two large manufacturing places in the vicinity of Lille, where the visitors were received with much courtesy; every workshop was eagerly thrown open for inspection.

At a general session held in the evening, M. Ménier, the large chocolate manufacturer who has realised an immense fortune in his trade, delivered a very appropriate lecture on the creation of wealth by science. No one has had so much practical experience on that subject in the society. M. Alglave, formerly a professor in the Academy of Douai, gave an impressive address on coal-mining in Northern France. It was the first time that M. Alglave, who is very popular in Northern France, was allowed to deliver an address since he got into difficulties with the Government. His address created quite a sensation in the city.

On Tuesday there was a general excursion to Anzin coal-mines. A splendid luncheon was given to the visitors by the Anzin Company, in a large storehouse tastefully ornamented for the occasion with national flags and a trophy of all implements used by miners in their underground industry. M. Marsilly, the general director, proposed "The Visitors," in the name of the Council of Administration. M. Wurtz, in return, proposed "The Council and the illustrious President," whom he did not name, but who is no less a person than M. Thiers, at the mention of whose name enthusiastic cheers broke forth, interrupting M. Wurtz for more than five minutes. M. de Marsilly delivered a very long and able address, summarising all that the mining industry owed to science, and giving a few curious figures relating to his Company. It is 137 years old, and was the first French firm to import steam-engines from England. The number of hands is 15,000, and persons depending upon them 60,000. They are now constructing steam-engines, of 500 horse-power, for underground work. The society visited the Haveley pit, one of the forty belonging to the Company, whose concession covers about 100,000 acres, and is said to be worth more than 8,000,000 sterling. On the same evening M. Gaston Tissander delivered an address on aërostation specially considered as to its meteorological uses. The lecture was illustrated by diagrams showing forms of clouds, optical phenomena connected with aërostation, &c.

On Wednesday all the Sections were busy discussing the several communications, and held two sessions. M. Bergeron gave a most interesting address in the Engineering Department, on the boring of the tunnel between France and England He said, upon authority, that the French Government had sent to Lord Derby a note asking him if he objected to the granting of the exclusive right for a number of years to a private Company. If the English Government does not raise any objection, the bill will be laid before the Versailles Assembly at the end of the present parliamentary holidays. Special provisions will be made for inundating the tunnel in case of war breaking out between the two countries. The holders of the concession can renounce their rights after spending 80,000*l*. in boring a gallery of exploration at least 1,100 ft. under the sea from low-water mark. The works are to begin on the French side as soon as the concession wilt have been granted. MM. Léon Say, Rothschild, André, &c. are amongst the petitioners.

There was a very sharp discussion in the Anthropological Section on some theological points which had been raised.

In the evening Col. Laussedat delivered a lecture on optical military telegraphy. Almost all the officers of the garrison were present at the lecture, which was practically illustrated by various experiments.

In the morning of Thursday the business of the Sections was transacted as on the previous day, and at one o'clock a general meeting was held in the Hôtel de Ville under the presidency of M. Wurtz. Some modifications of the by-laws and regulations of the society were unanimously adopted, and the committee was instructed to ask from the Government a decree declaring the society of public utility. This is a step necessary, according to the French laws, to give societies the right of holding properties, accepting legacies, and obtaining parliamentary grants.

M. Wurtz had directed a message to the British Association asking them to send a delegation to take part in the Lille meeting. This could not be accomplished, owing to the distance, but it ended in an exchange of telegraphic courtesies between the two societies.

The British Association being our model, it is necessary for us to study its workings, in order to adapt them as far as we can to our French circumstances and scientific peculiarities. Consequently, the committee was instructed not to name the opening day for the 1875 meeting before ascertaining whether it shall not coincide with the opening of the next session of the British Association.

Two cities were in competition for the 1875 meeting—Clermont Ferrand, where the Puy de Dome Observatory

will be inaugurated next year; and Nantes. It was generally supposed that Clermont Ferrand would be selected, but Nantes had sent a special delegate with the power of offering the grant of a large sum of money. Clermont Ferrand is poor and has drained its exchequer in helping M. Alluard in his admirable work; consequently Nantes was all but unanimously selected. The president for the Nantes meeting (1875) will be M. d'Eichtal, a gentleman of great fortune and influence, largely connected with the railway interest, and possessed of high scientific qualifications, having been educated at the Polytechnic School. The assembly appointed M. Faye, the astronomer, to be president of the 1876 meeting, but the town where it is to be held has not been decided on. The meeting was brought to a close by a banquet given at the Hôtel de Ville, by the Mayor of the city.

The number of the members of the Association is 800; it is an excess of 200 on the number of the Lyons meeting. The ladies are very few. Madame Thureau de Villeneuve, the wife of the secretary of the Société de Navigation Ardenne, was the only lady who delivered an address. This was in the section of Geography.

The Paris papers have published very short articles on the proceedings of the Association; none have shown so much interest as the *Times*, who sent a special reporter and published long telegrams on the work of the Sections.

Lille, August 29 W. DE FONVIELLE

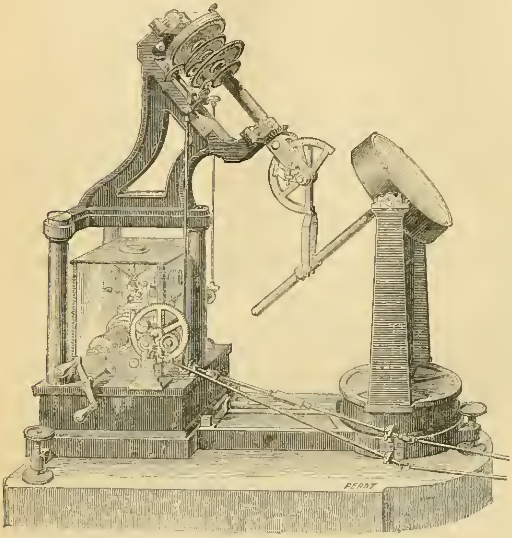


FIG. 1.—The Siderostat.

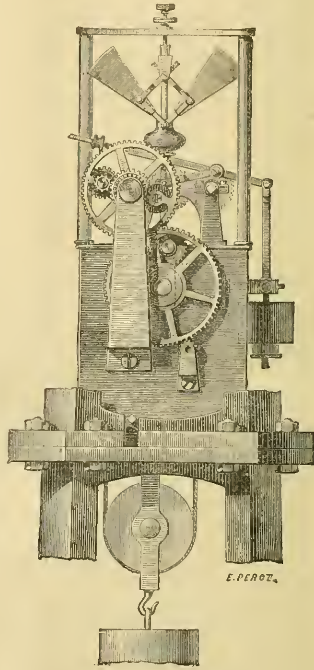


FIG. 2.—Clockwork movement, with isochronous regulator

*THE SIDEROSTAT**

THERE is in use at the present moment in the Paris Observatory an instrument of a new construction, which is destined to play a large part in the Astronomy of the future. It is not too much to say that the new instrument will play as important a part in, and will be as essential to the new Astronomy, as the transit instrument plays in the Astronomy of position.

For this instrument in its present form we are indebted to the genius of Foucault, who also gave it its name, the Siderostat.

The use of the present instruments obliges the astronomer to change his position to follow the eye-piece, and consequently to observe frequently in uncomfortable positions. To escape this inconvenience the Germans have long employed the bent telescope, meridian circles and theodolites. But the use of this arrangement is limited to small instruments, while it is precisely in the case of the largest instruments that it would be most useful.

Foucault, who died in the midst of his most important labours, wished in the latter years of his life to give to the equatorial the power of making the entire heavens pass before the observer without his having to disturb himself or to displace the instrument. A telescope fixed horizontally in an invariable position, before which a plane mirror brings successively the various points of the sky—such was the Siderostat in his mind, the idea in all probability having occurred to him from a singular employment of the heliostat by M. Laussedat in observations of the eclipse of 1860. (See Fig. 1.)

The instrument was constructed after the death of its inventor, by M. Eichens, under the direction of the Commission charged with the carrying out and the publica-

* In part translated from an article by M. A. Fraissenet, in *La Nature*. For the woodcuts we are indebted to the kindness of M. Gauthier-Villars.

tion of the works of Foucault, and at the expense of the Imperial treasury. It was presented to the Academy of Sciences on December 13, 1869, then given by Napoleon III. to the Observatory, where it has been installed since 1872.

The instrument, as designed by Foucault, of which M. Wolf has published a complete and detailed account, rests on a brass stand supported by three screws, with two levels placed crossways, and a regulating azimuth movement. There are three distinct parts—the mirror and its mounting, the polar axis and the mechanism which connects this axis with the mirror, and lastly the regulator.

The plane mirror, 30 centimetres in diameter, was constructed by M. Ad. Martin, according to the method devised by Foucault; it is carried by a horizontal axis on the top of two vertical supports, which turn round a centre. This movement is perfectly effected by means of a circle of small wheels placed at the foot of the supports. The mirror is kept in its mounting by means of cleats and spiral springs, in order to avoid all irregularity of surface. In the centre of the mounting is fixed perpendicularly a directing handle, which slides through a ring carried by a fork jointed to the lower extremity of the horary axis. The direction of the incident ray being that of the axis of the fork, and the length of this fork being equal to the distance of its point of articulation from the horizontal axis of the mirror, the line which measures that distance gives the constant direction of the reflected ray.

Finally, a clockwork movement, the isochronous regulator of Foucault (Fig. 2), placed at the foot of the instrument, communicates to the mirror a motion sensibly equal to the diurnal motion, so that the celestial bodies maintain invariable positions in the field of a horizontal telescope, in front of the apparatus directed towards the mirror.

The entire apparatus, the principle of which is the same as that of the heliostat, rests on a triangular support; a hole on the north side receives the weight which drives the clock. A wooden cabin, moving on wheels from north to south, forms a shelter for the instrument. For the purpose of observation the siderostat is completely exposed by rolling the hut towards the north. The telescope, supported on two pillars, is placed in a brick hut, some little distance from the siderostat; this hut is very slightly elevated for the purpose of intercepting the least possible portion of the southern sky. A telescope with a mirror of silvered glass, pierced in the centre to receive the eye-glass, is the one at present employed.

If it is desired to bring into the telescope the light proceeding from a star whose polar distance and right ascension are known, this is done by two circles, which correspond, the one to the polar distance and the other to the horary angle for the moment of observation in the usual way. Then, the circles being fixed, the clockwork is put in motion and the mirror throws continuously into the telescope the rays proceeding from the star under observation. The clock movement, already applied to some great equatorials, is perfectly regular, and obtained for its clever maker, M. Eichens, the grand prize in the mechanical arts at the Universal Exhibition of 1867.

It was necessary to possess, for the siderostat, some means of adjustment so as to be able to vary in very small quantities the horary angle or the polar distance without stopping the movement. The former variation is obtained by means of a subsidiary wheelwork which has already been long in use. But the variation of the polar distance was more difficult to accomplish; M. Eichens, however, has solved the difficulty after a very ingenious fashion.

The siderostat, since its construction, has been almost exclusively employed for photographic experiments in connection with the approaching transit of Venus. Consequently we do not yet know what results we have a right to look for. But in the ideal of Foucault, the instrument ought to be an indispensable auxiliary of physical astronomy; this is its proper purpose. Experiments which demand perfect steadiness will be advantageously made, such as the measure of the positions of spectrum lines and of the displacement of these lines by means of fixed spectroscopes of large dimensions. It is easy to conceive, besides, the numerous advantages resulting from the fixed direction of reflected rays. We may henceforth adapt, with the greatest ease, to the observing telescope, the apparatus necessary for the work of celestial photography for photometric researches.

The complete instrument, telescope and siderostat, placed in the plane of the meridian, may be regarded as a meridian instrument; and the determination of the right ascensions and polar distances of known stars will enable us to rectify the adjustment already made of the relation between the telescope and the siderostat. The purpose is evidently thus not to obtain a transit instrument, but only to get an approximation equal to that of equatorial observations. It is, besides, always in our power to increase the precision by comparing the star under observation with a well-known neighbouring star.

Observations by means of the siderostat may be made in two ways—with the mirror fixed, or turning under the action of the clockwork. In the former case, the instrument becomes to some extent an equatorial, but with the advantage to the observer that he has not to change his position. An inconvenience appears here; each time that the mirror is moved the direction of the apparent movement changes, and consequently it becomes necessary to make a new adjustment of the micrometer threads.

This inconvenience is more serious if, when the mirror is in motion, it is desired to effect measurements of double stars. In this case the direction of the diurnal motion changes the angles of position. It is then necessary to measure the angles of position by starting with the vertical and the horizontal, and, by means of the hour of observation, reducing them to the ordinary form.

The real defect of the siderostat, which, however, it has in common with all other instruments of observation, is that it does not enable us to examine the entire heavens. But the most interesting region for research is comprised between the pole and the southern horizon, and the siderostat which we have described permits observations between these limits. Should it be desired to investigate the rest of the sky, a second siderostat would be necessary, reflecting the rays towards the north.

Let us not, in conclusion, forget that the reflection from the mirror of the instrument causes a slight loss of light; the proportion of light reflected is constant and equal to 93·100 of the incident light for new silver.

From this description it is clear that it is only from the standpoint of physical astronomy that the employment of the instrument will be most useful; and no doubt, in this direction, it will give numerous and important results. The problems of the universe offer, indeed, a productive and inexhaustible mine, and the new astronomy, with its powerful means of investigation, gives us reason to hope that future researches will bring to light some brilliant discoveries.

NOTES

THE *Western Morning News* has received from its correspondent on board the *Challenger* an account of the voyage to New Zealand, which has been stormy and protracted. The result of the soundings has been most satisfactory, and it is confidently expected that New Zealand will be telegraphically connected with Europe next summer. The bottom was sand and mud, gradually shelving to a depth of 2,600 fathoms, at which it remained very evenly for a long distance, the temperature at this depth being 33 degrees and at the surface 64 degrees. At this point the

soundings commenced getting less, and the next was found to be 1,975 fathoms (temperature 36 degrees). Two days after this 1,100 fathoms was recorded, the temperature rising to 36 degrees. These indications of shallow water were not without cause, for on the second day they came unexpectedly into 400, 350, and at last only 275 fathoms. This was about 200 miles from land. The future movements of the *Challenger* have now been arranged, and are thus stated :—At Wellington we remain till July 6, then proceed along the east coast, probably calling at Auckland for a few days, after which a course will be shaped to Tongataboo (Friendly Islands), and from thence to Kandsvan (Fiji Islands), where a supply of coal will be taken on board prior to leaving for New Guinea. Here a complete series of explorations and soundings will be made, and it is expected that the dredge and trawl will bring even greater wonders of marine life to the surface than have yet been secured, while the question of coral reefs and their history will have special attention. After cruising about Polynesia generally for some time, we expect to reach Hong Kong early in November, where probably a month will be spent in coaling, provisioning, refitting, &c.

THE last number of Petermann's *Mittheilungen* contains a summary of the recent work done by the *Challenger* Expedition, which is accompanied by an excellent and ingeniously constructed series of coloured diagrams, showing the distribution of temperature in the North and South Atlantic, as well as the configuration of the bottom over which the *Challenger* has sailed. The number also contains the continuation of Prof. Hans Höfer's paper on the structure of Novaya Zemlya.

THE growth of tea and sugar in European soil are perhaps branches of culture which we can scarcely expect to be remunerative in a commercial point of view. Be this as it may, the sugar-cane is now grown and sugar manufactured to some extent in the neighbourhood of Malaga, Spain. Tea has also been introduced into the southern districts of Sicily, and though the first attempt made last year to raise the plants on a large scale was not successful, owing, it is said, to the injury caused to the plants and seeds by immersion in sea-water on their transit from Japan, it is confidently hoped and believed by the promoters that another attempt with healthy seeds and plants will prove quite successful. Meanwhile tea is being grown at the Cinchona plantations in Jamaica, and a sample has recently been received at the Kew Museum which was grown and manufactured as above from Assam tea plants received through Kew in 1868. So far as the appearance of the sample is concerned, it is roughly manipulated, not being sufficiently twisted or curled, and apparently not sufficiently roasted. Nevertheless, its manufacture is little inferior to that of the earliest samples of Assam tea that appeared in the English market. Its quality, however, is another thing, for it produces a very watery infusion of a very herby flavour, and devoid of the aroma for which tea is noted. Care, however, in the cultivation of the plant, as well as in the selection and manipulation of the leaves, may in time produce a more marketable article.

THE Ochro (*Abelmoschus esculentus*), a Malvaceous plant, is well known in all tropical countries, being cultivated for the sake of its fruits, which are gathered in a green state, and either boiled and eaten as a vegetable, pickled in vinegar like capers, or used for thickening soups on account of the mucilage they contain—a common property of the Malvaceæ. In India the seeds are sometimes boiled for making a mucilaginous drink. But we now learn that a fine oil has recently been discovered in them of a quality equal to olive oil, and that it is intended to introduce this oil to commerce. Supposing the oil to be all that is said about it, the question arises as to the supply of seeds. Though the plant is easily cultivated, can it compete with other oleaginous plants?

WE some time since noticed the formation, in connection with the French Geographical Society, of a Commission of Commercial Geography. Under the patronage of this Commission a joint stock company has been formed for the publication of a weekly journal to assist in carrying out the objects aimed at by the Commission. The title of the journal will be *L'Explorateur, Journal Géographique et Commercial.*

EXPERIMENTAL verifications are becoming daily more numerous in favour of the view that the phenomena attending the electrical stimulation of the brain are, in reality, dependent on the indirect excitation of the cerebral basal ganglionic centres by the currents employed. Besides the observations of Dr. Sanderson on this point, already published in this journal (NATURE, vol. x. p. 245), Dr. J. J. Putnam has recorded the results attending electrical stimulation of the so-called surface-centres after their almost complete separation from the rest of the hemisphere in the form of flaps. He finds that under these circumstances no movements follow the excitation; but that if the flap is raised and the surface below it irritated, a current slightly more powerful than the minimal required in the uninjured condition produces exactly similar results. The details of these experiments, taken from the *Boston Medical and Surgical Journal*, will be found in the *London Medical Record* for last week.

THERE has been issued from the Standards Department, by Mr. H. W. Chisholm, an account of the comparisons at that department between two Russian pendulums and Repsold's scale of 21 old French inches, and between Repsold's scale and the standard subdivided imperial yard.

THE French Geological Society has decided upon holding its next meeting at Mons, in Belgium, a most interesting place for excursions. It is very seldom that French Scientific Societies meet in a foreign land.

ON Friday evening M. Flammarion, the French astronomer, started from La Villette gas-works, Paris, in a balloon called *Lumen*, at half-past seven, with a brisk breeze from the north-west. The balloon was under the guidance of M. Jules Godard, and M. Flammarion, who was married in the beginning of August, was on board with his young wife; he wishes to spend his *lune de miel* in Italy. Such a trip was proposed in the beginning of the century to the celebrated Mdme. de Stael by the great philosopher, Saint-Simon; but the lady declined. The moon was full and bright.

THE use of carrier pigeons for press purposes is on the increase, and the breed is rapidly improving. By careful "selection" and allowing only the "survival of the fittest," powers have been developed which a few years ago would have been thought impossible. They can be specially trained to fly over 500 miles, and it is no uncommon thing for despatches to be brought to London from Paris, Lisbon, or Brussels. *Land and Water* records a case of interest. An ocean homing bird, of great docility, intelligence, and spirit, has been found in Iceland which flies at the meteor-like speed of 150 miles an hour. A pair of these birds whose present home is in Kent, within ten miles of London, recently carried despatches from Paris to their home in one hour and a quarter. Press pigeons carried on the despatches to London, and the whole journey of the despatches from Paris to London occupied only one hour and a half. The press pigeons now commonly used are not the ordinary carrier pigeons but are bred by Messrs. Hartley, of Woolwich, from prize birds selected from the best lofts of Antwerp, Brussels, and Liege.

AN alarming shock of earthquake was felt in the island of Porto Rico on the morning of Aug. 26, at 6.15 A.M. The

vibration lasted two minutes. No report of the extent of damage done has yet been received.

An eruption broke out in Mount Etna on Sunday evening last. The lava issued from the crater by three mouths, all of which, however, are happily some distance from human habitations.

The *Times of India* states that the report which M. Victor de Lesseps and Mr. C. Stuart will have to make on their return to Europe on the feasibility of the great Central Asian Railway scheme will be of a character to render it likely that preliminary funds will be subscribed to enable the first surveys to be effected with a view to definitely settle the route which it would be desirable to follow.

We have received from Mr. Stanford the Alpine Club Map of Switzerland, edited by Mr. R. C. Nichols, the preparation of which we noticed in vol. vi. p. 205. It is a very fine specimen of map making, and a credit to English cartography. We hope soon to notice it in detail.

If the observations recorded by Mr. F. M. Balfour at the recent meeting of the British Association, on the development of the notocord from the hypoblastic, instead of the mesoblastic layer of the embryo in the shark, are confirmed, they will shake to the foundation the importance of the elaborate arguments which have been, of late, so frequently based upon the origin of the different morphological elements of the living frame.

We are sure many of the recent visitors to Belfast must have found an invaluable aid in their wanderings about the town and district, which so abounds in varied interest, in the very excellent "Guide to Belfast and the Adjacent Counties" (Belfast, Ward and Co.), which has been brought out under the care of the members of the Belfast Naturalists' Field Club. Great prominence is of course given to the scientific aspects of the districts embraced in the Guide, but a fair portion is also devoted to the ordinary objects of interest, to trade, commerce, manufactures, &c. The Guide is well arranged under the various headings of Physical Geography, Geology, Botany, Zoology, Topography, &c., and is amply illustrated with forty-six roughly executed but very useful plates, mostly of objects of antiquarian interest. We heartily recommend the book to any visitor who wants an intelligent guide to the counties of Down and Antrim, a good map of which is appended.

The additions to the Zoological Society's Gardens during the past week include a Cassowary (*Casuarius?*) from N.E. New Guinea, presented by Capt. Maisby; a Javan Chevrotain (*Tragulus javanicus*) from Java, presented by Mr. G. Mannings; a Formosan Deer (*Cervus pseudaxis*) from the Island of Formosa, presented by Mr. Abel A. J. Gower; two Black Swans (*Cygnus atratus*) from Australia, presented by Mr. R. H. Bower; an Indian Python (*Python molurus*); a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mr. C. Hassam; two Black-eared Marmosets (*Hapale penicillata*) from Brazil, presented by Mr. J. P. Harrison.

THE BRITISH ASSOCIATION

The Belfast Session of the British Association was brought to a conclusion on Wednesday, the 26th ult., with mutual congratulations between all concerned. In our animadversions on the high charges for sleeping accommodation charged from some of the members of the Association, we of course meant in no way to reflect on the local authorities or local committee, who exerted themselves to the utmost to render the meeting in every way a success. The vote of thanks to the Mayor was thoroughly deserved, as was also the tribute of praise awarded by the Rev. Dr. Henry to the "unflagging zeal" of Dr. Andrews in behalf of this meeting of the Association. One very pleasing result of the meeting, and of a discussion in the Economical Section, was the sudden termination of the extensive strike which had existed in Belfast for a considerable time. The various excursions organised on Thursday were a decided success.

The next meeting opens at Belfast on August 25, 1875.

The Committee, among other things, have recommended, and their recommendation has been adopted, that the Council of the Association be requested to take such steps as they may think expedient to urge upon the Government of India the desirableness of continuing solar observations; that the Council of the Association be requested to take such steps as they may think desirable with the view of appointing naturalists to vessels engaged on coasts of little-known parts of the world; that they be requested to take such steps as they may think desirable to promote any application that may be made to her Majesty's Government by the Royal Society to promote physiological and biological explorations in the seas round the British Isles; that they be requested to take such steps as they think desirable for supporting a request to her Majesty's Government to undertake an Arctic expedition on the basis proposed by the Council of the Royal Geographical Society at the beginning of the present year, and which will be made again by that body.

The following is a synopsis of grants of money appropriated to scientific purposes by the General Committee at the Belfast Meeting:—

Mathematics and Physics.	
*Cayley, Prof.—Printing Mathematical Tables ...	£100
*Balfour Stewart, Prof.—Magnetisation of Iron	20
*Brooke, Mr.—British Rainfall	120
*Glaisher, Mr. J.—Luminous Meteors	30
Maxwell, Prof. C.—Testing the Exactness of Ohm's Law	50
Stokes, Prof.—Reflective Power of Silver and other Substances	20
*Herschel, Prof.—Thermal Conducting Powers of Rocks	10
*Tait, Prof.—Thermo-Electricity (renewed)	50
Chemistry.	
*Williamson, Prof. A. W.—Records of the Progress of Chemistry	100
Roscoe, Prof.—Specific Volumes of Liquids	25
Allen, Mr.—Estimation of Potash and Phosphoric Acid	10
*Armstrong, Dr.—Isomeric Cresols and their Derivatives (renewed)	20
Geology.	
*Willett, Mr. H.—The Sub-Wealden Exploration ..	100
*Lyell, Sir C., Bart.—Kent's Cavern Exploration ...	100
*Lubbock, Sir J.—Exploration of Victoria Cave, Settle...	50
*Bryce, Dr.—Earthquakes in Scotland (renewed) ...	20
Hull, Prof.—Underground Waters in New Red Sandstone and Permian	10
Biology.	
Dresser, Mr.—Report on Ornithology	10
Rolleston, Prof.—Development of Myxinoid Fishes ...	20
*Stainton, Mr.—Record of the Progress of Zoology ...	100
*Fox, Col. Lane.—Forms of Instruction for Travellers...	20
*Brunton, Dr.—The Nature of Intestinal Secretion ...	20
Geography.	
Wilson, Major.—Palestine Exploration Fund	100
Statistics and Economic Science.	
*Houghton, Lord.—Economic Effects of Trades' Unions	25
Mechanics.	
Froude, Mr.—Instruments for Measuring the Speed of Ships (renewed)	50
Total	£1,180

* Reappointed.

ON THE HYPOTHESIS THAT ANIMALS ARE AUTOMATA, AND ITS HISTORY*

AT this period of the meeting of the British Association I am quite sure it is hardly necessary for me to call to your minds the nature of the business which takes place at our sectional meetings. We there register the progress which science has made during the past year, and we do our best to advance that progress by original communications and free discussion. But when the honourable task of delivering this evening's lecture was imposed upon me, or rather as my friend the President has just said, when I undertook to deliver it, it occurred to me that the occasion of an evening lecture might be turned to a different purpose, that we might with much propriety and advantage turn our minds back to the past to consider what had been done by the great men of old, who "had gone down into the grave with their weapons of war," but who had fought bravely for the cause of truth while they yet lived—to recognise their merits, and to show ourselves duly grateful for their services. I propose, therefore, to take a retrospect of the condition of that branch of science with which it is my business to be more or less familiar—not to a very remote period, for I shall go no further back than the seventeenth century, and the observations which I shall have to offer you will be confined almost entirely to the biological science of the time between the middle of the seventeenth and the middle of the eighteenth centuries. I propose to show what great ideas in biological science took their origin at that time, in what manner the speculations then originated have been developed, and in what relation they stand to what is now understood to be the body of scientific biological truth. The middle of the sixteenth century, or rather the early part of it, is one of the great epochs of biological science. It was at that time that an idea, which had been dimly advocated previously, took the solid form which can only be given to scientific ideas by the definite observation of fact—I mean the idea that vital phenomena, like all other phenomena of the physical world, are capable of mechanical explanation, that they are reducible to law and order, and that the study of biology, in the long run, is an application of the great sciences of physics and chemistry. The man to whom we are indebted for first bringing that idea into a plain and tangible shape, I am proud to say, was an Englishman, William Harvey. Harvey was the first clearly to explain the mechanism of the circulation of the blood, and by that remarkable discovery of his, and by the clearness and precision with which he reduced that process to its mechanical elements, he laid the foundation of a scientific theory of the larger part of the processes of living beings—those processes, in fact, which we now call processes of sustentation—and by his studies of development he, further, first laid the foundation of a scientific knowledge of reproduction. But besides these great powers of living beings, there remains another class of functions—those of the nervous system—with which Harvey did not grapple. It was, indeed left for a contemporary of his, a man who, as he himself tells us, was mainly stimulated in these inquiries by the brilliant researches of Harvey—René Descartes—to play a part in relation to the phenomena of the nervous system, which, in my judgment, is equal in value to that which Harvey played in regard to the circulation. And when we consider who Descartes was, how brief the span of his life, I think it is a truly wonderful circumstance that this man, who died at fifty-four, should be one of the recognised leaders of philosophy—that, as I am informed by competent autnority, he was one of the first and most original mathematicians who has ever lived, and that, at the same time, the fertility of his intellect and the grasp of his genius should have been so great that he could take rank, as I believe he must, beside the immortal Harvey as a physiologist. And you must recollect that Descartes was not merely, as some had been, a happy speculator. He was a working anatomist and physiologist, conversant with all the anatomical and physiological lore of his time, and practised in all methods by which anatomical and physiological discoveries were then made; and it is related of him—and a most characteristic anecdote it is, and one which should ever put to silence those shallow talkers who speak of Descartes as a merely hypothetical and speculative philosopher—that a friend once calling upon him in Holland begged to be shown his library. Descartes led him into a sort of shed, and, drawing aside a curtain, displayed a dissecting-room full of bodies of animals in course of dissection, and said, "There is my library." It would take us a very long time if I were to attempt to pursue the method which would be requisite for the full establishment of all that I am about to say; that is to say, if I were to quote the several passages of Descartess works which bear out my ascription to him of the several propositions which I am going to bring before you. And I must beg you, therefore, to be so good as to take it on my authority for the present, although for the present only, that there are to be found clearly expressed in Descartes' works the propositions which I shall proceed to lay before you, and each of which I shall compare as we go on, as briefly as may be, with the existing state of physiological science, in order that you may see in what position with respect to physiology—ay, even to the advanced physiology of the present time—this man stood. And, happily, the matters with which we shall treat are such as to require no extensive knowledge of anatomy—no more, in fact, than such as, I presume, must be familiar to almost every person.

I think I need only premise that what we call the nervous system in one of the higher animals consists of a central apparatus, composed of the brain, which is lodged in the skull, and of a cord proceeding from it, which is termed the spinal marrow, and which is lodged in the vertebral column or spine, and that from these soft white masses—for such they are—there proceed cords which are termed nerves, some of which nerves end in the muscles, while others end in the organs of sensation. That bare and bald statement of the fundamental composition of the nervous system will be enough for our present purpose.

The first proposition culled from the works of Descartes which I have to lay before you, is one which will sound very familiar. It is the view, which he was the first, so far as I know, to state, not only definitely, but upon sufficient grounds, that the brain is the organ of sensation, of thought, and of emotion—using the word "organ" in this sense, that certain changes which take place in the matter of the brain are the essential antecedents of those states of consciousness which we term sensation, thought, and emotion. Nowadays that is part of popular and familiar knowledge. If your friend disagrees with your opinion, runs amuck against any of your pet prejudices, you say, "Ah! poor fellow, he is a little touched here;" by which you mean that his brain is not doing its business properly, and, therefore, that he is not thinking properly. But in Descartes' time, and I may say for 150 years afterwards, the best physiologists had not reached that point. It remained down to the time of Bichat a question whether the passions were or were not located in the abdominal viscera. This, therefore, was a very great step. It is a statement which Descartes makes from the beginning, and from which he never swerves. In the second place, Descartes lays down the proposition that all the movements of animal bodies are effected by the change of form of a certain part of the matter of their bodies, to which he applies the general term of muscle. You must be aware of this in reading Descartes; you must use the terms in the sense in which he used them, or you will not understand him. That is a proposition which is now placed beyond all doubt whatever. If I move my arm, that movement is due to the change of this mass of flesh in front called the biceps muscle: it is shortened and it becomes thicker. If I move any of my limbs the reason is the same. As I now speak to you, the different tones of my voice are due to the exquisitely accurate adjustment of the contractions of a multitude of such portions of flesh; and there is no considerable and visible movement of the animal body which is not, as Descartes says, resolvable into these changes in the form of matter termed muscle. But Descartes went further, and he stated that in the normal and ordinary condition of things, these changes in the form of muscle in the living body only occur under certain conditions; and the essential condition of the change is, says Descartes, the motion of the matter contained within the nerves, which go from the central apparatus to the muscle. Descartes gave this moving material a particular name—the animal spirits. Nowadays we should not talk of the existence of animal spirits, but we should say that a molecular change takes place in the nerve, and that that molecular change is propagated with a certain velocity, from the central apparatus to the muscle. Nevertheless, the modification of the idea is not greater than that which has taken place in our view of electricity, in our change of conception of it as a fluid to our conception of it as a condition of propagated molecular change. Modern physiology has measured the rate of the change to which I have referred; it has thrown marvellous light upon its nature; it has increased our knowledge of its characters, but the fundamental conception

* Address by Prof. Huxley, F.R.S., at the British Association, Belfast, Aug. 24.

remains exactly what it was in the time of Descartes. Next, Descartes says that, under ordinary circumstances, this change in the contents of a nerve, which gives rise to the contraction of a muscle, is produced by a change in the central nervous apparatus, as, for example, in the brain. We say at the present time exactly the same thing. Descartes said that the animal spirits were stored up in the brain, and flowed out along the motor nerves. We say that a molecular change takes place in the brain that is propagated along the motor nerve. The evidence of that is abundantly supplied by experimental research. Further, Descartes stated that the sensory organs, or those apparatuses which give rise to our feelings when acted upon by the influences which produce sensation, caused a change in the sensory nerves, which he described as a flow of animal spirits along those nerves, which flow was propagated to the brain. If I look at this candle which I hold before me, the light falling on the retina of my eye gives rise to an affection of the optic nerve, which affection Descartes described as a flow of the animal spirits to the brain. We should now speak of it as a molecular change propagated along the optic nerve to the brain; but the fundamental idea is the same. In all our notions of the operations of nerve we are building upon Descartes' foundation. Not only so, but Descartes lays down over and over again, in the most distinct manner, a proposition which is of paramount importance not only for physiology but for psychology. He says that when a body which is competent to produce a sensation touches the sensory organs, what happens is the production of a mode of motion of the sensory nerves. That mode of motion is propagated to the brain. That which takes place in the brain is still nothing but a mode of motion. But, in addition to this mode of motion, there is, as everybody can find by experiment for himself, something else which can in no way be compared to motion, which is utterly unlike it, and which is that state of consciousness which we call a sensation. Descartes insists over and over again upon this total disparity between the agent which excites the state of consciousness and the state of consciousness itself. He tells us that our sensations are not pictures of external things, but that they are symbols or signs of them; and in doing that he made one of the greatest possible revolutions, not only in physiology but in philosophy. Till his time it was conceived that visible bodies, for example, gave from themselves a kind of film which entered the eye and so went to the brain, *species intentionales* as they were called, and thus the mind received an actual copy or picture of things which were given off from it. It is to Descartes we owe that complete revolution in our ideas, which has led us to see that we have really no knowledge whatever of the causes of those phenomena which we term external things, and that the only certainty we possess is that they cannot be like those phenomena. In laying down that proposition upon what I imagine to be a perfectly irrefragable basis, Descartes laid the foundation of that form of philosophy which is termed idealism, which was subsequently expanded to its uttermost by Berkeley, and has since taken very various shapes.

But Descartes noticed not only that under certain conditions an impulse made by the sensory organ may give rise to a sensation, but that under certain other conditions it may give rise to motion, and that this motion may be effected without sensation, and not only without volition, but even contrary to it. I trouble you with as little reading as I can, because it occupies so much time; but I must ask your patience for one very remarkable passage which is contained in the answer that Descartes gave to the objections raised by the famous Port Royalist Arnauld to his Fourth Meditation. Descartes says: "It appears to me to be a very remarkable circumstance that no movement can take place either in the bodies of beasts or even in our own, if these bodies have not in themselves all the organs and instruments by means of which the very same movement would be accomplished in a machine, so that, even in us, the spirit or the soul does not directly move the limb, but only determines the course of that very subtle liquid which is called the animal spirits, which, running continually from the heart by the brain into the muscles, is the cause of all the movements of our limbs, and often may cause many different motions, one as easily as the other. And it does not even always exert this determination, for, among the movements which take place in us, there are many which do not depend upon the mind at all, such as the beating of the heart, the digestion of food, the nutrition, the respiration of those who sleep, and, even in those who are awake, walking, singing, and other similar actions when they are performed without the mind thinking about them. And when one who falls from a height throws his hands forward to save his head, it is in virtue of no ratiocination that he performs this action; it does not depend upon his mind, but takes place merely because his senses, being affected by the present danger, cause some change in his brain, which determines the animal spirits to pass thence into the nerves in such a manner as is required to produce this motion, in the same way as in a machine, and without the mind being able to hinder it." I know in no modern treatise of a more clear and precise statement, of a more perfect illustration than this of what we understand by the automatic action of the brain. And what is very remarkable, in speaking of these movements which arise by a sensation being as it were reflected from the central apparatus into a limb—as, for example, when one's finger is pricked and the arm is suddenly drawn up, the motion of the sensory nerve travels to the spine and is again reflected down to the muscles of the arm—Descartes uses the very phrase that we at this present time employ; he speaks of the "*esprits réfléchis*," the reflected spirits; and that this was no mere happy phrase lost upon his contemporaries will be obvious if you consult the famous work of Willis, the Oxford professor, "De Anima Brutorum," which was published about 1672. In giving an account of Descartes' views he borrows this very phrase from him, and speaks of this reflection of the motion of a sensory nerve into the motion of a motor nerve, "sicut undulatione reflexa," as if it were a wave thrown back; so that we have not only the thing reflex action described, but we have the phrase "reflex" recognised in its full significance.

And the last great service to the physiology of the nervous system which I have to mention as rendered by Descartes was this, that he first, so far as I know, sketched out a physical theory of memory. What he tells you in substance is this, that when a sensation takes place, the animal spirits travel up the sensory nerve, pass to the appropriate part of the brain, and there, as it were, find their way through the pores of the substance of the brain. And he says that when this has once taken place, when the particles of the brain have themselves been, as it were, shoved aside a little by a single passage of the animal spirits, the passage is made easier in the same direction for any subsequent flow of animal spirits; and that the repetition of this action makes it easier still, until, at length, it becomes very easy for the animal spirits to move these particular particles of the brain, the motion of which gives rise to the appropriate sensation; and, finally, the passage is so easy that almost any impulse which stirs the animal spirits causes them to flow into these already open pores more easily than they would flow in any other direction; and the flow of the animal spirits recalls the image, the state of consciousness called into existence by a former sensory impression. This view is essentially at one with all our present physical theories of memory. That memory is dependent upon a physical process stands beyond question. The results of the study of disease, the results of the action of poisonous substances, all conclusively point to the fact that memory is inseparably connected with the integrity of certain material parts of the brain and dependent upon them, and I know of no hypothesis by which this fact can be accounted for except by one which is essentially similar to the notion of Descartes, a notion that the impression once made makes subsequent impressions easier and therefore allows almost any indirect disturbance of the brain to call up this particular image.

So far, the ideas started by Descartes have simply been expanded, enlarged, and defined by modern research; they are the keystones of the modern physiology of the nervous system. But in one respect Descartes proceeded further than any of his contemporaries, and has been followed by very few of his successors in later days, although his views were for the best part of a century largely dominant over the intellectual mind of Europe. Descartes reasoned thus: "I can account for many of the actions of living beings mechanically, since reflex actions take place without the intervention of consciousness, and even in opposition to the will." As, for example, when a man in falling mechanically puts out his hand to save himself, or when a person, to use another of Descartes' illustrations, strikes at his friend's eye, and although the friend knows he does not mean to hit him, he nevertheless cannot prevent the muscles of his eye from winking. "In these cases," Descartes said, "I have clear evidence that the nervous system acts mechanically without the intervention of consciousness and without the intervention of the will, or, it may be, in opposition to it. Why, then, may I not extend this idea further? As actions of a certain amount of complexity are brought about in this way, why may not actions of still greater

complexity be so produced? Why, in fact, may it not be that the whole of man's physical actions are mechanical, his mind living apart, as it were, and only occasionally interfering by means of volition?" And it so happened that Descartes was led by some of his speculations to believe that beasts had no souls, and consequently could have no consciousness; and thus, his two ideas harmonising together, he developed that famous hypothesis of the automatism of brutes, which is the main subject of my present discourse. What Descartes meant by this was that animals are absolute machines, as if they were mills or barrel organs; that they have no feelings; that a dog does not see, and does not hear, and does not smell, but that the impressions which would produce those states of consciousness in ourselves, give rise in the dog, by a mechanical reflex process, to actions which correspond to those which we perform when we do smell, and do taste, and do see. On the face of it this appears to be a most surprising hypothesis, and I do not wonder that it proved to be a stumbling-block even to such acute and subtle men as Henry More, who was one of Descartes' correspondents; and yet it is a very singular thing that this, the boldest and most paradoxical notion which Descartes broached, has received as much and as strong support from modern physiological research as any other of his hypotheses. I will endeavour to explain to you in as few words as possible what is the nature of that support, and why it is that Descartes' hypothesis, although I am bound to say I do not agree with it, nevertheless, remains at this present time not only quite as defensible as it was in his own time, but I should say, upon the whole, a little more defensible.

If it should happen to a man that by accident his spinal cord is divided, he would become paralysed below the point of injury. In such case his limbs would be absolutely paralysed; he would have no control over them, and they would be devoid of sensation. You might prick his feet, or burn them, or do anything else you like with them, and they would be absolutely insensible. Consciousness, therefore, so far as we can have any knowledge of it, would be entirely abolished in that part of the central nervous apparatus which lies below the injury. But although the man under these circumstances is paralysed in the sense of not being able to move his own limbs, he is not paralysed in the sense of their being deprived of motion, for if you tickle the soles of his feet with a feather the limbs will be drawn up just as vigorously, perhaps a little more vigorously, than when he was in full possession of the consciousness of what happened to him. Now, that is a reflex action. The impression is transmitted from the skin to the spinal cord, it is reflected from the spinal cord, and passes down into the muscles of the limbs, and they are dragged up in this manner—dragged away from the sources of irritation, though the action, you will observe, is a purely automatic or mechanical action. Suppose we deal with a frog in the same way, and cut across the spinal cord. The frog falls into precisely the same condition. So far as the frog is concerned, his limbs are useless; but you have merely to apply the slightest irritation to the skin of the foot, and the limb is instantly drawn away. Now, if we have any ground for argument at all, we have a right to assume that, under these circumstances, the lower half of the frog's body is as devoid of consciousness as is the lower half of the man's body; and that the body of the frog below the injury is in this case absolutely devoid of consciousness, is a mere machine like a musical box or a barrel-organ, or a watch. You will remark, moreover, that the movement of the limbs is purposive—that is to say, that when you irritate the skin of the foot, the foot is drawn away from the danger, just as it would be if the frog were conscious and rational, and could act in accordance with rational consciousness. But you may say it is easy enough to understand how so simple an action might take place mechanically.

Let us consider another experiment. Take this creature, which certainly cannot feel, and touch the skin of the side of the body with a little acetic acid, a little vinegar, which in a frog that could feel would give rise to great pain. In this case there can be no pain, because the application is made below the point of section; nevertheless, the frog lifts up the limb of the same side, and applies the foot to rubbing off the acetic acid; and, what is still more remarkable, if you hold down the limb so that the frog cannot use it, he will, by and by, take the limb of the other side and turn it across the body, and use it for the same rubbing process. It is impossible that the frog, if it were in its entirety and were reasoning, could perform actions more purposive than these, and yet we have most complete assurance that in this case the frog is not acting from purpose, has no consciousness, is a mere automatic machine. But now suppose that instead of making your section of the cord in the middle of the body, you had made it in such a manner as to divide the hindermost part of the brain from the foremost part of the brain, and suppose the foremost two-thirds of the brain entirely taken away, the frog is then absolutely devoid of any spontaneity; it will remain for ever where you leave it; it will not stir unless it is touched; it sits upright in the condition in which a frog habitually does sit; but it differs from the frog which I have just described in this, that if you throw it into the water it begins to swim—swims just as well as the perfect frog does. Now, swimming, you know, requires the combination, and indeed the very careful and delicate combination, of a great number of muscular actions, and the only way we can account for this is, that the impression made upon the sensory nerves of the skin of the frog by the contact of the water, conveys to the central nervous apparatus a stimulus which sets going a certain machinery by which all the muscles of swimming are brought into play in due order and succession. Moreover, if the frog be stimulated, be touched by some irritating body, although we are quite certain it cannot feel, it jumps or walks as well as the complete frog can do. But it cannot do more than this.

Suppose yet one other experiment. Suppose that all that is taken away of the brain is what we call the cerebral hemispheres, the most anterior part of the brain. If that operation is properly performed, the frog may be kept in a state of full bodily vigour for months, or it may be for years; but it will sit for ever in the same spot. It sees nothing; it hears nothing. It will starve sooner than feed itself, although if food is put into its mouth it swallows it. On irritation it jumps or walks; if thrown into the water it swims. But the most remarkable thing that it does is this—you put it in the flat of your hand; it sits there, crouched, perfectly quiet, and would sit there for ever. Then if you incline your hand, doing it very gently and slowly, so that the frog would naturally tend to slip off, you feel the creature's fore-paws getting a little slowly on to the edge of your hand until he can just hold himself there, so that he does not fall; then, if you turn your hand, he mounts up with great care and deliberation, putting one leg in front and then another, until he balances himself with perfect precision upon the edge of your hand; then if you turn your hand over, he goes through the opposite set of operations until he comes to sit in perfect security upon the back of your hand. The doing of all this requires a delicacy of co-ordination, and an adjustment of the muscular apparatus of the body which is only comparable to that of a rope-dancer among ourselves; though in truth a frog is an animal very poorly constructed for rope-dancing, and on the whole we may give him rather more credit than we should to a human dancer. These movements are performed with the utmost steadiness and precision, and you may vary the position of your hand, and the frog, so long as you are reasonably slow in your movements, will work backwards and forwards like a clock. And what is still more wonderful is, that if you put the frog on a table, and put a book between him and the light, and give him a little jog behind, he will jump—take a long jump, very possibly—but he won't jump against the book; he will jump to the right or to the left, but he will get out of the way, showing that although he is absolutely insensible to ordinary impressions of light, there is still a something which passes through the sensory nerve, acts upon the machinery of his nervous system, and causes it to adapt itself to the proper action.

Can we go further than this? I need not say that since those days of commencing anatomical science when criminals were handed over to the doctors, we cannot make experiments on human beings, but sometimes they are made for us, and made in a very remarkable manner. That operation called war is a great series of physiological experiments, and sometimes it happens that these physiological experiments bear very remarkable fruit. I am indebted to my friend General Strachey for bringing to my notice an account of a case which appeared within the last four or five days in the scientific article of the *Journal des Débats*. A French soldier, a sergeant, was wounded at the battle of Bazeilles, one, as you recollect, of the most fiercely contested battles of the late war. The man was shot in the head, in the region of what we call the left parietal bone. The bullet fractured the bone. The sergeant had enough vigour left to send his bayonet through the Prussian who shot him. Then he wandered a few hundred yards out of the village, fell senseless, but, after the action, was picked up and taken to the hospital, where he remained some time. When he came to himself, as usual in such cases of injury, he was paralysed on the opposite side of the body, that is to say, the right arm and the right leg were completely paralysed. That state of

things lasted, I think, the better part of two years, but sooner or later he recovered from it, and now he is able to walk about with activity, and only by careful measurement can any difference between the two sides and his body be ascertained. The inquiry, the main results of which I shall give you, has been conducted by exceedingly competent persons, and they report that at present this man lives two lives, a normal life and an abnormal life. In his normal life he is perfectly well, cheerful, does his work as a hospital attendant, and is a respectable, well-conducted man. This normal life lasts for about seven-and-twenty days, or thereabouts, out of every month ; but for a day or two in each month he passes suddenly and without any obvious change into his abnormal condition. In this state of abnormal life he is still active, goes about as usual, and is to all appearance just the same man as before, goes to bed and undresses himself, gets up, makes his cigarette and smokes it, and eats and drinks. But he neither sees, nor hears, nor tastes, nor smells, nor is he conscious of anything whatever, and he has only one sense organ in a state of activity, namely, that of touch, which is exceedingly delicate. If you put an obstacle in his way, he knocks against it, feels it and goes to the one side ; if you push him in any direction, he goes straight on until something stops him. I have said that he makes his cigarettes, but you may supply him with shavings or of anything else instead of tobacco, and still he will go on making his cigarettes as usual. His actions are purely mechanical. He feeds voraciously, but whether you give him aloes or assafœtida, or the nicest thing possible, it is all the same to him. The man is in a condition absolutely parallel to that of the frog I have just described, and no doubt when he is in this condition the functions of his cerebral hemispheres are, at any rate, largely annihilated. He is very nearly —I don't say wholly, but very nearly—in the condition of an animal in which the cerebral hemispheres are extirpated. And his state is wonderfully interesting to me, for it bears on the phenomena of mesmerism, of which I saw a good deal when I was a young man. In this state he is capable of performing all sorts of actions on mere suggestion. For example, he dropped his cane, and a person near him putting it into his hand, the feeling of the end of the cane evidently produced in him those molecular changes of the brain which, had he possessed consciousness, would have given rise to the idea of his rifle ; for he threw himself on his face, began feeling for his cartridges, went through the motions of touching his gun, and shouted out to an imaginary comrade, "Here they are, a score of them ; but we will give a good account of them." But the most remarkable fact of all is the modification which this injury has made in the man's moral nature. In his normal life he is an upright and honest man. In his abnormal state he is an inveterate thief. He will steal everything he can lay his hands upon, and if he cannot steal anything else, he will steal his own things and hide them away.

Now, if Descartes had had this fact before him, need I tell you that his theory of animal automatism would have been enormously strengthened? He would have said: "Here is a case of a man performing actions more complicated, and to all appearance more dependent on reason, than any of the ordinary operations of animals, and yet you have positive proof that these actions are purely mechanical. What, then, have you to urge against my doctrine that all animals are mere machines?" In the words of Malebranche, who adopted Descartes' view, "In dogs, cats, and other animals, there is neither intelligence nor piritual soul as we understand the matter commonly ; they eat without pleasure, they cry out without pain, they grow without knowing it, they desire nothing, they know nothing, and .f they act with dexterity and in a manner which indicates intelligence, it is because God having made them with the intention of preserving them, He has constructed their bodies in such a manner that they escape organically, without knowing it, everything which could injure them and which they seem to fear." Descartes put forward this hypothesis, and I do not know that it can be positively refuted. We can have no direct observation of consciousness in any creature but ourselves. But I must say for myself—looking at the matter on the ground of analogy—taking into account that great doctrine of continuity which forbids one to suppose that any natural phenomena can come into existence suddenly and without some precedent, gradual modification tending towards it, and taking into account the incontrovertible fact that the lower vertebrated animals possess, in a less developed condition, that part of the brain which we have every reason to believe is the organ of consciousness in ourselves, it seems vastly more probable that the lower animals, although they may not possess that sort of consciousness which we have ourselves, yet have it in a form proportional to the comparative development of the organ of that consciousness, and foreshadow more or less dimly those feelings which we possess ourselves. I think that is the most rational conclusion that can be come to. It has this advantage, though this is a consideration which could not be urged in dealing with questions that are susceptible of demonstration, but which is well worthy of consideration in a case like the present, that it relieves us of the very terrible consequences of making any mistake on this subject. I must confess that, looking at the terrible struggle for existence which is everywhere going on in the animal world, and considering the frightful quantity of pain with which that process must be accompanied, if animals are sensitive, I should be glad if the probabilities were in favour of the view of Descartes. But, on the other hand, considering that if we were to regard animals as mere machines, we might indulge in unnecessary cruelties and in careless treatment of them, I must confess I think it much better to err on the right side, and not to concur with Descartes on this point.

But let me point out to you that although we may come to the conclusion that Descartes was wrong in supposing that animals are insensible machines, it does not in the slighest degree follow that they are not sensitive and conscious automata ; in fact, that is the view which is more or less clearly in the minds of every one of us. When we talk of the lower animals being provided with instinct, and not with reason, what we really mean is, tha although they are sensitive and although they are conscious, yet they act mechanically, and that their different states of consciousness, their sensations, their thoughts (if they have any), their volitions (if they have any), are the products and consequences of their mechanical arrangements. I must confess that this popular view is to my mind the only one which can be scientifically adopted. We are bound by everything we know of the operations of the nervous system to believe that when a certain molecular change is brought about in the central part of the nervous system, that change, in some way utterly unknown to us, causes that state of consciousness that we term a sensation. It is not to be doubted that those motions which give rise to sensation leave in the brain changes of its substance which answer to what Haller called "*vestigia rerum*," and to what that great thinker, David Hartley, termed "Vibratiuncules." The sensation which has passed away leaves behind molecules of the brain competent to its reproduction—"sensigenous molecules," so to speak—which constitute the physical foundation of memory. Other molecular changes give rise to conditions of pleasure and pain, and to the emotion which in ourselves we call volition. I have no doubt that is the relation between the physical processes of the animal and his mental processes. In this case it follows inevitably that these states of consciousness can have no sort of relation of causation to the motions of the muscles of the body. The volitions of animals will be simply states of emotion which precede their actions. To make clear what I mean, suppose I had a frog placed in my hand, and that I could make it, by turning my hand, perform this balancing movement. If the frog were a philosopher, he might reason thus :—"I feel myself uncomfortable and slipping, and, feeling myself uncomfortable, I put my legs out to save myself. Knowing that I shall tumble if I do not put them further, I put them further still, and my volition brings about all these beautiful adjustments which result in my sitting safely." But if the frog so reasoned, he would be entirely mistaken ; for the frog does the thing just as well when he has no reason, no sensation, no possibility of thought of any kind. The only conclusion, then, at which there seems any good ground for arriving is that animals are machines, but that they are conscious machines.

I might with propriety consider what I have now said as the conclusion of the observations which I have to offer concerning animal automatism. So far as I know, the problem which we have hitherto been discussing is an entirely open one. I do not know that there is any reason why any person, whatever his opinions may be, should be prevented, if he be so inclined, from accepting the doctrine which I have just now put before you. So far as we know, animals are conscious automata. That doctrine is perfectly consistent with any view that we may choose to take on the very curious speculation—Whether animals possess souls or not, and if they possess souls, whether those souls are immortal or not. The doctrine to which I have referred is not inconsistent with the perfectly strict and literal adherence to the Scripture text concerning "the beast that perisheth," nor, on the other hand, does it prevent anyone from entertaining the amiable con-

victions ascribed by Pope to his untutored savage, that when he passed to the realms of the blessed "his faithful dog should bear him company." In fact, all these accessory questions to which I have referred involve problems which cannot be discussed by physical science, inasmuch as they do not lie within the scope of physical science, but come into the province of that great mother of all science, Philosophy. Before any direct answer can be given upon any of these questions we must hear what Philosophy has to say for or against the views that may be held. I need hardly say—especially having detained you so long as I find I have done—that I do not propose to enter into that region of discussion, and I might, properly enough, finish what I have to say upon the subject—especially as I have reached its natural limits—if it were not that an experience, now, I am sorry to say, extending over a good many years, leads me to anticipate that what I have brought before you to-night is not likely to escape the fate which, upon many occasions within my recollection, has attended statements of scientific doctrine and of the conclusions towards which science is tending, which have been made in a spirit intended at any rate to be as calm and as judicial as that in which I have now laid these facts before you. I do not doubt that the fate which has befallen better men will befall me, and that I shall have to bear in patience the reiterated assertion that doctrines such as I have put before you have very evil tendencies. I should not wonder if you were to be told by persons speaking with authority—not, perhaps, with that authority which is based upon knowledge and wisdom, but still with authority—that my intention in bringing this subject before you is to lead you to apply the doctrine I have stated, to man as well as brutes, and it will then certainly be further asserted that the logical tendency of such a doctrine is Fatalism, Materialism, and Atheism. Now, let me ask you to listen to another product of that long experience to which I referred. Logical consequences are very important; but in the course of my experience I have found that they are the scarecrows of fools and the beacons of wise men. Logical consequences can take care of themselves. The only question for any man to ask is—"Is this doctrine true, or is it false?" No other question can possibly be taken into consideration until that one is settled. And, as I have said, the logical consequences of doctrines can only serve as a warning to wise men to ponder well whether the doctrine submitted for their consideration be true or not, and to test it in every possible direction. Undoubtedly I do hold that the view I have taken of the relations between the physical and mental faculties of brutes applies in its fulness and entirety to man; and if it were true that the logical consequences of that belief must land me in all these terrible consequences, I should not hesitate in allowing myself to be so landed. I should conceive that if I refused I should have done the greatest and most abominable violence to everything which is deepest in my moral nature. But now I beg leave to say that, in my conviction, there is no such logical connection as is pretended between the doctrine I accept and the consequences which people profess to draw from it. Some years ago I had occasion, in dealing with the philosophy of Descartes, and some other matters, to state my conviction pretty fully on those subjects, and, although I know from experience how futile it is to endeavour to escape from those nicknames which many people mistake for argument, yet, if those who care to investigate these questions in a spirit of candour and justice will look into those writings of mine, they will see my reasons for not imagining that such conclusions can be drawn from such premises. To those who do not look into these matters with candour and with a desire to know the truth, I have nothing whatever to say, except to warn them on their own behalf what they do; for assuredly if, for preaching such doctrine as I have preached to you to-night, I am cited before the bar of public opinion, I shall not stand there alone. On my one hand I shall have, among theologians, St. Augustine, John Calvin, and a man whose name should be well known to the Presbyterians of Ulster—Jonathan Edwards—unless, indeed, it be the fashion to neglect the study of the great masters of divinity, as many other great studies are neglected nowadays; and I should have upon my other hand, among philosophers, Leibnitz; I should have Père Malebranche, who saw all things in God; I should have David Hartley, the theologian as well as philosopher; I should have Charles Bonnet, the eminent naturalist, and one of the most zealous defenders Christianity has ever had. I think I should have, within easy reach, at any rate, John Locke. Certainly the school of Descartes would be there, if not their master; and I am inclined to think that, in due justice, a citation would have to be served upon Immanuel Kant himself. In such society it may be better to be a prisoner than a judge; but I would ask those who are likely to be influenced by the din and clamour which are raised about these questions, whether they are more likely to be right in assuming that those great men I have mentioned—the fathers of the Church and the fathers of Philosophy—knew what they were about; or that the pigmies who raise the din know better than they did what they meant. It is not necessary for any man to occupy himself with problems of this kind unless he so choose. Life is full enough, filled to the brim, by the performance of its ordinary duties; but let me warn you, let me beg you to believe, that if a man elect to give a judgment upon these great questions; still more, if he assume to himself the responsibility of attaching praise or blame to his fellow-men for the judgments which they may venture to express—then, unless he would commit a sin more grievous than most of the breaches of the Decalogue, he must avoid a lazy reliance upon the information that is gathered by prejudice and filtered through passion. Let him go to those great sources that are open to him as to every one, and to no man more open than to an Englishman; let him go back to the facts of nature, and to the thoughts of those wise men who for generations past have been the interpreters of nature.

THE CARNIVOROUS HABITS OF PLANTS*

I HAVE chosen for the subject of my address to you from the chair in which the Council of the British Association has done me the honour of placing me, the carnivorous habits of some of our brother-organisms—Plants.

Various observers have described with more or less accuracy the habits of such vegetable sportsmen as the Sundew, the Venus's Fly-trap, and the Pitcher-plants, but few have inquired into their motives; and the views of those who have most accurately appreciated these have not met with that general acceptance which they deserved.

Quite recently the subject has acquired a new interest, from the researches of Mr. Darwin into the phenomena which accompany the placing albuminous substances on the leaves of Drosera and Pinguicula, and which, in the opinion of a very eminent physiologist, prove, in the case of Dionæa, that this plant digests exactly the same substances and in exactly the same way that the human stomach does. With these researches Mr. Darwin is still actively engaged, and it has been with the view of rendering him such aid as my position and opportunities at Kew afforded me, that I have, under his instructions, examined some other carnivorous plants.

In the course of my inquiries I have been led to look into the early history of the whole subject, which I find to be so little known and so interesting that I have thought that a sketch of it, up to the date of Mr. Darwin's investigations, might prove acceptable to the members of this Association. In drawing it up, I have been obliged to limit myself to the most important plants; and with regard to such of these as Mr. Darwin has studied, I leave it to him to announce the discoveries which, with his usual frankness, he has communicated to me and to other friends; whilst with regard to those which I have myself studied, Sarracenia and Nepenthes, I shall briefly detail such of my observations and experiments as seem to be the most suggestive.

Dionæa.—About 1768 Ellis, a well-known English naturalist, sent to Linnæus a drawing of a plant, to which he gave the poetical name of Dionæa. "In the year 1765," he writes, "our late worthy friend, Mr. Peter Collinson, sent me a dried specimen of this curious plant, which he had received from Mr. John Bartram, of Philadelphia, botanist to the late King." Ellis flowered the plant in his chambers, having obtained living specimens from America. I will read the account which he gave of it to Linnæus, and which moved the great naturalist to declare that, though he had seen and examined no small number of plants, he had never met with so wonderful a phenomenon:—

"The plant, Ellis says, shows that Nature may have some views towards its nourishment, in forming the upper joint of its leaf like a machine to catch food; upon the middle of this lies the bait for the unhappy insect that becomes its prey. Many minute red glands that cover its surface, and which perhaps discharge sweet liquor, tempts the animal to taste them; and the instant these tender parts are irritated by its feet, the two lobes rise up, grasp it fast, lock the rows of spines together, and squeeze it to death. And further, lest the strong efforts for life in the creature just taken should serve to disengage it, three

* Address in the Department of Zoology and Botany, British Association, Belfast, August 21, by Dr. Hooker, C.B., D.C.L., Pres. R.S.

small erect spines are fixed near the middle of each lobe, among the glands, that effectually put an end to all its struggles. Nor do the lobes ever open again, while the dead animal continues there. But it is nevertheless certain that the plant cannot distinguish an animal from a vegetable or mineral substance; for if we introduce a straw or pin between the lobes, it will grasp it fully as fast as if it was an insect."

This account, which in its way is scarcely less horrible than the descriptions of those mediæval statues which opened to embrace and stab their victims, is substantially correct, but erroneous in some particulars. I prefer to trace out our knowledge of the facts in historical order, because it is extremely important to realise in so doing how much our appreciation of tolerably simple matters may be influenced by the prepossessions that occupy our mind.

We have a striking illustration of this in the statement published by Linnæus a few years afterwards. All the facts which I have detailed to you were in his possession; yet he was evidently unable to bring himself to believe that Nature intended the plant—to use Ellis's words—"to receive some nourishment from the animals it seizes;" and he accordingly declared, that as soon as the insects ceased to struggle, the leaf opened and let them go. He only saw in these wonderful actions an extreme case of sensitiveness in the leaves, which caused them to fold up when irritated, just as the sensitive plant does; and he consequently regarded the capture of the disturbing insect as something merely accidental and of no importance to the plant. He was, however, too sagacious to accept Ellis's sensational account of the *coup de grace* which the insects received from the three stiff hairs in the centre of each lobe of the leaf.

Linnæus's authority overbore criticism, if any were offered; and his statements about the behaviour of the leaves were faithfully copied from book to book.

Broussonet (in 1784) attempted to explain the contraction of the leaves by supposing that the captured insect pricked them, and so let out the fluid which previously kept them turgid and expanded.

Dr. Darwin (1761) was contented to suppose that the Dionæa surrounded itself with insect traps to prevent depredations upon its flowers.

Sixty years after Linnæus wrote, however, an able botanist, the Rev. Dr. Curtis (dead but a few years since) resided at Wilmington, in North Carolina, the head-quarters of this very local plant. In 1834 he published an account of it in the *Boston Journal of Natural History*, which is a model of accurate scientific observation. This is what he said:—"Each half of the leaf is a little concave on the inner side, where are placed three delicate hair-like organs, in such an order that an insect can hardly traverse it without interfering with one of them, when the two sides suddenly collapse and enclose the prey, with a force surpassing an insect's efforts to escape. The fringe of hairs on the opposite sides of a leaf interlace, like the fingers of two hands clasped together. The sensitiveness resides only in these hair-like processes on the inside, as the leaf may be touched or pressed in any other part without sensible effects. The little prisoner is not crushed and suddenly destroyed, as is sometimes supposed, for I have often liberated captive flies and spiders, which sped away as fast as fear or joy could carry them. At other times I have found them enveloped in a fluid of a mucilaginous consistence, which seems to act as a solvent, the insects being more or less consumed in it."

To Ellis belongs the credit of divining the purpose of the capture of insects by the Dionæa. But Curtis made out the details of the mechanism, by ascertaining the seat of the sensitiveness in the leaves; and he also pointed out that the secretion was not a lure exuded before the capture, but a true digestive fluid poured out, like our own gastric juice after the ingestion of food.

For another generation the history of this wonderful plant stood still; but in 1868 an American botanist, Mr. Canby, who is happily still engaged in botanical research—while staying in the Dionæa district, studied the habits of the plant pretty carefully, especially the points which Dr. Curtis had made out. His first idea was that "the leaf had the power of dissolving animal matter, which was then allowed to flow along the somewhat trough-like petiole to the root, thus furnishing the plant with highly nitrogenous food." By feeding the leaves with small pieces of beef, he found, however, that these were completely dissolved and absorbed; the leaf opening again with a dry surface, and ready for another meal, though with an appetite somewhat jaded. He found that cheese disagreed horribly with the leaves, turning them black, and finally killing them. Finally, he details the useless struggles of a Curculio to escape, as thoroughly establishing the fact that the fluid already mentioned is actually secreted, and is not the result of the decomposition of the substance which the leaf has seized. The Curculio being of a resolute nature, attempted to eat his way out,—"when discovered he was still alive, and had made a small hole through the side of the leaf, but was evidently becoming very weak. On opening the leaf, the fluid was found in considerable quantity around him, and was without doubt gradually overcoming him. The leaf being again allowed to close upon him, he soon died."

At the meeting of this Association last year, Dr. Burdon-Sanderson made a communication, which, from its remarkable character, was well worthy of the singular history of this plant; one by no means closed yet, but in which his observations will head a most interesting chapter.

It is a generalisation—now almost a household word—that all living things have a common bond of union in a substance—always present where life manifests itself—which underlies all their details of structure. This is called *protoplasm*. One of its most distinctive properties is its aptitude to contract; and when in any given organism the particles of protoplasm are so arranged that they act as it were in concert, they produce a cumulative effect which is very manifest in its results. Such a manifestation is found in the contraction of muscle; and such a manifestation we possibly have also in the contraction of the leaf of Dionæa.

The contraction of muscle is well known to be accompanied by certain electrical phenomena. When we place a fragment of muscle in connection with a delicate galvanometer, we find that between the outside surface and a cut surface there is a definite current, due to what is called the electromotive force of the muscle. Now, when the muscle is made to contract, this electromotive force momentarily disappears. The needle of the galvanometer, deflected before, swings back towards the point of rest; there is what is called a *negative variation*. All students of the vegetable side of organised nature were astonished to hear from Dr. Sanderson that certain experiments which, at the instigation of Mr. Darwin, he had made, proved to demonstration that when a leaf of Dionæa contracts, the effects produced are precisely similar to those which occur when muscle contracts.

Not merely, then, are the phenomena of digestion in this wonderful plant like those of animals, but the phenomena of contractility agree with those of animals also.

Drosera.—Not confined to a single district in the New World, but distributed over the temperate parts of both hemispheres, in sandy and marshy places, are the curious plants called Sundews—the species of the genus Drosera. They are now known to be near congeners of Dionæa, a fact which was little more than guessed at when the curious habits which I am about to describe were first discovered.

Within a year of each other, two persons—one an Englishman, the other a German—observed that the curious hairs which everyone notices on the leaf of Drosera were sensitive.

This is the account which Mr. Gardom, a Derbyshire botanist, gives of what his friend Mr. Whateley, "an eminent London surgeon," made out in 1780:—"On inspecting some of the contracted leaves we observed a small insect or fly very closely imprisoned therein, which occasioned some astonishment as to how it happened to get into so confined a situation. Afterwards, on Mr. Whateley's centrically pressing with a pin other leaves yet in their natural and expanded form, we observed a remarkably sudden and elastic spring of the leaves, so as to become inverted upwards, and, as it were, encircling the pin, which evidently showed the method by which the fly came into its embarrassing situation."

This must have been an account given from memory, and represents the movement of the hairs as much more rapid than it really is.

In July of the preceding year (though the account was not published till two years afterwards), Roth, in Germany, had remarked in *Drosera rotundifolia* and *longifolia*, "that many leaves were folded together from the point towards the base, and that all the hairs were bent like a bow, but that there was no apparent change on the leaf-stalk." Upon opening these leaves, he says, "I found in each a dead insect; hence I imagined that this plant, which has some resemblance to the *Dionæa muscipula*, might also have a similar moving power."

"With a pair of pliers I placed an ant upon the middle of the leaf of *D. rotundifolia*, but not so as to disturb the plant The ant endeavoured to escape, but was held fast by the clammy juice at the points of the hairs, which was drawn out by its feet

into fine threads. In some minutes the short hairs on the disc of the leaf began to bend, then the long hairs, and laid themselves upon the insect. After a while the leaf began to bend, and in some hours the end of the leaf was so bent inwards as to touch the base. The ant died in fifteen minutes, which was before all the hairs had bent themselves."

These facts, established nearly a century ago by the testimony of independent observers, have up to the present time been almost ignored; and Trecul, writing in 1855, boldly asserted that the facts were not true.

More recently, however, they have been repeatedly verified: in Germany by Nilschke, in 1860; in America by a lady, Mrs. Treat, of New Jersey, in 1871; in this country by Mr. Darwin, and also by Mr. A. W. Bennett.

To Mr. Darwin, who for some years past has had the subject under investigation, we are indebted, not merely for the complete confirmation of the facts attested by the earliest observers, but also for some additions to those facts which are extremely important. The whole investigation still awaits publication at his hands, but some of the points which were established have been announced by Professor Asa Gray in America, to whom Mr. Darwin had communicated them.

Mr. Darwin found that the hairs on the leaf of Drosera responded to a piece of muscle or other animal substance, while to any particle of inorganic matter they were nearly indifferent. To minute fragments of carbonate of ammonia they were more responsive.

I will now give the results of Mrs. Treat's experiments, in her own words:—

"Fifteen minutes past ten I placed bits of raw beef on some of the most vigorous leaves of *Drosera longifolia*. Ten minutes past twelve two of the leaves had folded around the beef, hiding it from sight. Half-past eleven on the same day, I placed living flies on the leaves of *D. longifolia*. At twelve o'clock and forty-eight minutes, one of the leaves had folded entirely round its victim, and the other leaves had partially folded, and the flies had ceased to struggle. By half-past two, four leaves had each folded around a fly. The leaf folds from the apex to the petiole, after the manner of its vernation. I tried mineral substances, bits of dried chalk, magnesia, and pebbles. In twenty-four hours neither the leaves nor the bristles had made any move in clasping these articles. I wetted a piece of chalk in water, and in less than an hour the bristles were curving about it, but soon unfolded again, leaving the chalk free on the blade of the leaf."

Time will not allow me to enter into further details with respect to Dionæa and Drosera. The repeated testimony of various observers spreads over a century, and though at no time warmly received, must, I think, satisfy you that in this small family of the Droseraceæ we have plants which in the first place capture animals for purposes of food, and in the second, digest and dissolve them by means of a fluid which is poured out for the purpose; and thirdly, absorb the solution of animal matter which is so produced.

Before the investigations of Mr. Darwin had led other persons to work at the subject, the meaning of these phenomena was very little appreciated. Only a few years ago, Duchartre, a French physiological botanist, after mentioning the views of Ellis and Curtis with respect to Dionæa, expressed his opinion that the idea that its leaves absorbed dissolved animal substances was too evidently in disagreement with our knowledge of the function of leaves and the whole course of vegetable nutrition to deserve being seriously discussed.

Perhaps if the Droseraceæ were an isolated case of a group of plants exhibiting propensities of this kind, there might be some reason for such a criticism. But I think I shall be able to show you that this is by no means the case. We have now reason to believe that there are many instances of these carnivorous habits in different parts of the vegetable kingdom, and among plants which have nothing else in common but this.

As another illustration I shall take the very curious group of Pitcher-plants which is peculiar to the New World. And here also I think we shall find it most convenient to follow the historical order in the facts.

Sarracenia.—The genus Sarracenia consists of eight species, all similar in habit, and all natives of the Eastern States of North America, where they are found more especially in bogs, and even in places covered with shallow water. Their leaves, which give them a character entirely their own, are pitcher-shaped or trumpet-like, and are collected in tufts springing immediately from the ground; and they send up at the flowering season one or more slender stems bearing each a solitary flower. This has a singular aspect, due to a great extent to the umbrella like expansion in which the style terminates; the shape of this, or perhaps of the whole flower, caused the first English settlers to give to the plant the name of Side-saddle Flower.

Sarracenia purpurea is the best known species. About ten years ago it enjoyed an evanescent notoriety from the fact that its rootstock was proposed as a remedy for small-pox. It is found from Newfoundland southward to Florida, and is fairly hardy under open-air cultivation in the British Isles. At the commencement of the seventeenth century, Clusius published a figure of it, from a sketch which found its way to Lisbon and thence to Paris. Thirty years later Johnson copied this in his edition of Gerard's Herbal, hoping "that some or other that travel into foreign parts may find this elegant plant, and know it by this small expression, and bring it home with them, so that we may come to a perfecter knowledge thereof." A few years afterwards this wish was gratified. John Tradescant the younger found the plant in Virginia, and succeeded in bringing it home alive to England. It was also sent to Paris from Quebec by Dr. Sarrazin, whose memory has been commemorated in the name of the genus, by Tournefort.

The first fact which was observed about the pitchers was, that when they grew they contained water. But the next fact which was recorded about them was curiously mythical. Perhaps Morrison, who is responsible for it, had no favourable opportunities of studying them, for he declares them to be, what is by no means really the case, intolerant of cultivation (*respuere culturam videntur*).

He speaks of the lid, which in all the species is tolerably rigidly fixed, as being furnished, by a special act of providence, with a hinge. This idea was adopted by Linnæus, and somewhat amplified by succeeding writers, who declared that in dry weather the lid closed over the mouth, and checked the loss of water by evaporation. Catesby, in his fine work on the Natural History of Carolina, supposed that these water-receptacles might "serve as an asylum or secure retreat for numerous insects, from frogs and other animals which feed on them;"—and others followed Linnæus in regarding the pitchers as reservoirs for birds and other animals, more especially in times of drought; "*præbet aquam sitientibus aviculis.*"

The superficial teleology of the last century was easily satisfied without looking far for explanations, but it is just worth while pausing for a moment to observe that, although Linnæus had no materials for making any real investigation as to the purpose of the pitchers of Sarracenias, he very sagaciously anticipated the modern views as to their affinities. They are now regarded as very near allies of water-lilies—precisely the position which Linnæus assigned to them in his fragmentary attempt at a true natural classification. And besides this, he also suggested the analogy, which, improbable as it may seem at first sight, has been worked out in detail by Baillon (in apparent ignorance of Linnæus' writings) between the leaves of Sarracenia and water-lilies.

Linnæus seems to have supposed that Sarracenia was originally aquatic in its habits, that it had Nymphæa-like leaves, and that when it took to a terrestrial life its leaves became hollowed out, to contain the water in which they could no longer float—in fact, he showed himself to be an evolutionist of the true Darwinian type.

Catesby's suggestion was a very infelicitous one. The insects which visit these plants may find in them a retreat, but it is one from which they never return. Linnæus' correspondent Collinson remarked in one of his letters, that "many poor insects lose their lives by being drowned in these cisterns of water;" but William Bartram, the son of the botanist, seems to have been the first to put on record, at the end of the last century, the fact that Sarracenias catch insects and put them to death in the wholesale way that they do.

Before stopping to consider how this is actually achieved, I will carry the history a little further.

In the two species in which the mouth is unprotected by the lid it could not be doubted that a part, at any rate, of the contained fluid was supplied by rain. But in *Sarracenia variolaris*, in which the lid closes over the mouth, so that rain cannot readily enter it, there is no doubt that a fluid is secreted at the bottom of the pitchers, which probably has a digestive function. William Bartram, in the preface to his travels in 1791, described this fluid, but he was mistaken in supposing that it acted as a lure. There is a sugary secretion which attracts insects, but

this is only found at the upper part of the tube. Bartram must be credited with the suggestion, which he, however, only put forward doubtfully, that the insects were dissolved in the fluid, and then became available for the alimentation of the plants.

Sir J. E. Smith, who published a figure and description of *Sarracenia variolaris*, noticed that it secreted fluid, but was content to suppose that it was merely the gaseous products of the decomposition of insects that subserved the processes of vegetation. In 1829, however, thirty years after Bartram's book, Burnett wrote a paper containing a good many original ideas expressed in a somewhat quaint fashion, in which he very strongly insisted on the existence of a true digestive process in the case of Sarracenia, analogous to that which takes place in the stomach of an animal.

Our knowledge of the habits of *Sarracenia variolaris* is now pretty complete, owing to the observations of two South Carolina physicians. One, Dr. M'Bride, made his observations half a century ago, but they had, till quite recently, completely fallen into oblivion. He devoted himself to the task of ascertaining why it was that *Sarracenia variolaris* was visited by flies, and how it was that it captured them. This is what he ascertained :—

"The cause which attracts flies is evidently a viscid substance resembling honey, secreted by or exuding from the internal surface of the tube. From the margin, where it commences, it does not extend lower than one-fourth of an inch. The falling of the insect as soon as it enters the tube is wholly attributable to the downward or inverted position of the hairs of the internal surface of the leaf. At the bottom of a tube split open, the hairs are plainly discernible, pointing downwards ; as the eye ranges upward they gradually become shorter and attenuated, till at or just below the surface covered by the bait they are no longer perceptible to the naked eye, nor to the most delicate touch. It is here that the fly cannot take a hold sufficiently strong to support itself, but falls."

Dr. Mellichamp, who is now resident in the district in which Dr. M'Bride made his observations, has added a good many particulars to our knowledge. He first investigated the fluid which is secreted at the bottom of the tubes. He satisfied himself that it was really secreted, and describes it as mucilaginous, but leaving in the mouth a peculiar astringency. He compared the action of this fluid with that of distilled water on pieces of fresh venison, and found that after fifteen hours the fluid had produced most change, and also most smell ; he therefore concluded that as the leaves when stuffed with insects become most disgusting in odour, we have to do, not with a true digestion, but with an accelerated decomposition. Although he did not attribute any true digestive power to the fluid secreted by the pitchers, he found that it had a remarkable anæsthetic effect upon flies immersed in it. He remarked that "a fly when thrown into water is very apt to escape, as the fluid seems to *run* from its wings," but it never escaped from the Sarracenia secretion. About half a minute after being thrown in, the fly became to all appearance dead, though, if removed, it gradually recovered in from half an hour to an hour.

According to Dr. Mellichamp, the sugary lure discovered by Dr. M'Bride, at the mouth of the pitchers, is not found on either the young ones of one season or the older ones of the previous year. He found, however, that about May it could be detected without difficulty, and more wonderful still, that there is a honey-baited pathway leading directly from the ground to the mouth, along the broad wing of the pitcher, up which insects are led to their destruction. From these narratives it is evident that there are two very different types of pitcher in Sarracenia, and an examination of the species shows that there may probably be three. These may be primarily classified into those with the mouth open and lid erect, and which consequently receive the rain-water in more or less abundance ; and those with the mouth closed by the lid, into which rain can hardly, if at all, find ingress.

To the first of these belongs the well-known *S. purpurea*, with inclined pitchers, and a lid so disposed as to direct all the rain that falls upon it also into the pitcher; also *S. flava*, *rubra*, and *Drummondii*, all with erect pitchers and vertical lids ; of these three, the lid in a young state arches over the mouth, and in an old state stands nearly erect, and has the sides so reflected that the rain which falls on its upper surface is guided down the outside of the back of the pitcher, as if to prevent the flooding of the latter.

To the second group belong *S. psittacina* and *S. variolaris*.

The tissues of the internal surfaces of the pitchers are singularly beautiful. They have been described in one species only, the *S. purpurea*, by August Vogl ; but from this all the other species which I have examined differ materially. Beginning from the upper part of the pitcher, there are four surfaces, characterised by different tissues, which I shall name and define as follows :—

1. An *attractive* surface, occupying the inner surface of the lid, which is covered with an epidermis, stomata, and (in common with the mouth of the pitcher) with minute honey-secreting glands ; it is further often more highly coloured than any other part of the pitcher, in order to attract insects to the honey.

2. A *conducting* surface, which is opaque, formed of glassy cells, which are produced into deflexed, short, conical, spinous processes. These processes, overlapping like the tiles of a house, form a surface down which an insect slips, and affords no foothold to an insect attempting to crawl up again.

3. A *glandular* surface (seen in *S. purpurea*), which occupies a considerable portion of the cavity of the pitcher below the conducting surface. It is formed of a layer of epidermis with sinuous cells, and is studded with glands ; and being smooth and polished, this too affords no foothold for escaping insects.

4. A *detentive* surface, which occupies the lower part of the pitcher, in some cases for nearly its whole length. It possesses no cuticle, and is studded with deflexed, rigid, glass-like, needle-formed, striated hairs, which further converge towards the axis of the diminishing cavity ; so that an insect, if once amongst them, is effectually detained, and its struggles have no other result than to wedge it lower and more firmly in the pitcher.

Now, it is a very curious thing that in *S. purpurea*, which has an open pitcher, so formed as to receive and retain a maximum of rain, no honey-secretion has hitherto been found, nor has any water been seen to be secreted in the pitcher ; it is, further, the only species in which (as stated above) I have found a special glandular surface, and in which no glands occur on the detentive surface. This concurrence of circumstances suggests the possibility of this plant either having no proper secretion of its own, or only giving it off after the pitcher has been filled with rain-water.

In *S. flava*, which has open-mouthed pitchers and no special glandular surface, I find glands in the upper portion of the detentive surface, among the hairs, but not in the middle or lower part of the same surface. It is proved that *S. flava* secretes fluid, but under what precise conditions I am not aware. I have found none but what may have been accidentally introduced in the few cultivated specimens which I have examined, either in the full-grown state, or in the half-grown when the lid arches over the pitcher. I find the honey in these as described by the American observers, and honey-secreting glands on the edge of the wing of the pitcher, together with similar glands on the outer surface of the pitcher, as seen by Vogl in *S. purpurea*.

Of the pitchers with closed mouths, I have examined those of *S. variolaris* only, whose tissues closely resemble those of *S. flava*. That it secretes a fluid noxious to insects there is no doubt, though in the specimens I examined I found none.

There is thus obviously much still to be learned with regard to Sarracenia, and I hope that American botanists will apply themselves to this task. It is not probable that three pitchers, so differently constructed as those of *S. flava*, *purpurea*, and *variolaris*, and presenting such differences in their tissues, should act similarly. The fact that insects normally decompose in the fluid of all, would suggest the probability that they all feed on the products of decomposition ; but as yet we are absolutely ignorant whether the glands within the pitchers are secretive, or absorptive, or both ; if secretive, whether they secrete water or a solvent ; and if absorptive, whether they absorb animal matter or the products of decomposition.

It is quite likely, that just as the saccharine exudation only makes its appearance during one particular period in the life of the pitcher, so the digestive functions may also be only of short duration. We should be prepared for this from the case of the Dionæa, the leaves of which cease after a time to be fit for absorption, and become less sensitive. It is quite certain that the insects which go on accumulating in the pitchers of Sarracenias must be far in excess of its needs for any legitimate process of digestion. They decompose ; and various insects, too wary to be entrapped themselves, seem habitually to drop their eggs into the open mouth of the pitchers, to take advantage of the accumulation of food. The old pitchers are consequently found to contain living larvæ and maggots, a sufficient proof that the original properties of the fluid which they secreted must have become exhausted ; and Barton tells us that various insectivorous

birds slit open the pitchers with their beaks to get at the contents. This was probably the origin of Linnæus' statement that the pitchers supplied birds with water.

The pitchers finally decay, and part, at any rate, of their contents must supply some nutriment to the plant by fertilising the ground in which it grows.

Darlingtonia.—I cannot take leave of Sarracenia without a short notice of its near ally, Darlingtonia, a still more wonderful plant, an outlier of Sarracenia in geographical distribution, being found at an elevation of 5,000 ft. on the Sierra Nevada of California, far west of any locality inhabited by Sarracenia. It has pitchers of two forms; one, peculiar to the infant state of the plant, consists of narrow, somewhat twisted, trumpet-shaped tubes, with very oblique open mouths, the dorsal lip of which is drawn out into a long, slender, arching, scarlet hood, that hardly closes the mouth. The slight twist in the tube causes these mouths to point in various directions, and they entrap very small insects only. Before arriving at a state of maturity the plant bears much larger, suberect pitchers, also twisted, with the lip produced into a large inflated hood, that completely arches over a very small entrance to the cavity of the pitcher. A singular orange-red, flabby, two-lobed organ hangs from the end of the hood, right in front of the entrance, which, as I was informed last week by letter from Prof. Asa Gray, is smeared with honey on its inner surface. These pitchers are crammed with large insects, especially moths, which decompose in them, and result in a putrid mass. I have no information of water being found in its pitchers in its native country, but have myself found a slight acid secretion in the young states of both forms of pitcher.

The tissues of the inner surfaces of the pitchers of both the young and the old plant I find to be very similar to those of *Sarracenia variolaris* and *flava*.

Looking at a flowering specimen of Darlingtonia, I was struck with a remarkable analogy between the arrangement and colouring of the parts of the leaf and of the flower. The petals are of the same colour as the flap of the pitcher, and between each pair of petals is a hole (formed by a notch in the opposed margins of each) leading to the stamens and stigma. Turning to the pitcher, the relation of its flap to its entrance is somewhat similar. Now, we know that coloured petals are specially attractive organs, and that the object of their colour is to bring insects to feed on the pollen or nectar, and in this case by means of the hole to fertilise the flower; and that the object of the flap and its sugar is also to attract insects, but with a very different result, cannot be doubted. It is hence conceivable that this marvellous plant lures insects to its flowers for one object, and feeds them while it uses them to fertilise itself, and that, this accomplished, some of its benefactors are thereafter lured to its pitchers for the sake of feeding itself!

But to return from mere conjecture to scientific earnest, I cannot dismiss Darlingtonia without pointing out to you what appears to me a most curious point in its history; which is, that the change from the slender, tubular, open-mouthed to the inflated closed-mouthed pitchers is, in all the specimens which I have examined, absolutely sudden in the individual plant. I find no pitchers in an intermediate stage of development. This, a matter of no little significance in itself, derives additional interest from the fact that the young pitchers to a certain degree represent those of the Sarracenias with open mouths and erect lids; and the old pitchers those of the Sarracenias with closed mouths and globose lids. The combination of representative characters in an outlying species of a small order cannot but be regarded as a marvellously significant fact in the view of those morphologists who hold the doctrine of evolution.

Nepenthes.—The genus Nepenthes consists of upwards of thirty species of climbing, half shrubby plants, natives of the hotter parts of the Asiatic Archipelago from Borneo to Ceylon, with a few outlying species in New Caledonia, in Tropical Australia, and in the Seychelle Islands on the African coast. Its pitchers are abundantly produced, especially during the younger state of the plants. They present very considerable modifications of form and external structure, and vary greatly in size, from little more than an inch to almost a foot in length; one species, indeed, which I have here from the mountains of Borneo, has pitchers which, including the lid, measure a foot and a half, and its capacious bowl is large enough to drown a small animal or bird.

The structure of the pitcher of Nepenthes is less complicated on the whole than that of Sarracenia, though some of its tissues are much more highly specialised. The pitcher itself is here not a transformed leaf, as in Sarracenia, nor is it a transformed leaf-blade, like that of Dionæa, but an appendage of the leaf developed at its tip, and answers to a water-secreting gland that may be seen terminating the mid-rib of the leaf of certain plants. It is furnished with a stalk, often a very long one, which in the case of pitchers formed on leaves high up the stem has (before the full development of the pitcher) the power of twisting like a tendril round neighbouring objects, and thus aiding the plant in climbing, often to a great height in the forest.

In most species the pitchers are of two forms, one appertaining to the young, the other to the old state of the plant, the transition from one form to the other being gradual. Those of the young state are shorter and more inflated; they have broad fringed longitudinal wings on the outside, which are probably guides to lead insects to the mouth; the lid is smaller and more open, and the whole interior surface is covered with secreting glands. Being formed near the root of the plant, these pitchers often rest on the ground, and in species which do not form leaves near the root they are sometimes suspended from stalks which may be fully a yard long, and which bring them to the ground. In the older state of the plant the pitchers are usually much longer, narrower, and less inflated, and are trumpet-shaped, or even conical; the wings also are narrower, less fringed, or almost absent. The lid is larger and slants over the mouth, and only the lower part of the pitcher is covered with secreting glands, the upper part presenting a tissue analogous to the conducting tissue of Sarracenia, but very different anatomically. The difference in structure of these two forms of pitcher, if considered in reference to their different positions on the plant, forces the conclusion on the mind that the one form is intended for ground game, the other for winged game. In all cases the mouth of the pitcher is furnished with a thickened corrugated rim, which serves three purposes: it strengthens the mouth and keeps it distended; it secretes honey (at least in all the species I have examined under cultivation, for I do not find that any other observer has noticed the secretion of honey by Nepenthes), and it is in various species developed into a funnel-shaped tube that descends into the pitcher and prevents the escape of insects, or into a row of incurved hooks that are in some cases strong enough to retain a small bird, should it, when in search of water or insects, thrust its body beyond a certain length into the pitcher.

In the interior of the pitcher of Nepenthes there are three principal surfaces: an *attractive*, *conductive*, and a *secretive* surface; the *detentive* surface of Sarracenia being represented by the fluid secretion, which is here invariably present at all stages of growth of the pitcher.

The attractive surfaces of Nepenthes are two: those, namely, of the rim of the pitcher, and of the under surface of the lid, which is provided in almost every species with honey-secreting glands, often in great abundance. These glands consist of spherical masses of cells, each embedded in a cavity of the tissue of the lid, and encircled by a guard-ring of glass-like cellular tissue. As in Sarracenia, the lid and mouth of the pitcher are more highly coloured than any other part, with the view of attracting insects to their honey. It is a singular fact that the only species known to me that wants these honey-glands on the lid is the *N. ampullaria*, whose lid, unlike that of the other species, is thrown back horizontally. The secretion of honey on a lid so placed would tend to lure insects away from the pitcher instead of into it.

From the mouth to a variable distance down the pitcher is an opaque glaucous surface, precisely resembling in colour and appearance the conductive surface of the Sarracenia, and, like it, affording no foothold to insects, but otherwise wholly different; it is formed of a fine network of cells, covered with a glass-like cuticle, and studded with minute reniform transverse excrescences.

The rest of the pitcher is entirely occupied with the secretive surface, which consist of a cellular floor crowded with spherical glands in inconceivable numbers. Each gland precisely resembles a honey-gland of the lid, and is contained in a pocket of the same nature, but semicircular, with the mouth downwards, so that the secretive fluid all falls to the bottom of the pitcher. In the *Nepenthes Rafflesiana* 3,000 of the glands occur on a square inch of the inner surface of the pitcher, and upwards of 1,000,000 in an ordinary sized pitcher. I have ascertained that, as was indeed to be expected, they secrete the fluid which is contained in the bottom of the pitcher before this opens, and that the fluid is always acid.

The fluid, though invariably present, occupies a comparatively small portion of the glandular surface of the pitcher, and is collected before the lid opens. When the fluid is emptied out of a

fully formed pitcher that has not received animal matter, it forms again, but in comparatively very small quantities; and the formation goes on for many days, and to some extent even after the pitcher has been removed from the plant. I do not find that placing inorganic substances in the fluid causes an increased secretion, but I have twice observed a considerable increase of fluid in pitchers after putting animal matter in the fluid.

To test the digestive powers of Nepenthes I have closely followed Mr. Darwin's treatment of Dionæa and Drosera, employing white of egg, raw meat, fibrine, and cartilage. In all cases the action is most evident, in some surprising. After twenty-four hours' immersion the edges of the cubes of white of egg are eaten away and the surfaces gelatinised. Fragments of meat are rapidly reduced; and pieces of fibrine weighing several grains dissolve and totally disappear in two or three days. With cartilage the action is most remarkable of all; lumps of this weighing 8 or 10 grains are half gelatinised in twenty-four hours, and in three days the whole mass is greatly diminished, and reduced to a clear transparent jelly. After drying some cartilage in the open air for a week, and placing it in an unopened but fully formed pitcher of *N. Rafflesiana*, it was acted upon similarly and very little slower.

That this process, which is comparable to digestion, is not wholly due to the fluid first secreted by the glands, appears to me most probable; for I find that very little action takes place in any of the substances placed in the fluid drawn from pitchers, and put in glass tubes; nor has any followed after six days' immersion of cartilage or fibrine in pitchers of *N. ampullaria* placed in a cold room; whilst on transferring the cartilage from the pitcher of *N. ampullaria* in the cold room to one of *Rafflesiana* in the stove, it was immediately acted upon. Comparing the action of fibrine, meat, and cartilage placed in tubes of Nepenthes fluid, with others in tubes of distilled water, I observed that their disintegration is three times more rapid in the fluid; but this disintegration is wholly different from that effected by immersion in the fluid of the pitcher of a living plant.

In the case of small portions of meat, $\frac{1}{2}$ to 2 grains, all seem to be absorbed; but with 8 to 10 grains of cartilage it is not so—a certain portion disappears, the rest remains as a transparent jelly, and finally becomes putrid, but not till after many days. Insects appear to be acted upon somewhat differently, for after several days' immersion of a large piece of cartilage I found that a good-sized cockroach, which had followed the cartilage and was drowned for his temerity, in two days became putrid. In removing the cockroach the cartilage remained inodorous for many days. In this case no doubt the antiseptic fluid had permeated the tissue of the cartilage, whilst enough did not remain to penetrate the chitinous hard covering of the insect, which consequently decomposed.

In the case of cartilage placed in fluid taken from the pitcher —it becomes putrid, but not so soon as if placed in distilled water.

From the above observations it would appear probable that a substance acting as pepsine is given off from the inner wall of the pitcher, but chiefly after placing animal matter in the acid fluid; but whether this active agent flows from the glands or from the cellular tissue in which they are imbedded, I have no evidence to show.

I have here not alluded to the action of these animal matters in the cells of the glands, which is, as has been observed by Mr. Darwin in Drosera, to bring about remarkable changes in their protoplasm, ending in their discoloration. Not only is there aggregation of the protoplasm in the gland-cells, but the walls of the cells themselves become discoloured, and the glandular surface of the pitcher that at first was of a uniform green, becomes covered with innumerable brown specks (which are the discoloured glands). After the function of the glands is exhausted, the fluid evaporates, and the pitcher slowly withers.

At this stage I am obliged to leave this interesting investigation. That Nepenthes possesses a true digestive process such as has been proved in the case of Drosera, Dionæa, and Pinguicula, cannot be doubted. This process, however, takes place in a fluid which deprives us of the power of following it further by direct observation. We cannot here witness the pouring out of the digestive fluid; we must assume its presence and nature from the behaviour of the animal matter placed in the fluid in the pitcher. From certain characters of the cellular tissues of the interior walls of the pitcher, I am disposed to think that it takes little part in the processes of either digestion or assimilation, and that these, as well as the pouring out of the acid fluid, are all functions of the glands.

In what I have said I have described the most striking instances of plants which seem to invert the order of nature, and to draw their nutriment—in part, at least—from the animal kingdom, which it is often held to be the function of the vegetable kingdom to sustain.

I might have added some additional cases to those I have already dwelt upon. Probably, too, there are others still unknown to science, or whose habits have not yet been detected. Delpino, for example, has suggested that a plant, first described by myself in the Botany of the Antarctic Voyage, *Caltha dionææfolia*, is so analogous in the structure of its leaves to Dionæa, that it is difficult to resist the conviction that its structure also is adapted for the capture of small insects.

But the problem that forces itself upon our attention is, How does it come to pass that these singular aberrations from the otherwise uniform order of vegetable nutrition make their appearance in remote parts of the vegetable kingdom? why are they not more frequent, and how were such extraordinary habits brought about or contracted? At first sight the perplexity is not diminished by considering—as we may do for a moment—the nature of ordinary vegetable nutrition. Vegetation, as we see it everywhere, is distinguished by its green colour, which we know depends on a peculiar substance called chlorophyll, a substance which has the singular property of attracting to itself the carbonic acid gas which is present in minute quantities in the atmosphere, of partly decomposing it, so far as to set free a portion of its oxygen, and of recombining it with the elements of water, to form those substances, such as starch, cellulose, and sugar, out of which the framework of the plant is constructed.

But, besides these processes, the roots take up certain matters from the soil. Nitrogen forms nearly four-fifths of the air we breathe, yet plants can possess themselves of none of it in the free uncombined state. They withdraw nitrates and salts of ammonia in minute quantities from the ground, and from these they build up with starch, or some analogous material, albuminoids or protein compounds, necessary for the sustentation and growth of protoplasm.

At first sight nothing can be more unlike this than a Dionæa or a Nepenthes capturing insects, pouring out a digestive fluid upon them, and absorbing the albuminoids of the animal, in a form probably directly capable of appropriation for their own nutrition. Yet there is something not altogether wanting in analogy in the case of the most regularly constituted plants. The seed of the castor-oil plant contains, besides the embryo seedling, a mass of cellular tissue or endosperm filled with highly nutritive substances. The seedling lies between masses of this, and is in contact with it; and as the warmth and moisture of germination set up changes which bring about the liquefaction of the contents of the endosperm and the embryo absorbs them, it grows in so doing, and at last, having taken up all it can from the exhausted endosperm, develops chlorophyll in its cotyledons under the influence of light, and relies on its own resources.

A large number of plants, then, in their young condition, borrow their nutritive compounds ready prepared; and this is in effect what carnivorous plants do later in life.

That this is not a merely fanciful way of regarding the relation of the embryo to the endosperm, is proved by the ingenious experiments of Van Tieghem, who has succeeded in substituting for the real, an artificial endosperm, consisting of appropriate nutritive matters. Except that the embryo has its food given to it in a manner which needs no digestion—a proper concession to its infantine state—the analogy here with the mature plants which feed on organic food seems to be complete.

But we are beginning also to recognise the fact that there are a large number of flowering plants that pass through their lives without ever doing a stroke of the work that green plants do. These have been called Saprophytes. Monotropra, the curious bird's nest orchis (*Neottia nidus-avis*), Epipogium, and Corallorhiza are instances of British plants which nourish themselves by absorbing the partially decomposed materials of other plants, in the shady or marshy places which they inhabit. They reconstitute these products of organic decomposition, and build them up once more into an organism. It is curious to notice, however, that the tissues of Neottia still contain chlorophyll in a nascent though useless state, and that if a plant of it be immersed in boiling water, the characteristic green colour reveals itself.

Epipogium and Corallorhiza have lost their proper absorbent organs; they are destitute of roots, and take in their food by the surfaces of their underground stem structures.

The absolute difference between plants which absorb and nourish themselves by the products of the decomposition of plant-structures, and those which make a similar use of animal structures, is not very great. We may imagine that plants accidentally permitted the accumulation of insects in some parts of their structure, and the practice became developed because it was found to be useful. It was long ago suggested that the receptacle formed by the connate leaves of Dipsacus might be an incipient organ of this kind; and though no insectivorous habit has ever been brought home to that plant, the theory is not improbable.

Linnæus, and more lately Baillon, have shown how a pitcher of Sarracenia may be regarded as a modification of a leaf of the Nymphæa type. We may imagine such a leaf first becoming hollow, and allowing *débris* of different kinds to accumulate; these would decompose, and a solution would be produced, some of the constituents of which would diffuse themselves into the subjacent plant tissues. This is in point of fact absorption, and we may suppose that in the first instance—as perhaps still in *Sarracenia purpurea*—the matter absorbed was merely the saline nutritive products of decomposition, such as ammoniacal salts. The act of digestion—that process by which soluble food is reduced without decomposition to a soluble form fitted for absorption—was doubtless subsequently acquired.

The secretion, however, of fluids by plants is not an unusual phenomenon. In many Aroids a small gland at the apex of the leaves secretes fluid, often in considerable quantities, and the pitcher of Nepenthes is, as I have shown elsewhere, only a gland of this kind, enormously developed. May not, therefore, the wonderful pitchers and carnivorous habit of Nepenthes have both originated by natural selection out of one such honey-secreting gland as we still find developed near that part of the pitcher which represents the tip of the leaf? We may suppose insects to have been entangled in the viscid secretion of such a gland, and to have perished there, being acted upon by those acid secretions that abound in these and most other plants. The subsequent differentiation of the secreting organs of the pitcher into aqueous, saccharine, and acid, would follow *pari passu* with the evolution of the pitcher itself, according to those mysterious laws which result in the correlation of organs and functions throughout the kingdom of Nature; and which, in my apprehension, transcend in wonder and interest those of evolution and the origin of species.

Delpino has recorded the fact that the spathe of Alocasia secretes an acid fluid which destroys the slugs that visit it, and which he believes subserves its fertilisation. Here any process of nutrition can only be purely secondary. But the fluids of plants are in the great majority of cases acid, and, when exuded, would be almost certain to bring about some solution in substances with which they came in contact. Thus the acid secretions of roots were found by Sachs to corrode polished marble surfaces with which they came in contact, and thus to favour the absorption of mineral matter.

The solution of albuminoid substances requires, however, besides a suitable acid, the presence of some other albuminoid substance analogous to pepsine. Such substances, however, are frequent in plants. Besides the well-known diastase, which converts the starch of malt into sugar, there are other instances in the synaptase which determines the formation of hydrocyanic acid from emulsine, and the myrosin which similarly induces the formation of oil of mustard. We need not wonder, then, if the fluid secreted by a plant should prove to possess the ingredien s necessary for the digestion of insoluble animal matters.

These remarks will, I hope, lead you to see, that though the processes of plant nutrition are in general extremely different from those of animal nutrition, and involve very simple compounds, yet that the protoplasm of plants is not absolutely prohibited from availing itself of food, such as that by which the protoplasm of animals is nourished; under which point of view these phenomena of carnivorous plants will find their place, as one more link in the continuity of nature.

BRITISH ASSOCIATION REPORTS

Report of the Committee on Mathematical Tables.

The objects for which the Committee were appointed at Edinburgh were twofold, viz., the preparation of a list of tables scattered about in books and mathematical journals and transactions, and the calculation of new tables. With regard to the first object, the tables were roughly divided into three classes, viz. (1) ordinary tables (such as trigonometrical and logarithmic) usually published in books; (2) tables of continuously varying quantities, generally definite integrals; and (3) theory of number of tables. On the first class Mr. J. W. L. Glaisher had already written a report, to which it was intended, after the lapse of several years, to add a supplement; with the second some progress had been made; while Prof. Cayley proposed to undertake the third. The Committee had to acknowledge the assistance of several foreigners, and chiefly of Prof. Bierens de Haan, who had forwarded to them an account of 128 logarithmic and 105 non-logarithmic tables; to Dr. Carl Ohrtmann, of Berlin; and Profs. W. W. Johnson and J. M. Rice, of Annapolis, Maryland. The principal achievement, however, which the Committee had to report related to the second object, and was the completion of the tables of the Elliptic Functions, the commencement of which was noticed in NATURE nearly two years ago, and on which six or seven computers, under the superintendence of Mr. J. Glaisher, F.R.S., and Mr. J. W. L. Glaisher, have since been constantly engaged. These tables (which are of double entry) give the four theta functions, which form the numerators and denominators of the three elliptic functions, and their logarithms for 8,100 arguments; so that they contain nearly 65,000 tabular results. The calculation has been carried to ten figures, but only eight will be printed, the tabular portion of the work occupying 360 pages. Parts of the introduction will be written by Prof. Cayley, Sir William Thomson, and Prof. H. J. S. Smith, and it is hoped that before the next meeting of the Association the whole work, which will form one of the largest tables that have appeared as the result of an original calculation, will be in print. It is perhaps desirable to state that the elliptic functions which have thus been tabulated are, as it were, generalised sines and cosines. Sines and cosines may be combined so as to represent any singly periodic function, as is well known; and in the same way elliptic functions represent every possible doubly periodic function; and no quantities can be of a higher degree of periodicity. The elliptic functions (which are in a sense inverse to Legendre's Elliptic Integrals) are thus quantities of the highest importance and generality in mathematics, and they are daily becoming of more importance in physics. They appear conspicuously in the investigation of the motion of a rigid body and in electrostatics, and have also numerous applications in the theory of numbers. The calculations were just completed before the meeting, and the printing will commence immediately: it is intended that the tables shall be stereotyped to ensure freedom from typographical errors.

Report of the Committee on the Nomenclature of Dynamical and Electrical Units.

They have circulated numerous copies of their last year's report among scientific men both at home and abroad. They believe, however, that in order to render their recommendations fully available for science teaching and scientific work, a full and popular exposition of the whole subject of physical units is necessary, together with a collection of examples (tabular and otherwise) illustrating the application of systematic units to a variety of physical measurements. Students usually find peculiar difficulty in questions relating to units; and even the experienced scientific calculator is glad to have before him concrete examples with which to compare his own results as a security against misapprehension or mistake.

Some members of the Committee have been preparing a small volume of Illustrations of the C. G. S. System (centimetre-gramme-second system) intended to meet this want. The Committee do not desire to be re-appointed; at all events at present.

On Siemens' Pyrometer, by Prof. G. C. Foster.

The committee appointed to report upon Siemens' pyrometer has sought to determine whether or no the resistance is altered after exposure to high temperatures. The resistance was measured by means of Wheatstone's Bridge. An arrangement was adopted whereby the heat of the connecting wires was prevented from affecting the measurements. As a long thick iron tube surrounded the platinum coil of the pyrometer, it was impossible, in order to secure a standard temperature, to plunge the instrument into ice-cold water, because, owing to the conductivity of the iron, there was no certainty that the pyrometer wire was actually at the same temperature as the water. The temperature of 10°, which was near the usual atmospheric temperature, was adopted as the standard.

Four instruments were examined: in one of them (1) the coil was surrounded by an iron sheath, in (2) and (3) a piece of stout platinum foil surrounded the cylinder between the iron sheath and the coil. In (4) there was no iron sheath, but a platinum

tube instead. Nos. (1) (2) and (3) were found to be considerably altered after having been exposed to a high temperature. The instruments were placed in an ordinary fire and repeatedly heated to a red heat, at which they were maintained for several hours. The original resistance was ten units. The following numbers show the increase of resistance :—

(1) 0·834 (2) 1·608 (3) 1·169

These numbers expressed as fractions of the original resistance become (1) ·0834 (2) ·1608 (3) ·1169.

Equivalent change of temperature = (1) 30°, (2) 58°, (3) 43°. These measurements show that the change in resistance produced by exposure to high temperatures is so great as to invalidate the usefulness of these instruments.

No. (4). Resistance increased ·046, which expressed as a portion of the original resistance = ·0046. Equivalent change of temperature = 1°·5 The last instrument therefore gives results which are sufficiently constant for industrial application if not for strictly scientific purposes.

Prof. Williamson suggested that the change in the resistance might be due to a change in the platinum, as it has been found that platinum in contact with silica, in a reducing atmosphere, is altered at high temperatures.

Report of the Committee appointed to prepare and print tables of Wave Numbers.

Mr. G. J. Stoney stated that the work of this Committee was in progress, and that the Committee hoped to be in a position to make a full report at the next meeting of the Association. Under these circumstances they merely asked to be reappointed.

Second Report on the Sub-Wealden Exploration. By H. Willett and W. Topley.

This Report gave an account of the progress of the work since the last meeting of the Association. Most of the results attained have been already made public through the Quarterly Reports, and they were recently summarised in these columns. At the time of the Bradford meeting only 300 feet had been reached, and the age of the beds then being traversed was unknown. Mr. Peyton and Prof. Phillips discovered Kimmeridge Clay fossils immediately after the Report was read ; since that time a large collection of fossils has been made, including most of the characteristic English Kimmeridge species, and some which are new. An undescribed species of *Modiola* is very abundant, and so is a small *Astarte*—the *A. Mysis* of D'Orbigny. A new species of this genus has been found, and a small *Trigonia* which Dr. Lycett believes to be also new.

The Kimmeridge Clay appears to be nearly 700 feet thick ; generally it is a rather sandy clay, but towards the base there are some thick bands of cement stone. The Coral Rag is apparently absent. Amongst the fossils from the Oxford Clay the following were noticed :—*Ammonites Jason*, *Am. Lamberti*, *Am. Sedgwicki*, *Pollicipes concinnus*, *Gervillia*, and *Macrodon*. The total depth now reached is 1,030 feet, and 3,000*l.* has been spent. The Association has voted an increased grant of 100*l.*, and the Government has promised aid to the extent of 100*l.* for each 100 feet completed below 1,000 feet ; but as each 100 feet will cost from 300*l.* to 400*l.* (including the cost of lining the hole), the Committee trust that subscriptions will still be forthcoming to enable them to continue the work.

Report of the Committee on the Influence of Forests on Rain.—It appeared from the very lengthened report that the operations of the committee during the past year had been restricted to the meteorological observations made at Carnwath, Lanarkshire. In order to carry on the operations at Carnwath, and extend them, a grant from the Association of not less than 25*l.* would be required for next year. They did not propose to commence observations at any new station.

SCIENTIFIC SERIALS

The Journal of Mental Science, July 1874—Dr. Nicolson proceeds with his Morbid Physiology of Criminals, discussing, on this occasion, prison discipline as a test of mind ; and he finds a large number of prisoners who, tried by this test, he must class together as "weak-minded." In spite of his strong common sense, Dr. Nicolson at times betrays amiable leanings towards the hopeful rather than towards a perhaps unpalatable truth. We must confess ourselves among the "sceptics" from whom "the sight of a class of adult and veteran criminals plodding away at their books in the halls of a prison" "would but draw an ominous shake of the head." Granting that the book education of criminals could be carried further than there is any reason to believe possible, the assumption remains that this would tend more than any other form of discipline to make them less criminal than before—the only thing in which society has any special interest concerning them. The "weak-minded" criminal, being on the border line of sanity, is naturally a perplexing subject to the prison authorities. In dealing with him practically Dr. Nicolson's sagacity might be fully relied on, though in such expressions as "we can *punish* badness, but we must *treat* madness," there is implied a sharp line of distinction which exists only in our phraseology. Madness ought to be punished when that is the best treatment ; and badness ought to be treated when treatment is the best remedy. —In an interesting paper On children fostered by wild beasts, W. W. Ireland, M.D., favours the opinion that there is not a single authentic instance of the kind.—J. H. Balfour Browne, barrister, makes a psychological and medico-legal problem of the character of Léonce Miranda, the hero of Mr. Browning's Red Cotton Night-Capt Country ; and by intensely commonplace standards of measurement concludes that Léonce was mad. We sincerely hope his principles of judgment will never find place in the deliberations of actual legal tribunals. It would be a terrible prospect to think that our wills might be set aside at the instance of greedy relatives on the ground that we were somewhat "anomalous," not exactly like the herd "in our mental constitution ;" "to say which," says Mr. Balfour Browne, "is only to say that a man is insane." Perhaps "all the doctrines of Rome will not make a *practical* man who *professes* its creed believe in a nowadays miracle ;" but what is the worth of the statement ? Strike out the word *practical*, which here means stupid, and give the sentence definite meaning by substituting *believes* for *professes*, and the proposition becomes a contradiction in terms. But to be logical may be to be insane, according to the wisdom of our practical men who profess instead of believing.—The Morisonian Lectures ; The treatment of insanity, abstracted from Drs. Bucknill and Tuke's chapter on that subject ; Clinical notes and cases ; Notes of the quarter, and reviews, make up the number. Dr. Carpenter's "Mental Physiology" is the most important review. His defence of the old free-will doctrine is severely handled ; and an attempt, not quite so successful, is made to set aside the theory of unconscious cerebration.

Journal of the Franklin Institute, July.—Among the matter contained in this number is the first instalment of an elaborate paper by Mr. J. A. Henderson, M.E., On the theory of aëro-steam engines, which, an editorial note informs us, is the first theoretical treatise on the subject that has appeared to complement the work of the late Prof. Rankine on other heat-engines. The "Principles of Shop Manipulation" is continued by Mr. J. Richards.—Chief Engineer W. H. Shock, U.S. Navy, under the head of "Strength of Materials," gives an account of a series of very carefully conducted experiments on bolts of various dimensions, under the two possible conditions—double cut and single cut—in which they might be used in connection with the bracing of boilers, and for other purposes.—There is a translation of M. Baudrimont's paper, On the tenacity of malleable metals at various temperatures.—Mr. C. J. Wister, in a paper On the moon's figure as obtained in the spectroscope, objects to Gussew's deductions from De la Rue's photographs of the moon at the extremes of her librations.—Prof. Thurston's paper On the mechanical properties of materials of construction, is continued.

The American Naturalist, August.—On the Flora of Southern Florida, by Frederick Brandel. The question considered is whether the flora of Southern Florida and the Keys is really North American or South Indian ; and the conclusion reached is that it is not North American, but a link between it and that of the West Indies, and that a portion of those species which are peculiar to the northern portions of the State and the immediately adjacent region may have been derived from the south.—The Classification of the Rhynchophorous Coleoptera, by Dr. John L. Leconte.—Herbarium Cases, by Dr. C. C. Parry. A case is described, with a woodcut, specially designed for being readily moved.—A Key to the higher Algæ of the Atlantic Coast between Newfoundland and Florida, by Prof. D. S. Jordan. Part II. Rhodospermeæ. Part III. Chlorospermeæ. An etymology of names of genera is appended.—Under the section Zoology a new species of North American

bird is described, named *Tringa ptilocnemis.*—In the Mammoth Cave Mr. A. S. Packard met with a new Japyx, to which he has given the specific name "*subterraneus.*"

Astronomische Nachrichten, No. 2,003.—This number contains a paper by W. A. Rogers, of Harvard, On the orbit of the minor planet Felicitas (109). The elements and perturbations are given. Tacchini gives a number of observations of Coggia's comet, made with the meridian circle at Palermo. Schmidt also gives a list of observations of the position of the same comet for almost every night from May 3 to July 15. Schulhof gives several sets of elliptic elements for Coggia's comet, and it appears that it may be the same body as was seen in 1734, and so having a period of 137·1 years; or it may have a period of 12184·3 years, as shown by another set of elements. The author also adds an ephemeris from Aug. 31 to Oct. 6. D'Arrest also gives observations on this comet.—Dr. Zenker contributes a note On the light of the comet being polarised in a plane passing through the sun and comet, showing the presence of reflected sunlight.—Konkoly adds a note On the spectrum of the comet.

No. 2,004 contains a catalogue by Engelmann of the positions of fixed stars.—Pogson gives his observations on Biela's comet, made in November and December 1872. At Madras, on Nov. 2, at 17h. 31m. 1·3s. Madras mean time, its R.A. was 14h. 7m. 12·66s., and P.D. 124° 45′ 21·1″; and on Dec. 3, at 17h. 13m. 11·3s. its R.A. was 14h. 21m. 55·11s., and P.D. 124° 4′ 37·5′ —Prof. Watson gives the elements and an ephemeris of Aethra (132).—Winnecke and Bruhns contribute notes on the positions of Borrelly's comet, and Dr. Holetschek has calculated the following element and ephemeris:—

T = Aug. 26.7199 Berlin time.

	°	′	″
π =	343	57	50
☊ =	251	44	18
i =	41	55	32

Log. q = 9·99292

	R.A. h.	m.	s.	D. °	′
Aug. 26 . .	12	33	48	+ 74	4·0
,, 30 . .	11	58	19	+ 74	20·7
Sept. 15 . .	9	50	27	+ 72	0·6
Oct. 1 . .	8	22	21	+ 66	17·0

Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie, Aug. 1.—The first article in this number is a statement by Capt. Hoffmeyer, director of the Royal Meteorological Institute at Copenhagen, of his plan, already noticed in NATURE, vol. x. p. 146, by Mr. R. H. Scott, for publishing daily weather charts for Europe and part of the Atlantic. It is here illustrated by a specimen chart. Next follows an examination by M. Raulin of the distribution of rain in Turkey in Europe and neighbouring parts. Observations were made at Pirano and Trieste between 1787 and 1807, and since 1841; in Corfu since 1845; at Ragusa since 1851; and at other stations, of which five are outside the peninsula, in later years. All the stations are near the margin of this large region, so that the weather of the interior is not yet well known. M. Raulin divides the year into two periods, a cold one from October to March, and a warm one from April to September. The practical significance of this division is that the rainfall of the warm period satisfies the immediate wants of vegetation, while that of the cold season goes mainly to the supply of wells and rivers. The rainfall at Fiume is very large, also at Ragusa, Janina, and Corfu, but very small at Athens and Smyrna. France has been divided into districts, each having its peculiar distribution of rain through the year, and the same method is adopted here. The first district, like the plain of Northern Europe, has more rain in summer than in winter, and includes Austria, Carinthia, Styria, Hungary, Southern Russia, and the Lower Danube, to Bucharest. Laibach belongs to the second district, having a rainfall steadily increasing from winter to autumn. To the third, with a very dry winter and summer and very wet autumn, belong St. Magdalena, Trieste, and Semlin. To the fourth, with a dry summer and rainy autumn, Dalmatia, Albania, Athens, Pera, and Scutari. Among the "Kleinere Mittheilungen" we have an interesting account of the climate of the Isthmus of Tehuantepec, from a report of the United States Government Survey Expedition; a notice of Herr Mohn's results derived from observations at Novaya Zemlya and Spitzbergen, made by Tobiesen, who died while wintering at the former place; and of Mr. Draper's paper, in which he shows the fears of a supposed change of climate in the Eastern States of North America to be groundless.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, Aug. 24.—M. Bertrand in the chair. The following papers were read:—Ninth note on guano, by M. E Chevreul.—Study of the fossil grain found in a silicified state in the coal formation of Saint-Etienne. Second part: Description of genera, by Ad. Brongniart. The author describes *Polylophospermum*, *Codonospermum*, *Stephanospermum*, and *Ætheotesta.*—Note on the Central Sea of Algeria, by M. E. Roudaire. This is a reply to objections raised by MM. Fuchs and E. Cosson.—Researches on the effects of powder in fire-arms, by M. E. Sarrau.—On the passivity of iron; second note, by M. A. Renard.—Memoir on vegetable protoplasm, by M. Ganeau.—On some phenomena of localisation of mineral substances in the Articulata; physiological consequences of these facts, by M. E. Heckel. The author has been feeding insects with arsenic. The metallic powder was mixed with flour, and after repeated small doses the insects (*Mantis religiosa*, *Blatta occidentalis*, and *Cerambyx heros*) were killed and various parts of the intestinal tube examined. The Malpighian tubes only gave decided indications of arsenic.—Various communications on *Phylloxera vastatrix* were received from MM. Ador, Boutin, Rommier, Morlot, Barnier, and others.—On a new formula for obtaining by successive approximations the roots of an equation of which all the roots are real, by M. Laguerre.—On the direct combination of chromic acid with wool and silk; applications to the colouring and analysis of wines, by M. C. Jacquemin. M. C. Chevreul made some remarks on the foregoing paper.—On the ureides of pyruvic acid and its brominated derivatives, by M. E. Grimaux. Pyruvic acid heated with urea gives a substance of the formula $C_{12}H_{14}N_8O_4$. When excess of urea is employed the compound $C_{10}N_{18}N_8O_7$ is produced. With excess of acid another body is obtained, of which the composition has not yet been established. A nitro-body of the formula $C_{12}H_{10}N_8O_{11}$ has been prepared from these compounds, and likewise a ureide of tribrompyruvic acid of the formula $C_{10}H_8Br_6N_8O_6$.—Analyses of various pieces of calf flesh, mutton, and pork sold in the Paris market in 1873 and 1874, by M. Ch. Mène.—Anæsthesia produced by the injection of chloral into the veins for the removal of a cancerous tumour, by M. Oré.—Application of the graphical method to the determination of the mechanism of rejection in rumination, by M. J. A. Toussaint.—Note on the physiological action of apomorphine, by M. C. David. The author has experimented on dogs, cats, pigeons, rabbits, and guinea-pigs. The influence of various reagents on the alkaloid has also been studied.—Action of the sulphydric acid of the sources of the Luchon on granitic galleries, by M. F. Garrigou.—Observations of the Perseides made at the Observatory of Toulouse on August 5, 7, 8, and 9, 1874, by M. Gruey.—Observations made at Paris of the shooting stars of the month of August 1874; progress of the phemonenon from 1837 to 1874, by M. Chapelas.

CONTENTS

THURSDAY, SEPTEMBER 10, 1874

THE INTERNATIONAL CONGRESS OF ORIENTALISTS

THE International Congress of Orientalists, which is about to be held in London, from the 14th to the 19th of September, promises fairly to become one of the most striking events of the autumn. This philological parliament is the successor and outcome of a similar Congress held last year in Paris, which inaugurated a movement likely to bear good fruit for a long time to come. The idea of holding once during every year a meeting of this nature in a different city originated with M. Gabriel Mortillet, a distinguished French *savant*, who proposed an annual International Congress of Prehistoric Archæology. Of these, the first was held at Neuchâtel, in Switzerland, in 1866. At the Brussels Congress of this body, two monarchs, the Kings of Denmark and Sweden, commissioned agents to represent them on the occasion, and their example was followed by the municipal authorities of Bologna. The French Congress of Orientalists of 1873 was mainly due to the exertions of M. Léon de Rosny, who organised its machinery with the co-operation of MM. Madier de Montjau and Zelinsky. The most prominent considerations of this Congress were directed towards the Japanese Empire, history, and language, and a very large and extremely interesting mass of literary and scientific material was accumulated, and is now in course of publication and distribution among the members of that meeting. This collection of essays is all the more important when we consider how few really accurate channels of knowledge concerning that remote country are available to the European student. Although the French Congress was supported by a greater number of members than the approaching London Congress seems at present likely to enrol, nevertheless it was not well attended; for the principal Orientalists who occupy *fauteuils* in the Institute held aloof from various motives, while on the other hand the *savants* of Germany, in consequence of the recent war, were, however willing, yet prevented by the French national feeling from making their appearance in the capital city. Yet by far the larger number of the most eminent professors in Germany enrolled their names on the list of the supporters of the Congress.

The London Congress has, however, no difficulties of this nature to surmount, and it will without doubt show a great preponderance of learned Germans; at the same time a reference to the list of members indicates a very strong contingent from the other side of the Channel. The vital principle of these Congresses is, that each, at the conclusion of its labours, transmits its powers to a chosen individual who becomes president for the ensuing year; this president is elected after the country has been fixed upon in which the next meeting is to be held. The Paris Congress, in accordance with this principle, selected London, as the metropolis of England, to be the place where the Congress of the current year should be held; and this was done out of respect for the learning of the country, although very flattering and advantageous offers had been made by other European countries, which would have perhaps accorded an official reception more cordial than is likely to be given by the imperial authorities in this country. At the conclusion of the French Congress in September last year, Dr. Samuel Birch, K.R., Keeper of the Egyptian and Oriental Antiquities in the British Museum, a gentleman whose knowledge of the whole range of ancient remains, whether Greek, Roman, or Oriental, makes him *facile princeps* in this particular study, was elected president of the English meeting, and an executive committee was afterwards nominated to carry out the necessary arrangements. These preliminary matters are now so far advanced that the programme has just been issued, and the sittings, which will occupy the entire week, will commence on Monday next, the 14th inst. These Congresses are likely to produce several very excellent effects, by bringing together distinguished Orientalists who would probably not otherwise become personally acquainted with each other; by the mutual interchange of ideas, by the bringing about some understanding on many disputed points, and by the arrangement of some uniform system of transliteration and transcription of Oriental texts. But above all it will call public attention to the importance of Oriental studies, alas! too long neglected in Great Britain, and will elevate in public opinion the position of Oriental students and studies, which already exercise, and will hereafter still more powerfully exercise, an influence over European thought.

The number of English members is at present about 180, daily increasing and comprising all the names distinguished in Oriental studies; indeed, it would be difficult to mention any Orientalist of leading note in England who is not a member of this Congress. In addition to these, Prof. Dr. Brugsch will represent Egypt. France will be represented by upwards of thirty members, of whom we may mention M. François Lenormant, Professor of Archæology at the French Institute; Prof. Jules Oppert, whose labours on the Cuneiform languages are well known; and Prof. Léon de Rosny, who was president of the Congress last year. Germany is also well represented, sending such men as Prof. Brockhaus of Leipzig, a leading expounder of the old school of Sanscrit learning, with whom we may unite the name of Prof. Stenzler of Breslau; Prof. Dillmann of Berlin, chiefly known for his Ethiopic researches and his valuable lexicon and catalogues of Ethiopic MSS. in the British Museum and the Bodleian Library; Herr Euting, Librarian of Strassburg, who has specially studied Phœnician inscriptions; Prof. Haug of Munich, whose particular branch of study is the Sanscrit, Zend, and Pehlvi languages; Prof. Krehl of Leipzig, an illustrious Arabic scholar; Prof. Lepsius of Berlin, an Egyptologist of universal repute; Prof. Nöldeke of Strassburg, who takes prominence for his knowledge of Arabic and Syriac, and has lately published works on the modern language of Syria; Herr Pertsch, Librarian of Gotha; Prof. Roth of Tübingen, whose Sanscrit Lexicon of the University of St. Petersburg is perhaps the best work of its kind; Prof. Spiegel, famed for deep studies in the Zend-Avesta and languages of Persia; Herr Trumpp of Munich, privatdocent, and lately appointed Professor of Arabic and Persian, who has published many works in the language of Afghan, Sindhi, and Punjabi; Prof. Weber of Berlin,

a Sanscrit authority of the new school; Prof. Weil and Prof. Windisch, both of Heidelberg, the former noted for Arabic learning, the other for Sanscrit and Celtic studies.

The programme of meetings is as follows:—

Sept. 14.—Inaugural Meeting. With Address. 8.30 P.M., at the Royal Institution, 21, Albemarle Street. The meeting will commence with the election of the Council.

Sept. 15.—Semitic Section. President, Sir Henry Rawlinson, K.C.B. Secretary, W. S. Vaux, Esq., F.R.S. Sitting, 2.30 P.M., at the rooms of the Royal Society of Literature, 4, St. Martin's Place, Charing Cross.

Sept. 16.—Turanian Section. President, Sir Walter Elliot, K.C.S.I. Secretary, Prof. Douglas. Sitting, 8.30 P.M., at King's College, Strand.

Sept. 17.—Aryan Section. President, Prof. Max Müller. Secretary, Prof. Eggeling. Sitting, 2.30 P.M., at the Royal Institution, 21, Albemarle Street.

Sept. 17.—Hamitic Section. President, Dr. Birch, LL.D. Secretary, W. R. Cooper, Esq. Sitting, 8.30 P.M., at the rooms of the Society of Biblical Archæology, 9, Conduit Street.

Sept. 18.—Archæological Section. President, M. Grant Duff, Esq., M.P. Secretary, E. Thomas, Esq., F.R.S. Sitting, 11 A.M., at the rooms of the Royal Asiatic Society, 22, Albemarle Street.

Sept. 19.—Ethnological Section. President, Prof. Owen, C.B. Secretary, R. Cull, Esq., F.S.A. Sitting, 2.30 P.M., at the rooms of the Royal Asiatic Society, 22, Albemarle Street. At the close of the sitting the members of the Congress will decide in what country the next Congress shall be held, and will nominate the president.

There will be receptions on the following occasions:—

Sept. 15.—10 A.M., at the British Museum.

Sept. 16.—11 A.M. The Right Hon. Sir Bartle Frere will give a breakfast to the members of the Congress, at his residence, Wressil Lodge, Wimbledon.

Sept. 17.—10 A.M., at the India Office Library. 12 noon, at the Soane Museum.

Sept. 18.—Mr. Bosanquet will give an afternoon garden party to the members of the Congress, at his residence, Claymoor House, Enfield.

Sept. 19.—10 A.M., at the South Kensington Museum.

During the meeting of the Congress a Bureau will be opened at the Royal Asiatic Society's Rooms, 22, Albemarle Street, W., where every information concerning the Congress may be obtained.

The Committee of the Scientific Club have kindly invited the members of the Congress to make use of their club house, 7, Savile Row, W., during the session of the Congress. The foreign members of the Congress and their friends are invited by the Council of the Royal Botanic Society of London to visit the gardens of the Society, in Regent's Park, at any time during their stay in London. Such members will be admitted to the gardens by producing their cards of membership.

ANDERS JONAS ANGSTRÖM

ANDERS JONAS ANGSTRÖM, Professor of Physics in the University of Upsala, after a short illness of less than a fortnight, died, as we have already announced, on June 20, from an attack of inflammation of the brain. The death of Prof. Angström, who has been cut down in the full vigour of his powers and in the midst of a noble and active scientific career, is a loss to the entire world of science.

Angström was born Aug. 13, 1814, at the Lögdo Iron Works Settlement in Medelpad. He was the son of a pastor, who in the early childhood of Anders Jonas, removed to Ullänger, in Angermanland, and a few years afterwards to Sättna in the neighbourhood of Sandsvall, where he remained till his death in 1847. With no other means than the extremely limited stipend of a Swedish country minister, supplemented by the proceeds of a small glebe, the elder Angström kept his three sons—the present Dr. Johan Angström and Prof. Anders Jonas and his young brother Carl Arendt at school, and even assisted them in their subsequent attendance at the University classes at Upsala. In these efforts the father was strenuously supported by his wife, without whose good management such efforts would have been impracticable; and to advanced age this admirable housewife continued to prosecute her daily task of spinning, without remitting her active supervision of her household.

Although circumstances compelled Angström to eke out the means necessary for his University course by his own exertions, he passed through all his requisite examinations with distinction and within the usual terms. After matriculating in the autumn of 1833, he took the degree of Doctor of Philosophy in 1839; became a physical tutor in the same year, and assistant in practical astronomy in 1843; while in the years 1846 and 1847 he fulfilled the duties of the Chair of Astronomy at the University, during the temporary absence on the continent of the professor. Owing to want of interest he had, however, five years to wait before he obtained any other fixed employment. The Chair of Physics had fallen vacant in 1839, the same year in which Angström graduated; but then, and for some time afterwards, his abilities were not fully recognised in the University, while with his natural modesty he abstained from presenting himself as a candidate, although he might then have enjoyed the same good fortune as his friend and fellow-student, Malmsten, who, after having had four years in which to prepare himself, was able on the death of the Professor of Mathematics, in the year 1843, to offer himself as a successful candidate for the vacant chair. At length, in 1858, on the public recommendation of the Consistory, Angström was nominated to the Chair of Physics, the duties of which he had performed for two years in the character of a *pro tempore* professor. This chair he continued to hold for the remaining sixteen years of his life.

During his occupancy of the chair Angström secured for the physical museum of the University an admirable collection of instruments for the determination of different exact measurements in the various departments of physical science; and as far as the limited resources at his disposal permitted, he improved the physical laboratories, and strove to awaken amongst the students an interest in the study of the exact sciences. He also continued for a number of years, in the capacity of Secretary to the Royal Society at Upsala, to conduct its transactions with a zeal and devotion which secured for him the grateful recognition of foreigners as well as of his own countrymen.

Although Angström published memoirs on almost all branches of physical science, his name will be for ever associated with the history of spectral analysis, for which he obtained from the Royal Society of London in 1870 the Rumford gold medal, a distinction which no Swede had ever before enjoyed.

In order to show Angström's place in scientific history in regard to this class of researches, it will be well in this place to briefly recapitulate the capital points.*

* This recapitulation is based upon the historical statement in Lockyer's "Solar Physics."

Fraunhofer, at the beginning of this century, pointed out the coincidence of place in the spectrum between certain dark lines which he saw in the spectrum of the sun and the bright lines in the spectrum of the flame of a lamp. In Dr. Brewster's note-book, dated St. Andrews, Oct. 28, 1841, this passage occurs :—"I have this evening discovered the remarkable fact that, in the combustion of nitre upon charcoal, there are definite bright rays corresponding to the double lines of A and B, and the group of lines *a* in the space A B. *The coincidence of two yellow rays with the two deficient ones at* D, *with the existence of definite bright rays in the nitre flame, not only at* D *but at* A, *a and* B, *is so extraordinary that it indicates some regular connection between the two classes of phenomena.*"

We next have an important experiment made by Foucault in 1849, who pointed out that the electric arc presented us with a medium which emits the rays D on its own account, and which at the same time absorbs them when they come from another quarter.

The received explanation of this coincidence between the two bright lines of burning sodium vapour, and the two dark lines D in the solar spectrum, which extended the grasp of spectrum analysis from terrestrial substances to the skies, was taught by Prof. Stokes in his lectures about 1852, but was not published.

In 1853 the idea was first published by Angström.*

In his memoir, for the purpose of illustrating the absorption of light, he made use of a principle already propounded by Euler, in his *Theoria lucis et caloris*, that the particles of a body, *in consequence of resonance*, absorb principally those ethereal undulatory motions which have previously been impressed upon them. He also endeavoured to show that *a body in a state of glowing heat emits just the same kinds of light and heat which it absorbs under the same circumstances.* He further undertook researches on the electric light, and stated that in many cases the Fraunhofer lines were an inversion of the bright lines, which he observed in the spectrum of various metals.

Early in 1859, Mr. Balfour Stewart independently discovered the law which binds together radiation and absorption, establishing it experimentally as an extension of Prévost's law of exchanges in the case of the heat rays, and generalising his conclusion for all rays.

In October of the same year, 1859, Kirchhoff established experimentally the same law for the light rays.

On the occasion of Angström's admission to the membership of the Royal Society, General Sabine in his introductory address mentioned that the obstacles opposed by the language in which Angström's treatise had been written, and by distance from the scene of his investigations, had for three years prevented its very existence from being known to the scientific world at large ; but when once the nature of that treatise became known, the fact was immediately acknowledged, that in Professors Stokes and Angström we are bound to recognise the fathers of spectral analysis. Indeed, in the "Optiska Undersökningar" of the latter are to be found many of the fundamental principles of much that has since been accomplished in that department of scientific inquiry. In his work entitled "Recherches sur le spectre solaire," with its atlas of the normal spectrum of the sun, Angström has given us an indispensable adjunct for all future students of spectrum analytical investigations.

* "Optiska Undersokningar :" Trans. Royal Academy of Stockholm, 1853. Translated in Phil. Mag. 4th series, vol. ix. p. 237.

We have already stated that Angström published memoirs on subjects connected with nearly every department of physical inquiry. Thus we have papers :—(1) "Sur la polarisation rectiligne et la double réfraction des cristaux à trois axes obliques" (Upsala Vetenskaps-Societets Acta), in which he gives the solution of the problem involved in the optical phenomena presented by such crystals which had been sought, but without success, by Neumann and MacCullogh. (2) On the "Monoklinoedriska kristallernas molekulära Constanter" (Vet. Akad.'s Handlingar, 1859). (3) "Ny metod at bestämma kroppars ledningsförmaga för Värme"—New method of determining the capacity for conducting heat in the human body—(Vet. Akad. Förh. 1861) ; which contains the first determinations ever given of the absolute values of the capacity for conducting heat. (4) "Sur deux inégalités d'une grandeur remarquable dans les apparitions de la Comète de Halley" (Upsala Vet. Soc. Acta.). This treatise first excited the expectation amongst astronomers of obtaining certain results by means of a single method. (5) "Sur les Spectres des gas simples" (*Comptes Rendus*, 1871).

These are among the most important of Angström's numerous treatises, and in addition we may instance his celebrated monograph, "Mémoire sur la temperature de la terre" (Upsala Vet. Soc.'s Acta.), as well as a paper belonging to an earlier period, which appeared in the "Denkschriften der Münchener Academie," 1844, under the title of "Magnetische Beobachtungen bei Gelegenheit einer Reise nach Deutschland und Frankreich."

As might naturally be expected, numerous scientific Societies sought the honour of numbering Angström amongst their members, as for instance :—Kungl. Vet. Akad. i. Stockholm ; Kungl. Vet. Akad. i. Upsala ; the Royal Societies of Berlin, Copenhagen, London, &c. He was, moreover, appointed Corresponding Member of the French Institute ; he twice obtained the Wallmarsk prize of the Vet. Akad. of Stockholm in 1865, in conjunction with Professors Thalén and H. Holmgren, and in 1869 with the former alone. He carried off two other prizes given by the same Society, and once he obtained a grant of money for his observations from the University of Upsala, before he had become a member of the Upsala Vet. Soc., which was the more acceptable to him, since for a long period he reaped a very inadequate pecuniary return for his scientific labours. Partly by the aid of the State, but mostly at his own personal expense, Angström several times visited the Continent, especially France and Germany. He was absent from Sweden in the years 1843, 1844, 1859, and during the summers of 1866 and 1867 ; but with one exception he attended all the meetings of the Scandinavian Association for Natural and Physical History. In recognition of his great merits, Angström was made Knight of the "Order of the North," and Commander of the Vasa Order 1st Class, and of the "Crown of Italy."

THE IRON AND STEEL INSTITUTE

THIS prosperous and useful association held its sixth summer meeting last week, from the 1st to the 4th instant, at Barrow-in-Furness, a town whose rapidity of growth is unparalleled out of America. Twenty-five years

ago the village of Barrow, near the southern extremity of the peninsula of Furness, in Lancashire, had a population of barely 200; now the municipal borough extends over an area of about 15,000 acres, with a population of about 35,000. Even fourteen years ago, when the first volume of *Chambers' Encyclopædia* was published, it seems to have been so little known, or of so little importance, as not to find a place in that useful work. It is now a well-laid-out town, with fine docks, and some of the most important iron and engineering works in the kingdom; while one of the steel works are considered to occupy a leading position in connection with the manufacture of Bessemer steel. This unequalled growth of the town of Barrow is entirely owing to the rapid development of the various industries connected with iron, the mineral deposits of the district being unusually rich.

Such a town forms an appropriate meeting-place for an Institute which has done so much to develop the manufacture of iron and steel, by affording a medium for the interchange of ideas between those who are engaged in the practical work of these industries or in the investigation of the scientific principles on which they must be founded if they are to be successful. The Institute is to be congratulated on the scientific tone which has all along pervaded its proceedings and its publications since it was founded in 1869. Though it has had such a comparatively short existence, it seems to have been in all respects prosperous (it now numbers close on 600 members), and to have most satisfactorily fulfilled the purpose for which it was instituted, the improvement of the all-important manufacture of iron and steel by the free interchange of ideas generated by experience or scientific study. To quote the words of our contemporary *Iron*: "Anterior to the establishment of this important society, the manufacturers of iron in its various forms had scant opportunity of communicating in public the results of their own experience, and of comparing those results with the observations of other persons equally interested in their development. Various methods of working prevailed in different parts of the country, and not long ago many processes connected with iron and steel manufacture were regarded as trade secrets to be carefully treasured up and jealously guarded. To the abolition of these narrow and antiquated notions the Iron and Steel Institute addressed itself vigorously from its very inception. It soon became apparent that among the first promoters of the society there prevailed an earnest desire to cast aside all petty jealousy, and to add unreservedly their individual knowledge to the general stock of information. Adherence to this excellent principle produced a prompt effect on the minds of iron and steel makers in all parts of the British Empire, and secured the sympathy of continental and American manufacturers." This is a very valuable result to have been accomplished in so short a time, and may perhaps partly be accounted for by the high scientific character of those who have from the first been elected to hold office in the society. With such names on its list of office-bearers as his Grace the Duke of Devonshire, Mr. Isaac Lowthian Bell, F.R.S., Mr. Bessemer, Mr. John Jones, F.G.S. (general secretary), Mr. David Forbes, F.R.S. (foreign secretary), Dr. C. W. Siemens, F.R.S., and others, the Institute has every chance of doing good work and of imbuing its members with a feeling of the necessity, in order to secure the highest success in their important industry, of importing into it continually the results of the latest and highest scientific research. There is little fear of the practical side of the iron and steel manufacture being neglected; and if this as well as other similar Institutes, do their work faithfully, and if the members enter upon their work equipped with a thorough scientific as well as professional training, there will be little fear of other nations outstripping us in this, as they threaten to do in other industries. To keep up the tone of the Institute, the importance of electing right men to hold office in it cannot be too much insisted on, and we hope that in this respect it will go on as it has begun.

The Barrow meeting seems to have been a real success; the only complaint being, as is almost always the case at such meetings, the difficulty of getting sleeping accommodation for the members; in Barrow this is not to be wondered at, as the people have scarcely had time yet to think about building hotels. The Duke of Devonshire, who is intimately connected with Barrow, the Earl of Lonsdale, the Mayor, and other dignitaries, as well as the railway companies and proprietors of the numerous works in and around Barrow, entertained the members most hospitably, and gave them every opportunity of inspecting the working of the numerous vast establishments connected with the industries with which the Institute is concerned. Indeed, the greater part of the four days seems to have been spent in visits and excursions; and considering the nature and aims of the Institute, its time could not, perhaps, have been more profitably spent. A good many papers were also read, all of them of considerable practical value, but of too purely technical a nature for these columns. Among the more generally scientific we may mention Mr. Wurzburger's very interesting and well-informed paper on the Geology of the West Coast Iron Ore Districts, and Mr. Charles Smith's paper on the Iron Ores of Sweden. The last day, September 4, was entirely devoted to an inspection of various mining works in the West Cumberland district.

Altogether we have no doubt that the members of the Institute will look back upon the Barrow meeting as one of the pleasantest and most instructive they have had. The Right Hon. Earl Granville has been elected president for the years 1874-6.

SHARPE'S "BIRDS IN THE BRITISH MUSEUM"

Catalogue of the Birds in the British Museum. Vol. I.—Accipitres. By R. Bowdler Sharpe. (Printed by order of the Trustees.)

THE great value of Dr. Günther's "Catalogue of Fishes" in the British Museum is appreciated by all working zoologists; and when Mr. Sharpe was appointed one of the Senior Assistants in the Natural History Department of that noble institution, ornithologists had every reason to hope for an equally important work on the birds in the same collection, all fully realising Mr. Sharpe's perfect competency for the execution of so

arduous a task. The volume before us shows that their hopes were not misplaced. The "Hand-List of Birds," by the late Mr. G. R. Gray, invaluable as it is on account of its extensive indexes and easy method of reference, has a very definite and narrow limit of utility; it is an essential supplement to a library, but gives no detailed information itself. The work before us has a very different scope. Besides the nomenclature and the synonomy of the whole bird-class, it will contain the complete description of each species from the hand of one of our most able and enthusiastic ornithologists, based upon the finest collection in the world, the deficiencies of which, through the liberality of the trustees and the energy of its superintendent, are being so rapidly diminished, that, as we are told in the introduction, of the 354 certain species of diurnal birds of prey at present known, less than thirty are desiderata in the collection. Woodcuts, scattered through the volume, help to illustrate many of the peculiarities of the heads, tarsi, and toes of the species to which they refer; whilst twenty or so coloured plates, from the pencil of Mr. Keulemanns, assist in indicating the special characters of type-specimens and rare forms.

A glance through the work tends strongly to confirm our prejudice against the existing rules of avian nomenclature, and makes us hope that before long some improvement in the direction of simplification will be adopted. The system of Linnæus was a binominal one, no doubt; but though that at present in vogue still retains that name, it has gradually drifted into a quadrinominal system. The number of species of birds is certainly large, but hardly beyond the grasp of a binominal nomenclature. As it is, each bird receives its two Latin names, generic and specific, added to which is that of the author who originally described it as such, in brackets or not, according to whether he placed it in some other genus or in the one in which it is retained. Could not some universal congress be formed to determine once for all a name for each species, based on the laws of priority, present knowledge, and euphony, and so fix the appellation of all now known birds, as a starting-point for future workers, so that it need no longer be felt that the publication of every new book which has any pretension to sound work will bring with it changes in the naming of even our most familiar species, which are as confusing as they are unimportant? In the work before us the well-known smallest of the diurnal birds of prey is shown to have to be placed in a new genus, *Microhierax*, instead of retaining its habitual name *Hierax*, whilst the King Condor must in future be *Cathartes* instead of *Gyparchus*, the Black Buzzard changing to *Catharistes* or *Catharista*, according to the appreciation of gender in the author transcribing it.

The Turkey Buzzard fares still worse. Its generic distinctness from the last-mentioned bird must have struck Mr. Ridgeway in the United States and Mr. Sharpe in this country almost simultaneously. Both authors must have had the works in which they announce their proposed change in proof at the same time. The "History of North American Birds," however, appeared shortly before the volume under present review, and consequently the still-born *Œnops* has to sink into a synonym of *Rhinogryphus*. A similar fate has awaited *Urubitinga uricincta*, which will have to stand as *Antenor* instead of *Erythrocnema*. Among other fresh genera we find *Lophotriorchis*, which includes *Spizaëtus kieneri* and *S. isidorii*; and *Urotriorchis*, containing only *Astur macrurus*; and others. With regard to species, Mr. Sharpe has separated off the smaller brown Condor as *S. aequatorialis*; the Turkey Buzzard, with yellow head and white irides, as *R. pernigra*; an *Astur*, obtained by Mr. Wallace in Lombock and Bouru, as *A. wallacii*; and a Falcon, which Prince Bonaparte and Prof. Schlegel consider a melanism of *F. severus*, as *F. religiosus*.

Next with regard to the classification which is adopted; as the work does not profess to be more than a catalogue and a key for the identification of the species, it would not be fair to expect that in the separation of the different families and genera described all the known peculiarities should be given; sufficient for the ready identification of each being all that is required. Consequently when the sub-family *Polyborinæ* of the family *Falconidæ* is divided up as in the following table, without any further definition, it is evident that the author only attempts to give a minimum, and not a maximum number of distinguishing features.

POLYBORINÆ.

Key to the Genera.

a. Middle tail-feathers not elongated.
- *a'*. Nostrils oval . . . . POLYBORUS.
- *b'*. Nostrils round . . . IBICTER.

b. Middle tail-feathers extremely elongated; head with elongated plumes.
- *a'*. Nostrils vertical ovals; forehead with erect crest . . . . . . CARIAMA.
- *b'*. Nostrils perpendicular ovals; forehead not crested . . . . . SERPENTARIUS.

In the above instance we are astonished, as many others will no doubt be, not so much at the slightness of the differentiation of the genera, as at the fact that *Cariama* and *Serpentarius* are placed in such intimate relation with the Caracaras. The illustrious Nitzsch, whose opinions on classification are more to be relied on than those of any other zoologist, it is true, placed the Secretary Bird with the Accipitres, though he retained the Cariama with the Bustards. More recently there has been a tendency, which is daily becoming stronger, to combine the one with the other. The question then arises, are they Bustards or are they birds of prey? Internal structure is overpoweringly in favour of the former position; and such being the case, it is almost to be regretted that no further notice has been taken by Mr. Sharpe of their peculiarities than the statement that in two out of the four genera of the Polyborinæ, the median tail feathers are elongate, whilst in the other two they are short, especially when *Pandion* is placed in a sub-order by itself; and, as it happens, has its foot accidentally represented without the ungual phalanges or any of the three anterior toes. For though *Serpentarius* presents strongly marked external facial resemblances to *Polyborus*, which, by the way, are not to be found in *Cariama*, nevertheless in other respects they both differ so much from all other true Accipitres, that it would be impossible, even if they were birds of prey, to do otherwise than place them in a sub-order by themselves; which is the same thing as saying

that their relationship to the Caracaras is not more intimate than to the eagles and the hawks.

Similarly, the American Vultures, or *Cathartidæ*, if they are vultures at all, which is extremely improbable, can hardly be included in the same family with their typically accipitrine namesakes, but must be placed independently by themselves. The conformation of the feet alone, and more especially the difference in the proportionate length of the phalanges pointed out by Prof. Huxley, is alone sufficient to decide this point.

Leaving these minor points out of the question, however, as having little or no bearing on the true value of the whole, we look on the volume before us as the precursor of others, which if all completed in the same thorough and able manner that is throughout manifested in the first, will form a standard ornithological work, the importance of which it will be impossible to overestimate. We wish Mr. Sharpe all success in the further prosecution of his almost herculean task.

OUR BOOK SHELF

1. *The Principal Timber Trees.* 2. *Select Plants (exclusive of timber trees).* 3. *Additions to the Lists of the principal Timber Trees and other Select Plants readily eligible for Victorian Industrial Culture.* By Baron Ferd. von Mueller. (Melbourne)

THESE papers, drawn up by Baron Mueller, and first published in the Proceedings of the Zoological and Acclimatisation Society of Victoria, are something more than mere lists, inasmuch as in their separate pamphlet form, in which form they have all since been issued, the first occupies 58 pp. 8vo, and was issued in 1871; the second, 428 pp. 8vo, issued in 1872; and the third, the "Additions," 40 pp. 8vo, issued only a month or two since, and only just come to hand.

It is not on account of any original observation being made into the properties or uses of the trees or plants enumerated that we think these papers worthy of notice, but rather on account of their practical use in imparting to an unscientific colonist a knowledge, not only of such trees and other plants as may grow in the climate, but also of their value in an economic or commercial point of view. By means of a pamphlet like either of the above, we have ready references to plants, natives of nearly every part of the globe, which are, moreover, with some authority considered suitable for acclimatisation in Australia and other countries. Such information as the geographical distribution, habit of the plant, &c., could only be obtained by reference to the numerous Floras and bulky botanical works which are as sealed books to the colonists generally, while the economic applications would have to be sought for in numerous other and totally distinct works, for our Colonial Floras seldom or never even touch on this important part of the subject. Baron Mueller, indeed, says that these lists are intended not so much to contain records of original research as "to bring together information more condensed and more recent than would be attainable in costly or voluminous works of even several languages."

The arrangement of the genera is alphabetical instead of being scientific, and the following examples will show the sort of information given :—

"*Buxus sempervirens* L.—The Turkey Box Tree. South Europe, North Africa, South-west Asia. This slow-growing tree should be timely planted to provide the indispensable box-wood for wood-engravers and musical instrument makers as yet no good substitute for it having been discovered. The box tree needs calcareous soil for its best development. Among allied species, *B. balearica* attains a height of eighty feet."

Then follows a list of other species of *Buxus*, about which, however, little is known as to the value of the respective woods. Here is another example, taken haphazard :—

"*Guevina avellana* Molina.—Extends from Middle Chili to the Chonos Archipelago. Briefly alluded to already in the list of trees desirable for Victorian forest culture. One of the most beautiful trees in existence. The snowy white flower-spikes produced simultaneously with the ripening of the coral-red fruit. In the cooler southern regions the tree attains considerable dimensions. The wood, tough and elastic, used for boat-building. The fruit of the allied *Brabejum stellatifolium* can only be utilised with caution in a roasted state as an article of diet, because it is noxious, or even absolutely poisonous, in a raw state."

Guevina avellana is a Proteaceous tree, the fruits of which are very similar in appearance, and the seeds very similar in flavour, to those of the Australian tree *Macadamia ternifolia*. These lists will probably prove useful not only as a guide to the selection of plants for the purposes of acclimatisation, but also as a handy reference for economic species generally. J. R. J.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

A Remarkable Thunderstorm

[The following letter has been forwarded to us for publication by Mr. R. H. Scott, F.R.S.—ED.]

"Yorkshire Philosophical Society,
York, Sept. 2, 1874.

"Dear Sir,—I have to report to-day one of the most unusual thunderstorms that I ever remember. It began to be dark about 12 30 noon, and rain fell; at 12.40 it was much darker; at 12 43 rain fell in torrents, but was so much driven by the wind that you saw it being driven like snow in packs; so dense was it now and for ten minutes that I could not see chimney-pots 100 yards distant. The thermometer must have fallen tremendously, for windows were so steamed inside as to be opaque. I remarked that the clouds went in the direction of N.W., while the wind was S.S.W., and force about 8. Part of the time it went in whirlpools, as it were; during the climax of ten minutes we had rain with lightning and thunder, then snow, and snow and sleet, and distinct hail afterwards, but not of large size.

"I should have taken the state of the instruments, but I was about half a mile from the museum.—I am, &c.,
(Signed) "C. WAKEFIELD

"R. H. Scott, Esq., F.R.S.,
"Director, Meteorological Office.

"P.S.—Rain measures ·49. There was lightning (a little forked, the rest sheet) and thunder during all the storm."

The Exhibition of Specimens and Apparatus at the British Association

IF no one else has already done so, will you permit me to call attention to the valuable feature of the Belfast meeting of the British Association presented by the exhibition of specimens, apparatus, and diagrams in the Anatomical Museum, due, it is understood, to the energy and perseverance of Mr. Ray Lankester. Here were to be seen, for instance, Mr. Symons's series of thermometers illustrating variations in sensibility, a collection of bones and other remains found in Kent's Hole and the Victoria Cave, during 1873–74. Dr. Pye Smith's large undescribed Medusa, the diagrams and plants which illustrated Dr. Hooker's address on Carnivorous Plants, specimens of breech-loading fire-arms, and many other objects of interest, all catalogued in each day's issue of the "Journal." It is to be hoped that a similar collection, rendered still more complete through the co-operation of the authors of papers, will be an addition to the attractions of all future meetings of the Association.

Penmaenmawr, Sept. 4 ALFRED W. BENNETT

Photographic Irradiation

In NATURE, vol. x. p. 245, Mr. W. C. Crofts adds his experience to those previously given in your journal, and gives his conclusion as opposed to that of Mr. Aitken (vol. x. p. 185). Like most conclusions based on incomplete evidence, it does not conclude anything. The fact is as I have stated it in my previous note (vol. x. p. 205) on the subject, and when I return to England I will be most happy to demonstrate it to anyone who cares to examine the question thoroughly. Mr. Crofts' experience with the Liverpool dry plates agrees with my own, for these plates are prepared with a pyroxyline which gives a minimum of irradiation when "backed," and give the best quality of image for scientific purposes attainable with a bromide film; but certain qualities of pyroxyline prepared in precisely the same way will show irradiation that nothing can cure, even when used for making transparencies by contact, where, of course, there can be no question of influence of any optical defects. The unquestionable fact that a collodio-albumen film acts in so totally different a manner from one of bromized collodion should prove that the lens has next to nothing to do with it.

My conclusions may be very imperfect, but so far as they go they are definite, and are drawn, not from two or three, but from hundreds of experiments with all kinds of dry plates and many different samples of pyroxyline, and whatever they may be worth, they fully support Mr. Aitken's views.

New York, Aug. 19 W. J. STILLMAN.

Pfluger on the "Salivary Glands" of the Cockroach

I WAS much interested in reading Prof. Redfern's able address at the British Association this year, more especially with that portion which dealt with the observations of Prof. Pflüger on the histology of the so-called "salivary glands" of the cockroach. In the year 1871 I wrote a short paper in Professors Humphry and Turner's Journal (vol. v. p. 242 *et seq.*) upon these organs. In this I ventured to doubt the truth of the generally accepted hypothesis as to their functions. My reasons for so doing may be summarised as follows:—1. The appendages in question are perforated throughout by ramifying spirally coated tubules differing only from tracheæ in this respect; during their passage through the organs in question they receive a layer externally of yellowish tissue, which may be, as Prof. Pflüger suggests, epithelial glandular tissue. 2. These tubules with the sacculi opening into them can be more or less fully injected with a liquid by simply immersing the insect in a suitable menstruum, and placing it under the exhausting receiver of an air-pump. This experiment demonstrates indubitably that this tubular system contains an *elastic fluid*, which for anatomical and other reasons I conclude to be air. 3. As far as my experience carried me, the sacculi, the supposed reservoirs of the saliva, never contained naturally any liquid whatever, but upon opening the thorax were invariably found to be collapsed and apparently empty. This is precisely what would occur supposing that during life they were filled by and communicated readily with the external air.

I have not yet had an opportunity of referring to Prof. Pflüger's paper, and I am consequently obliged to accept his statements at second hand. In noticing the intimate connection there is between these organs and the nervous system of the insect, he confirms what I have myself observed. It is some years since I last anatomised a cockroach, and meanwhile I suppose these insects have utilised their organs in the way mentioned by Prof. Pflüger, and we can now see "transparent drops . . . transuding from the ends of cells when the saliva has been made to flow by irritation of the gland." On looking over my microscopic specimens I find that I still have by me one showing the so-called "salivary duct" and a sacculus injected in the way I have mentioned. Any one may satisfy himself that this result is feasible by trying the experiment. In doing so the only caution required is to exhaust the air gradually and to keep the immersed insect in a partial vacuum for a few hours. Failure under these circumstances is almost impossible.

London, Sept. 2 W. AINSLIE HOLLIS

THE CONFERENCE FOR MARITIME METEOROLOGY

THE Conference, held at the Meteorological Office, 116, Victoria Street, for the purpose of reconsidering the decisions regarding maritime meteorology made at the Brussels Conference in 1853, has concluded its sittings, and the Report of its proceedings will be presented to the Permanent Committee, appointed by the Meteorological Congress of Vienna (of 1873), which holds its meeting at Utrecht in the course of the present week. The Conference consisted of twenty-five members, belonging respectively to every maritime country of consequence in Europe, except Sweden and Turkey. India and China were also represented. Prof. Buys Ballot was elected president, and Capt. Hoffmeyer and Mr. Scott, F.R.S., secretaries. It met on the 31st ult., and at once subdivided itself into two sub-committees, dealing with the various questions connected with (1) "Observations," and (2) "Discussions." Each sub-committee held four sittings, and at the closing meeting of the Conference the several resolutions framed by the sub-committees were adopted, in most cases unanimously. Inasmuch as the Conference was an outcome of the Vienna Congress, these resolutions will not be published until they have been communicated to the Permanent Committee as above mentioned. Their general scope is towards the attainment of greater uniformity in the methods of meteorological observation at sea, and of subsequent publication of the results. On Thursday, by kind permission of the Astronomer-Royal, the members went to Greenwich in the morning, where they were conducted over the magnetical and meteorological department by Mr. J. Glaisher, F.R.S. In the afternoon they spent some hours at Kew Observatory, where they were received by Mr. Jeffery, the superintendent, and in the evening the whole party was entertained at dinner at the Star and Garter, by some of the members of the Meteorological Committee. On Friday several members availed themselves of the great courtesy of the War Office, and repaired to Woolwich, where they were conducted over the Arsenal by Colonel Field and other officers connected with that department. Finally, on Saturday, they inspected the Meteorological Office, where the meetings of the Conference had been held, and paid special attention to the arrangements there existing for reproducing the records of the photographic and other instruments at the several observatories in the United Kingdom.

ON SEWAGE AND SEWAGE FARMING

No. 1.—*Northampton.*

AFTER having had practical experience of the fertilising effects of sewage and liquid manure, I have for several years devoted part of my leisure time to an examination of the arrangements adopted by the principal cities and towns for disposing of sewage. At first I looked at it from the agricultural stand-point; but as I proceeded with the inquiry I had to widen the range of view.

The place I visited last is Northampton. I propose at present to write a concise note of what the authorities of that town have done.

Northampton has a Board of Commissioners for dealing with sewage and kindred nuisances, which is distinct from the corporation. I believe their number is limited to twelve; of whom six belong to one political body, and six to the other. These twelve Commissioners, as a body, must, therefore, be non-political: six of one being equal to half-a-dozen of another.

The town contains at present about 50,000 people. Many experiments were made at the expense of this body for purifying the sewage. At last they adopted the scheme which I proceed to describe.

Near the town there is a number of tanks in which the sewage is allowed to settle for some time so as to enable the more bulky of its solid contents to fall to the bottom and be collected. Deprived of these solid matters, the sewage is conveyed in a main culvert, about four miles from the town, where it is received on a tract of ground

containing upwards of 300 acres, which was purchased at a cost of 130*l.* an acre. I may mention that all the figures were obligingly communicated to me, verbally, by the chief officer of the Commissioners. Up to the present the outlay has amounted to upwards of 84,000*l.* The soil is not naturally the best adapted for sewage-farming; it does not, however, offer any insuperable obstacle to success. The sewage is received at the highest point of the farm, from which it flows by gravitation to the lowest, which is several feet below the river that runs by, and into which the sewage passes after it has undergone clarification.

The sewage is distributed over the farm by a simple system of carriers, and it is used mainly for irrigation. After it goes over one plot it flows to another, and so onwards. At the lowest part of the farm a permanent plot of osiers has been planted; the intention being that this plot will serve as a filter-bed for abstracting from the sewage all offending material which is not taken out by irrigation. After percolating through the soil of this osier-bed, the clarified sewage is received in a second, or outlet culvert, which is about two miles long, and in which the fall—one foot per mile—is less than that of the river.

Under cultivated crops of all kinds at the present time, there are about 100 acres. There is one good plot or field of Italian rye-grass; one good, and one indifferent plot of mangold wurzel; and one good plot of beans. A large field of Italian rye-grass has utterly failed, and in its place grew a luxuriant crop of weeds, which would have proved an attractive feature in a botanic garden. There are other failures on which it is useless to dwell.

The land is not farmed in what could be called a skilful manner; indeed, the engineer frankly said that up to the present, farming had been a secondary object with the Commissioners.

The greater part of the uncropped land has been recently purchased. It is now being prepared for the sewage at a cost which will doubtless exceed 20*l.* an acre. I cannot help thinking that a simpler scheme would answer equally well for irrigation.

It will be understood at once that the inhabitants of Northampton have been rid of the abominable stench which the sewage formerly inflicted on them. But there remain for consideration two points of very great importance to the people who live along the river below the sewage farm. In the first place, if the sewage be not deprived of its organic impurities on the farm, it must, on mixing again with the river, cause a fresh nuisance. That the people do think so is evidenced in a newspaper report which lies before me; and judging from what I saw of the effluent water, I can sympathise with these people. I took a small bottle of this water, which I find contains a large quantity of organic matter. As it went on the osier-bed it was still sewage most unmistakeably; and when the pores of this bed—this so-called filter bed—become full of the organic impurities, as they soon must, the complaints will become louder and louder, and justly so.

I have a second objection to the arrangements here adopted, and it is this: What guarantee is there that the *contagium* of any infectious disease which may be in the sewage is destroyed? That *some* of it would be oxidised or destroyed in flowing over the ground is certain; but the necessities of the case require that the whole of it should be destroyed. I have made experiments which prove conclusively that the contagium of infectious cattle diseases is not destroyed in flowing over land, nor in passing through such a filter as is here provided; and as there is no evidence to show that the contagious principle of human infectious diseases is not equally active, it cannot be said that the Commissioners of Northampton have satisfactorily disposed of the sewage of that town.

THOMAS BALDWIN

NOTES

WE take the following from the New York *Nation* of Aug. 20:—"The American Association for the Advancement of Science has held its annual meeting at Hartford during the past and present week. The most important business before the meeting has been the consideration and adoption of a new constitution, designed to remedy a long-continued evil growing out of the popular character of the Association. The scientific character of the papers and proceedings has very frequently been such as seriously to compromise the standing of the Association in the scientific world. To remedy this, it has been decided to select from the members those who are engaged in science and form them into a separate class of 'Fellows.' All the officers of the Association are now to be chosen from this class, and the power of the several committees to exclude improper or unsuitable communications has been increased. All friends of science will await with interest the working of this improvement. The necessity of some vigorous and effective measures must be obvious to any one who will simply examine the lists of papers presented for reading. Among some hundred authors, the number of really eminent men may be counted on one's fingers, while the large majority are entirely unknown, and present papers which, so far as can be judged from their titles, are of no scientific importance. We greatly doubt whether this evil will be cured by anything short of a radical change in the publishing system of the Association. So long as there is a volume of 'Proceedings' to be published, so long will there be a pressure on the part of the less desirable class of members to have their papers printed, and this pressure can be resisted only by a little more moral courage on the part of the Standing Committee than it has hitherto exhibited. While such papers are admitted, we may be sure that few of the abler members will wish their productions to be seen in such company. It is gratifying to notice that the present meeting exhibits a decided improvement in this respect, and that notwithstanding the general unimportance of the communications, the subjects of ether and atoms do not appear among those discussed before the Association."

UNDER the Principalship of Monsignor Capel, a Catholic College is shortly to be opened in Kensington, in which the Natural Sciences will be taught without restrictions. A museum, a laboratory, and lecture rooms are in readiness; and in the Educational department more than one appointment has already been made. Mr. St. George Mivart is to lecture on zoology during the winter months, and on botany in the summer. Mr. Barff is to lecture on chemistry. From what we hear, it will not be for lack of means that this institution will not be successful.

AMONGST those who will probably be candidates for the professorship of Zoology and Comparative Anatomy, now vacant in University College, London, are Mr. E. Ray Lankester, Dr. J. Murie, and Mr. H. Seeley.

DR. ALLEYNE NICHOLSON has been appointed to the chair of Biology and Physiology about to be established in the Durham University Colleges of Medicine and Physical Science, Newcastle-on-Tyne.

ON the 3rd inst. the Bishop of Exeter laid the foundation-stone of a high-class school, to be conducted under the provisions of the Endowed Schools Act, at Newcastle-under-Lyne. His lordship dwelt chiefly on the advantages of a modern education, embracing chemistry, mineralogy, and mathematics, as compared with the old Latin and Greek system. He congratulated the borough upon doing the most important work that not only the district, but the whole of England could be engaged in, by establishing a school in which boys might not only be taught a little Latin and less Greek, but might be taught modern languages and natural science, so as to fit them for the future occupations of life.

In this connection we would refer to Sir Charles Reed's statement, on Tuesday night, at the Radnor Street Schools, City Road. "With respect to scientific education," he said, "this country is far behind other countries; and in that she has fallen back, as she has also in manufactures and in trade, and is letting such countries as America and Germany run far ahead of her. More attention must be paid in all our schools to the scientific education of children."

THE Duke of Bedford has just sent 100*l.* for aiding in the establishment of the Artisans' Institute for Promoting General and Technical Knowledge, to the Rev. H. Solly, who is to be its first principal. Mr. Samuel Morley, M.P. (who is one of the trustees in conjunction with Lord Lyttelton and Mr. Hodgson Pratt), has also given 100*l.*, besides guaranteeing 100*l.* a year for three years. These, with smaller contributions from a number of other friends, have enabled the trustees to take premises in Upper St. Martin's Lane, which will be well adapted for the purpose when considerable alterations have been made in them. The object of the Institute appears to be to exemplify in a central locality, and in a special instance, those plans for the general and technical instruction of the working classes which so many of them now desire to see carried into effect, and which Mr. Solly aimed at promoting on a national scale by the formation of the "Trades Guild of Learning." Pending the satisfactory establishment and full development of the larger organisation, it is hoped that the proposed Artisans' Institute will, both directly and indirectly, give a considerable impulse to the higher as well as technical education of the skilled workmen of the metropolis, as many of their leading men have publicly signified their cordial approval of the project; and the desire for increased culture is rapidly increasing among that important and intelligent class. It is expected that the Institute will be ready to open early in October. Donations in aid of it will be thankfully received, and may be paid to the account of Mr. Hodgson Pratt, treasurer *pro tem.*, at the London and Westminster Bank, 217, Strand.

AN enthusiastic meeting was held in Bombay on the 1st of August, at which a committee was appointed for the purpose of raising a fund by public subscription for a memorial to the late Dr. Bhau Dajee, of whom we gave some account in a recent number.

THE Government of India, says the *Bombay Gazette*, has determined to perpetuate the memory of Dr. Stoliczka, the distinguished naturalist, who met his death on the return journey from Yarkand, by erecting, at the public expense, a tomb over his remains at Leh, and a tablet in the new Indian Museum at Calcutta.

THE death is announced of Sir John Rennie, C.E., F.R.S., the eminent civil engineer, under whose direction some of the most important engineering works of the past half-century have been carried out. Sir John, who died on Thursday last at Bengeo, in Hertfordshire, was born in 1794, and was the son of the late Mr. John Rennie, who designed new London Bridge, and who also designed and executed Southwark and Waterloo Bridges. Mr. Rennie educated his son for his own profession, and left to him the task of executing his designs for London Bridge. On its completion and opening in 1831 Mr. Rennie received the honour of knighthood. Several foreign distinctions had been conferred upon him.

OUR readers will be glad to hear of the safety of the members of the Austrian Payer and Weyprecht Arctic Expedition, who have been out for two years, and who, it was feared, had come to grief. A *Times* telegram, dated Christiania, Sept. 5, gives a brief history of the expedition. They left Tromsö in the *Tegethoff* on the 14th of July, 1872. They encountered compact drift ice in 48° E. long., and worked themselves through until, in 58° E. long., they reached the coast of Novaya Zemlya, under the Admiralty Peninsula. They sailed along the coast to Berch Islands, where they met Count Wiltczek's sloop *Isbjörn*. They sailed together with him further to Barents Islands, near the promontory of Cape Nassau, where they remained at anchor till the 21st of August, 1872, on account of south-westerly storms. There a depôt of provisions was established. They parted with Count Wiltczek and steered north-east the same day, and were completely frozen in. They drifted with the pack ice fourteen months, first north-east to 73° E. long., and then north-west until October 1873. In August 1873 a new land was discovered, They drifted with the ice along this land. They were frozen in, and wintered in 79° 51′ N. lat. and 59° E. long. In March and April 1874 sledge expeditions were sent north and west; 82° N. lat. was passed, and land was seen to the 83rd degree. The extent of the land northwards and westwards was, apparently, considerable. The ship, now being untenable, was abandoned. Starting on the 20th of May, 1874, with four sledge boats, they met the open water on the 15th of August, and crossed to Novaya Zemlya, and went along the coast in search of vessels. They met a Russian schooner on the 24th of August in Puchowa Bay, and arrived at Vardoe, in Norway, on the 3rd of September. The health of the crew was excellent. Engineer Krisch died in March 1874 from tuberculous disease. Large mountain ridges are said to have been observed in the newly discovered land, but no signs of animal life; and immense glaciers were met with.

THE loss is announced of the whaler *Arctic*, of Dundee, at Davis's Straits. The *Arctic* at the time she was lost was full. She was commanded by Capt. Adams, with whom, it will be remembered, Capt. Markham, R.N., of the *Sultan*, made a voyage of investigation a year ago. Capt. Adams had distinguished himself by the surveys which he made of several of the Arctic coasts. All hands have been saved.

THE Berlin African Exploration Society is fitting out a second expedition to the interior of Africa. Herr Alexander von Hormayer, the well-known ornithologist, will be the leader of the expedition, and will go from St. Paul de Loanda by way of Kassimbe to Moatta Jambe.

THE British Bee-keepers' Association, founded in May last, has been fortunate in securing Sir John Lubbock as its President, and though the members number but little over 120, they have already shown a commendable earnestness. On Tuesday they held, at the Crystal Palace, their first show of bees, hives, honey, and accessory apparatus; and during the day some of the bee masters manipulated their hives, showing how to take honey, introduce queens, and to do other necessary work usually supposed to be accompanied with some danger. The primary object of the Association is to promote the more extensive cultivation of bees, especially by cottagers, and the study of the best way of obtaining most honey with the least waste. The American "Slinger" was shown in operation, and effectually drives out by centrifugal force all honey from a comb without injuring the By the application of this principle much of the time that would be occupied in making cells is saved, and bees at once begin refilling the comb. A secondary object of the Association is to promote the study of the habits and powers of bees, and special prizes were offered for observatory hives. Now that Sir John Lubbock has led the way in showing how to observe individual bees (see NATURE, March 26), we may expect that many people will be induced to take up such an interesting subject and add to our stock of knowledge. Almost everything about the powers of bees has yet to be learned. An observatory hive stocked with bees costs, we believe, only about thirty shillings, and the *British Bee Journal* is always willing to give any information to inquirers needing instruction. The last number that has been forwarded to us, and besides giving a great deal of practical instruction, contains an interesting article on the Philosophy of Hive Shape.

THE Southport (Lancashire) Aquarium will be opened on the 16th inst.

AMONG the newly enrolled members of the Victoria Institute is M. Joachim Barrande, the Bohemian palæontologist.

A TELEGRAM from Rome of Sept. 5 announces that the eruption of Mount Etna has ceased, but that the shocks of earthquake continue.

THE *Melbourne Argus* has the following among its news from the South Sea Islands :— "On the 30th of April Captain M'Kenzie observed what he believed was a submarine volcano in a state of activity. When about midway between Haabai and Tonga, two of the Society Islands, about 12 miles from land, he observed a large column of water shoot up fully 100 feet into the air. There was a dense cloud of what appeared to be steam rising from the ejected water. Captain M'Kenzie was afraid to go sufficiently near to ascertain whether it was warm water that was ejected, but upon this point there can be little doubt. The spot where he saw the water sent up is marked on the chart as a shoal, and so long as he was in sight the water continued to be sent upwards with equal force."

THE additions to the Zoological Society's Gardens during the past week include a Toque Monkey (*Macacus pileatus*) from Ceylon, presented by Mrs. Thomas; a Macaque Monkey (*Macacus cynomolgus*) from India; a Malbrouck Monkey (*Cercopithecus cynosurus*) from West Africa, presented by Mr. H. C. Marckmann de Lichtabbell; an Arctic Fox (*Canis lagopus*) from the Arctic Circle; a Black-headed Gull (*Larus ridibundus*) European, presented by Mr. Keell; a Prairie Marmot (*Arctomys ludovicianus*) from North America, presented by Mr. Thellusson; a Guilding's Amazon (*Chrysotis guildingi*) from St. Vincent, purchased; four Houbara Bustards (*Houbaria undulata*) from Tripoli, deposited.

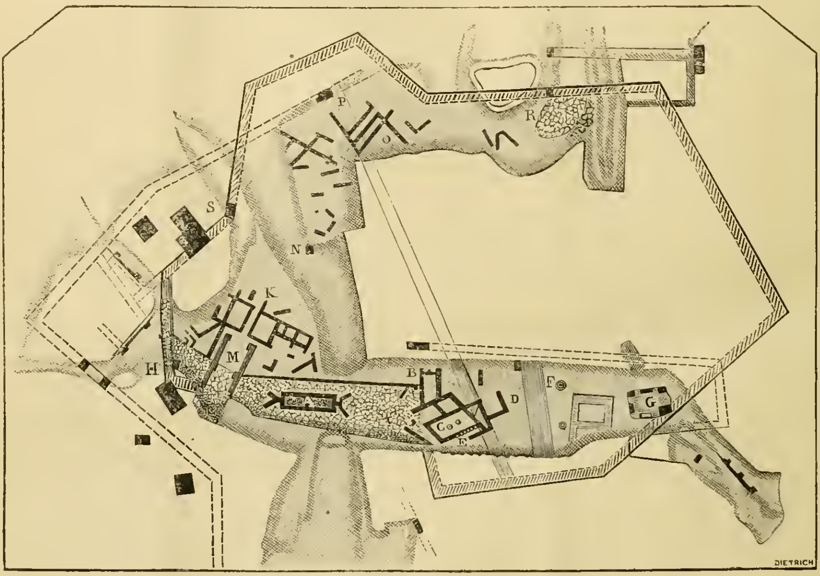


FIG. 1.—Plan of Troy in the time of Priam. A. Tower of Ilium. B House of two storeys before the taking of Troy. C. Trojan structures and later structures superposed. D. Trojan houses E. Large earthenware jars. F. Altar for sacrificing to the Trojan Minerva, with drain for carrying off the blood. G. Remains of Trojan houses. H. Place where the treasure of Priam has been found. K. Remains of Priam's palace. M. Gates. N. Wall prior to Troy. O. Trojan houses and later walls superposed. P. Fortified wall prior to Troy. R. Wall of defence prior to Troy. S. Remains of the *enceinte* of Troy.

THE RUINS OF TROY: RECENT DISCOVERIES OF DR. SCHLIEMANN *

OUR age is eminently an age of investigation, and, more than any previous one, is drawn towards archæological studies by a restless and feverish ardour. Dissatisfied with the present, it rushes back into the past, to seek for traces of the most ancient origins of man and of his races, the primitive sketches due to his artistic and industrial genius, the beginnings, still so obscure, of his history, and even of prehistoric times. The learned works of Mr. Layard on Nineveh and Khorsabad, the fruitful excavations of M. Mariette in Egypt, those of the Americans in the mounds and tumuli of the Ohio and Mississippi, the discoveries, so valuable for human palæontology, due to the courageous perseverance of Boucher de Perthes and to the ingenious sagacity of M. Lartet, of Sir Charles Lyell, of Sir John Lubbock, Prof. Wilson, Mr. E. B. Tylor, and others,—does not all this indicate a very distinct movement towards researches which have for their object the vestiges which man has left on the earth or in its depths from the most remote periods?

To the number of the most recent archæological labours which have strongly attracted public attention, we must add, with good reason, the important and magnificent work of Dr. Heinrich Schliemann, which has just been published at Leipzig, under the title of "Trojanische Alterthümer" (Trojan Antiquities).

A poet has said, in speaking of the ancient city, whose misfortunes another poet has sung in immortal verse,—

"Etiam periere ruinæ."

But Dr. Schliemann and the noble companion of his life and his labours have given the lie to Lucan. Others, it is

* Translated from an article in *La Nature*, by Dr. N. Joly, of Toulouse.

true, believed that they had discovered the ruins long ago. Towards the end of last century (1788), a French traveller, Le Chevalier, professed even to have proved that Virgil was mistaken in placing, along with all Greek antiquity, the city of Troy and its citadel on the heights indicated by Homer, the little hill which to-day bears the name of Hissarlik.* According to him, the Homeric city must have been built upon the site occupied by the present village of Bunarbashi; the citadel of Pergamos was situated, on the contrary, on one of the rocky hills which encloses the Scamander, and at the summit of which is seen three conical knolls, ranged in a line, which Le Chevalier regarded as the tombs of the Trojan heroes. As to the springs which flow from the foot of the hill, these were, according to the author of the "Voyage en Troade," those where the Trojan girls went to wash their clothes.

Although based on topographic data very open to controversy and upon texts falsely interpreted, the work published in 1788 by Le Chevalier had a very great success (three editions from 1788-1802), and his opinion, thoroughly erroneous as it was, acquired, so to speak, the force of law.

Even quite recently (in 1871), this opinion found an unfortunate defender in Dr. Karl Curtius, of Berlin, and that at the very moment when the excavations of Sir John Lubbock, of Consul Hahn, and, above all, those of Dr. Schliemann, put Bunarbashi out of the question, and brought forward the most convincing proofs in favour of Hissarlik.

In fact, these excavations have demonstrated, as far as evidence can go, that neither the pretended Trojan tombs indicated by Le Chevalier, nor the site of Bunarbashi itself, contains any archaic object, any trace of human habitation. It is, then, neither at Bunarbashi, nor at Chiblak, nor at Atchi-Kienni (which is now quite given up), that we must seek for the veritable Troy and the citadel of Pergamos. Let us see if we shall be more

FIG. 2.—Large earthenware jars found in the ruins of Troy, at E, in Fig. 1.

fortunate in carrying on our investigations on the site of Hissarlik; that is to say, in allowing ourselves to be guided by popular tradition, the writings of the most ancient trustworthy authors, and chiefly by the gigantic excavations executed at so great an expense and with so much zeal and intelligence by Dr. Schliemann and his wife.

Here, independently of the authority of Homer, we have still that of Herodotus, of Xenophon, of Arrian, of Plutarch, of Justin, who all agree in placing the Ilion of Homer at Hissarlik; that is, at the place where Dr. Schliemann has found ruins overlaid by many layers of more recent ruins. In one of these layers, which extends from seven to ten metres below the summit of the hill, are found, in fact, incontestable proofs of a violent fire,†—a palace, a double gate situated on the west of this palace, a tower rising at some distance from the double gate, religious symbols (images and vases in the shape of an owl, γλαυκῶπις Ἀθηνή), and finally a treasure containing objects which, in their smallest details, answer to the descriptions which Homer gives us. Is there not here enough to satisfy the most sceptical and most exacting?

Begun in the month of April 1870, the excavations executed by Dr. Schliemann were only terminated in October 1873. They have thus occupied him three entire years, and that in the midst of the greatest difficulties, sometimes even at the risk of his life and that of the numerous workmen, Turks and Greeks, whom he employs in these works. I pass in silence the harassing difficulties which the Turkish Government has raised to prevent him attaining the precious results with which these excavations have enriched the science of the past.

(*To be continued.*)

* For an excellent study on the topography of Troy, see an article by M. Emile Burnouf in the *Revue des Deux-Mondes* of Jan. 1, 1874.

† M. E. Burnouf places the fire in the seventeenth century B.C., 700 years, according to some, before the time of Homer.

THE BRITISH ASSOCIATION

Reports

Report of the Committee on Experiments to determine the Thermal Conductivities of certain Rocks, by Prof. Herschel and Mr. Lebour.

In the introductory notes on these experiments, published as an appendix (p. 233) in the last volume (for 1873) of the British Association Reports, the list of rocks selected and the manner of experimenting on them were described. With the exception that sections of Calton trap rock, of a great pyramid casing stone (nummulitic limestone), Caen stone (or Normandy building limestone), Cannel coal, chalk, and red brick were added to this list, and that the apparatus received some small but very important improvements to make it heat tight, the material of the experiments as well as the method of working them remained substantially the same as last year. Instead of a conical tin vessel with 1 lb. of water, a cylindrical one holding $2\frac{1}{2}$ lbs., with an internal agitator and thermometer, was used as the cooler. The opposite faces of the heater and cooler were lined with velvet and each clasped by a caoutchouc collar, which, projecting a little above them, clips the circular edge of the rock plate when it is placed between them, and two small notches cut in each collar also allow the wires of a thermocouple to be introduced, touching the rock-surfaces while the rock is being heated. With the view of traversing the plate with the thermopile in different directions, the piece of stout palladium wire (about 18 gauge) used as the electromotive element between the two iron wire branches of a delicate reflecting galvanometer, was silver-soldered to the iron wires at its two ends, all the wires being first rolled thin and flat to some distance from the junctions. The scythe or scimitar-blade shape most easily given to the wire in rolling it thin was advantageous in the construction, because, instead of uniting the wires continuously in one straight length and folding the points of junction on opposite sides of the rock (thus confining their range upon it to a single diameter or to one straight line), advantage of the curvature was taken to connect the wires by superposition, instead of by prolongation at their junctions, without overlying each other, into two flat ogee arches, or merry-thought-like blades, between which the rock is held as in a forceps. The straight unrolled parts of the wires are bound very firmly to a square piece of wood, which acts as a handle to guide the points of the forceps to various parts of the rock-faces, while it keeps them securely in their places, and thus allows the small elastic pressure of the wires to clasp the rock gently between the points of the thermo-electric pincette without assistance from the velvet covers. After thus inserting a rock section in the apparatus, protecting the rock and cooler from below with a stout wooden screen, and from loss or gain of heat in other directions by a suitably thick case of woollen stuff and a few bandages of similar materials, the rate of rise of temperature in the cooler, when agitated, was noted by the average number of seconds taken by a delicate thermometer contained in it to rise $\frac{1}{5}$° F. (one graduation on its stem) as soon as this rate of rise was found to have become sensibly constant. About twenty minutes were usually occupied in the beginning of an experiment with waiting for a steady condition of the thermometer readings, and ten or twelve minutes more were required to ensure it and to obtain the average rate of their increase for the rock specimen under observation. The temperature difference shown by the galvanometer at the same time at first rose rapidly to a high maximum and then descended very gradually to a fixed lower reading. The pincette was traversed to and fro over the rock surfaces while the thermometer was being noted, and exhibited during these motions fluctuations answering to about 1° or 2° F. on either side of an average position; corrected for zero of the scale and reduced by trials for this purpose between every two or three experiments to Fahrenheit degrees, the temperature difference thus formed, divided by the quantity of heat transmitted to the cooler per minute, gave the apparent thermal conductivity of the plate. The results in Peclet's units were scarcely more than one-third of what Peclet and other earlier experimenters had obtained. It was obvious that, instead of marking the temperature difference between the two solid contact surfaces of the rock and velvet which they touched, the points of the thermo-electric forceps showed the temperature of the fluid air-bath in which those two surfaces are immersed. The extreme mobility of this integument, enabling it to penetrate through the velvet to the plates of the heater and the cooler, while it equally insinuates itself between the rock surface and the thermopile that can only enter into actual solid contact with each other (at least theoretically) at three points, controls the temperature of the metallic thermometer far more powerfully than the rock face that it touches, and the real temperature differences between the rock faces are accordingly completely masked. It is very probable that if the velvet covers fitted on the instrument were replaced by soft wash-leather, the source of this error would be very much reduced; and although it is certain that the confronting surfaces of the rock and leather faces will nowhere have actually the same temperature, from the existence of a sensible quantity of resisting air between them, so that, as before, the thermopile will not mark the true rock temperature difference, but a mean between that difference and a similar difference for the leather faces, yet the range of this error will be incomparably smaller than in the experiments already made with velvet covers, whose loose texture precludes the possibility of regarding the comparative results now obtained as positively correct, or more than first approximations, from which the errors arising from surface characters of the rock sections tested have not yet been removed.

To obtain the true rock temperature differences, means were taken to cement the thermopile points to the rock with plaster, a course it would be desirable to adopt with as few samples as possible as standards of correction for the rest, on account of the tediousness of the process and the injury that it necessarily entails to the beautifully worked surfaces of many of the plates. If the correction so found to be required can be restricted by the mode of operating to a range of such small limits as to be applicable generally, without appreciable influence of the surface characters, in making its occasional departures from a mean value very sensible, then the reduction factor found by absolute experiments on a few rocks of characteristically rough and smooth or polished surfaces to obtain the true temperature difference for a given heat-flow from the apparent one shown by the thermocouple placed simply between the rock and leather faces will be admissible within the limits of error of the observations to convert a list of apparent conductivities as just supposed to be obtained from a mere comparative table of relative conducting powers to a table of absolute thermal conductivities, in which the errors of the values given will certainly not be greater than would in all probability have been committed had the direct method of absolute measurement been applied separately to each specimen of the list, instead of only to a few rocks, to furnish data on which calculations of the remainder may be founded. Circular discs of linen, well wetted with plaster of Paris, mixed with a little glue or white of egg, were laid over the surfaces of two or three of the rocks, enclosing under them and against the rock (to which they were also plaster-wetted) the two branches of the thermopile pincette. When these had set quite hard under pressure and were thoroughly dried by a gentle heat, they were placed in the apparatus, and a measurement of the absolute temperature difference and accompanying heat-flow was thus obtained, affording the real conductivity and a means of comparing it with the apparent one found by similar observations of the same rock when no plaster was used, and when the points of the thermopile merely pressed against its surface. Thus the thermo-electric difference obtained with the wire couples merely touching the surfaces of white statuary marble between velvet faces was 16°, while for the same heat-flow when the arms of the thermopile were firmly plastered to the marble plate, the temperature difference observed was only 16°·2*—being more than $2\frac{1}{2}$ times as large a difference in the former as in the latter case. With whinstone the corresponding temperature differences were 26° and 8°·5.—in the proportion of very nearly 3 : 1. A similar experiment was made with cannel coal, of which the conductivity is much less than that of the last-mentioned rocks, the temperature differences obtained being for the same heat-flow in the plain and plastered plate 53°·4 and 39°·7; in the proportion of only 1·37 : 1—a far smaller reduction than was observed in the two foregoing cases. Care is, however, necessary to introduce wet plaster under as well as over the points of the thermopile in cementing them to the rock, that air may be excluded and the junction may be solid, a precaution which was omitted in this case, as plaster without size was used, which in drying sometimes flakes off from the

* The heat-flow through the plate was actually greater in this latter than in the former case in the proportion of about 5 : 4, showing that the rough plaster-washed linen surface received and delivered heat to the velvet covers much more readily than the smoothly-dressed surface of the stone, and the whole resistance was less in the latter than in the former case, although the rock plate itself had been made thicker. The same diminution of the total resistance occurred also in the experiment with plastered whinstone.

rock surface either entirely or in places. This may render an experiment, as that on cannel coal may not impossibly have been, from this cause entirely valueless; yet this result presents itself, with many others met with in the investigation, as very well worth repetition, with fresh precautions and with new arrangements to guard against the possibility of false conclusions.

Adopting for the present, as probably not very far from the truth, a common reduction factor of $2\frac{2}{3}$ as the proportion in which the recorded temperature differences of the plain rock surfaces between velvet faces exceeded the true temperature differences of the surfaces of the rocks examined, and introducing some very small corrections for the thicknesses of the plates, the thermal capacity of the metal cooler, &c., which are all probably (as well as the allowance for heat-absorption in raising the temperature of the rock plates very slowly during the observations) really negligible in comparison with the uncertainty that attaches (except in one or two well-observed cases of absolutely measured temperature differences of the rock faces) to the great majority of the determinations from unknown peculiarities of surface contact and temperature assimilation where air is not excluded from the junctions, or rendered stagnant in its mode of heat transmission, the following table gives the absolute thermal conductivities (in centimetre-gramme-second, or absolute British Association units) thus provisionally obtained, together with a few similar results found by Peclet, Forbes, and Sir William Thomson in rocks differing little in their description from those included in the present list.

Provisional Determinations of Thermal Conductivities of certain Rocks.—First Experimental Results.

Description of Rock.	Thermal conductivity (gramme-water-degree heat units per second) at 1° difference of the faces, through a centimetre cube.	Earlier Observations of Conductivities of similar Rocks.		
			Description of Rock.	Observers.
Grey Aberdeen granite...	·00600			
Red Cornish serpentine	·00483			
Calton trap rock (first specimen)... ...	·00520	·00266	Calton trap rock	Forbes and Thomson.
Whinstone	·00312	·00169	Sand of experimental rock, Thermometer garden	Forbes and Thomson.
Kenton sandstone	·00489	·00689	Cragleith sandstone	Forbes and Thomson.
Congleton "second grit" stone	·00462			
Slate	·00392			
Alabaster	·00412			
Sicilian white statuary marble	·00559	·0097	Fine-grained grey marble...	Peclet.
Irish fossil ditto	·00559	·0077	Coarse crystalline white ditto	Peclet.
Devonshire red ditto	·00525	·0058	Fine-grained calcareous stone.	
Italian vein marble (white, grey veins)	·00512	·0047	" " "	
Irish green marble	·00507			
Nummulitic limestone (a piece of Great Pyramid casing-stone)	·00433			
Caen (building) limestone	·00395	·0037 ·0035	Coarse-grained lias building stone	Peclet.
Chalk...	·00384			
Black shale (Newcastle-on-Tyne) ...	·00178			
Cannel coal	·00161			
Plaster of Paris (for castings)	·00163	·00145	Ordinary fine plaster (made up)	Peclet.
		·00122	Finest ditto for casting (made up)	Peclet.

The Report of the Committee for superintending the monthly reports of the progress of Chemistry, by Profs. Roscoe and Williamson, was then read by Prof. Roscoe. The report was very short; the committee does not intend to apply to the British Association for a further grant after the present year.

Report of the Committee on Essential Oils, by W. Chandler Roberts.—The following oils have been examined: Wormwood, Citronella, and Cajeput. The actions of phosphorus pentasulphide, of zinc chloride, and of bromine upon the oils were described. The first-named reagent generally acts by removing the elements of water, with formation of terpenes and cymenes. Zinc chloride generally causes decomposition, giving rise to a mixture of hydrocarbons. Bromine usually forms a bromide, which is then decomposed with evolution of hydrobromic acid and water and formation of a cymene.

Various cymenes have been examined, all of which seemed to be the same. The formation of cymenes from terpenes by the action of sulphuric acid has been verified. Cymenes have also been obtained from oil of turpentine by continued fractionation.

The following numbers express the optical properties of some of these oils:—

	Specific refractive energy.	Specific dispersion.
Absinthol	·4887	·0234
Cajeput	·4916	·0251
Citronella	·5213	·0289
Citronellol	·5176	·0284

The conclusion drawn is, that cymene is the central body in these essential oils, to which the other constituents are closely related; the varying amounts of mechanical energy required for the formation of the different isomerides have not as yet been determined.

Dr. Gladstone said that the optical properties of sixteen cymenes had been examined. Some of these were obtained from substances of low, others from substances of high refractive energy, but in all cases the refraction of the cymene was the same; the refraction of a substance depends, therefore, on the constitution of the substance itself.

Report of the Committee on the Estimation of High Temperatures, by J. Dewar, F.R.S.E.—The committee has not carried on any investigations during the past year.

Gold Assays, by W. Chandler Roberts.—Little has been done by the committee during the past year, but they hope to be able to report fully at the next meeting.

Report of the Committee for assisting in the Exploration of the Victoria Cave, Settle, by R. H. Tiddeman, secretary to the committee.

The explorations have been continued throughout the chief part of the year. The Settle Committee have raised by private subscriptions and spent, besides the British Association grant of 50*l.*, a sum of 113*l.* 4*s.* 3*d.* The late determination of a bone which had been found by the committee in the cave in May 1872 as human, by so great an authority as Prof. Busk, induced the committee to pay their chief attention to the question of its position and the relation of the beds in which it occurred to the physical changes to which the district has been from time to time subjected. In order to do this it was necessary to remove a large portion of the tip of the older workings, which had unfortunately accumulated below the entrance of the cave. Beneath this the Romano-Celtic layer was reached, and several objects of bronze, including bracelets, a vinaigrette, and other articles, were obtained. The Romano-Celtic layer was from 1 ft. to 1 ft. 6 in. thick; beneath this was a thickness of 19 ft. of screes, consisting of angular fragments of limestone, which had fallen from the face of the cliff above. This contained no bones whatever, nor the smallest fragment of any rock but the white limestone of which the cliff above is made. But at the base of this a great many boulders were discovered of all dimensions up to 7 ft. in diameter. The number of these boulders and the peculiar conditions of their position render it quite impossible that they can have been brought through any fissure in the roof of the cave, and so washed in later times over the beds containing the human fibula and the remains of the older mammals. The great weight of some of them quite militates against this idea. Another suggestion, that they may not have been left in their present position at the melting of the ice-sheet, but may have fallen from the cliff in comparatively recent times, is also negatived by the complete absence of any evidence of any such fall through the long period represented by the 19 ft. of screes, their occurrence only at the base of the screes, and by the absence of any drift from the cliff above for some distance round. But another strong argument against this supposition lies in the fact that the boulders are so close beneath the cliff, that if all the limestone weathered from the cliff above and now resting on the boulders were restored to the cliff it would project so much further forward that

it would be impossible for them to fall into their present position; yet we know from their position that the boulders were dropped there before any portion of the screes had accumulated, and therefore at a time when the roof of the cave undoubtedly reached much further forward.

The inevitable conclusion is that man lived in Yorkshire with *Elephas antiquus*, *Rhinoceros tichorinus*, *Ursus priscus* and *spelæus*, *Hyæna*, *Bison*, and red deer long before the existence of the great ice-sheet in Northern Britain and Ireland.

Report of the Boulder Committee.

The Rev. W. H. Crosskey read the report of this committee appointed for the purpose of recording the position, height above the sea, lithological characters, size, and origin of the more important erratic blocks, and groups of erratic blocks, of England and Wales, and reporting other matters of interest connected with them. A schedule has been issued by the committee containing detailed questions of the information required. The object of the committee is not speculative, but to collect the facts, with the intention of afterwards proceeding to their classification, and pointing out their relations to the various theories under designation in glacial geology. Districts in which boulders are rarest are of special importance. The evidence regarding the southward extension of the ice sheet and the reach of the waters of the glacial sea depends largely upon their presence and absence; while their method of distribution is full of geological meaning. The necessity for the work of the committee is increased by the fact that all over England and Wales the destruction of boulders is rapidly proceeding. In the midland districts, a map is being constructed in which the approximate number of boulders and the character of the rocks of which they are formed, together with the effect of the configuration of the country on their distribution, will be shown. From the general position of the boulders it is evident that boulders were deposited at several ages. There are (1) boulders of the earliest ice periods, (2) boulders of the period of submergence, distributed in the lower parts of the glacial clays, (3) boulders of the period of the re-elevation of the land. These varieties have yet to be traced to their various sources, and upon this work members of the committee are engaged. It is as impossible to assign all the boulders to one epoch of distribution, as it is to relegate all glacial sands, clays, and gravels to one period. The report contains details regarding boulders of various districts. From Leicestershire, one fact of especial importance is recorded. Below the drift clay and quite distinct from the surface boulders freely scattered over the country, a group of boulders has been exposed in an excavation made in the centre of Leicester, 25 ft. deep, composed of rocks of foreign origin, and suggesting a stranded iceberg of an early period. In the same county, isolated boulders of large size, and groups traceable to sources some miles distant, prove Charnwood Forest to have been a centre of ice-action of considerable intensity. In Warwickshire a great change occurs. The drift-beds are reduced almost to pebbles; and local geologists give the name of boulders to specimens which in other parts would not be regarded as worthy of the name. Striations are faint and rare. Their grouping is remarkable, and they come from all points of the compass. Isolated boulders are recorded from Northumberland, Yorkshire, Lancashire, Devonshire, and Denbighshire. The committee request members of the Association who have received schedules to return them, and desire communications from geologists disposed to assist them in their work.

The Close Time Committee.

A report was read from the Close Time Committee with reference to the desirableness of establishing a close time for the preservation of indigenous animals. After stating the steps which had been taken with reference to this subject in Parliament, the committee stated its belief that the effect of birds' nesting on such kinds of birds as are known to be diminishing is altogether inappreciable, while its effect on those whose numbers are not decreasing may be safely disregarded, and consequently that there is no need of any legislative interference with the practice. The committee believed that the only practicable mode of checking the diminution of such birds as have been proved to be decreasing is the effectual protection of the adults from destruction during the breeding season. While the Sea Birds Preservation Act continued to work successfully, the Wild Birds Protection Act had done little, if anything, towards attaining the objects for which it was passed, and in various quarters gave considerable discontent. Birds commonly known as "wild fowl" were subjected to very great persecution through the inadequacy of the present law to protect them; they were rapidly reducing in number; they were not only innocuous, but were of great value as food. Consequently the committee hoped that the efforts they intended to make on behalf of wild fowl in the next session of Parliament would obtain a general support. Representations as to the inordinate slaughter of seals which took place every spring in the North Atlantic Ocean had been made to some members of the committee. There could be no doubt that such slaughter at that season would soon bring these animals to the verge of extermination, as had been the case in many other parts of the world, and since their destruction would affect a very large trade, their proper protection seemed to be a subject not at all unworthy of the consideration of the Government. The committee requested their reappointment.

SECTIONAL PROCEEDINGS

SECTION A—MATHEMATICS

On the Perturbations of the Compass produced by the rolling of the Ship, by Sir William Thomson.

The heeling error which has been investigated by Airy and Archibald Smith is the deviation of a compass produced by a "steady heel" (as a constant inclination of the ship round a longitudinal axis, approximately horizontal is called). It depends on a horizontal component of the ship's magnetic force, introduced by the inclination; which compounded with the horizontal component existing when the ship is upright, gives the altered horizontal component when the ship is inclined. Regarding only the error of direction and disregarding the change of the intensity of the directing force, we may define the heeling error as the angle between the directions, for the ship upright and for the ship inclined, of the resultant of the horizontal magnetic forces of earth and ship at the position of the compass. These suppositions would be rigorously realised with the compass supported on a point in the ordinary manner if the bearing point were carried by the ship uniformly in a straight line. They are nearly enough realised in a large ship to render inconsiderable the errors due to want of perfect uniformity of the motion of the bearing point if this point is placed anywhere in the "axis of rolling," * for in a large ship the compass, however placed, is not considerably disturbed by pitching, or by the inequalities of the translatory motion caused by waves.

Hence, supposing the compass placed in the axis of rolling, the perturbation produced in it by the rolling will be solely that due to the variation of the horizontal component of the ship's magnetic force. Such a position of the compass would have one great advantage—that the application of proper magnetic correctors adjusted by trial to do away with the rolling error would perfectly correct the heeling error. To set off against this advantage there are two practical disadvantages: one that the axis of rolling (being always below deck) would not be a convenient position for the ordinary modes of using the compass; the other, far more serious, that in ships, at all events with iron decks, the magnetic disturbance produced by the iron of the ship would probably be so much greater at any point of the axis of rolling than at suitably chosen positions above deck as to more than counterbalance the grand kinetic advantage of the axial position. But careful trials in ships of various classes ought to be made, and it *may* be found that in some cases the compass may with preponderating advantage be placed at the axis of rolling. Hitherto, however, this position for the compass has not been used in ships of any class, and, as we have seen, it is not probable that it can ever be generally adopted for ships of all classes. It is therefore an interesting and important practical problem to determine the perturbations of the compass produced by oscillations or other non-uniform motions of the bearing point.

The general kinetic problem of the compass is to determine the position at any instant of a rigid body, consisting of the needles, framework, and fly card, which for brevity will be called simply the compass, moveable on a bearing point, when this point moves with any given motion. Let the bearing point experience at any instant a given acceleration, α, in any given direction. Let w be the mass (or weight) of the compass, and $g\,w$ the force of gravity upon it, reckoned in kinetic units. The

* One way, probably the best in practice, of finding by observation the position of the axis of rolling is to hang pendulums from points at different levels in the plane through the heel perpendicular to the deck, till one is found which indicates the same degrees of rolling as those found geometrically by observing a graduated scale (or "batten") seen against the horizon.

position of kinetic equilibrium of the compass at that instant is the position in which it would rest under the magnetic forces and a force of *apparent gravity* equal to the resultant of gw and a force αw in the direction opposite to that of α. Now the weight of the compass is so great, and its centre of gravity so low, that the level of the card is scarcely affected sensibly by the greatest magnetic couple experienced by the needles.* Hence, in kinetic equilibrium the plane of the compass card is sensibly perpendicular to the direction of the "apparent gravity" defined above; and the magnetic axis of the needles is the direction of the resultant of the components in this plane of the magnetic forces of earth and ship. Hence it is simply through the *apparent level* at the place in the ship occupied by the compass differing from the true gravitation level that the problem of the kinetic equilibrium position of the compass in a rolling ship differs from the problem of the heeling error referred to above. That we may see the essential peculiarities of our present problem, let there be no magnetic force of the ship herself or cargo. The kinetic equilibrium position of the magnetic axis of the compass will be simply the line of the component of terrestrial magnetic force in the plane of the apparent level. The author then investigates, by a mathematical process, an expression for "the kinetic equilibrium error," which is so named in order to distinguish it from the error actually exhibited by the compass. The kinetic equilibrium error is exactly the error which would be shown by an ideal compass with infinitely short period of vibration. A light quick needle (either with silk fibre suspension or supported on a point in the ordinary way), having a period of not more than about two seconds, shows the rolling error very beautifully, taking at every instant almost exactly the position of kinetic equilibrium. Sir W. Thomson has thus found it so great in a small wooden sailing vessel that it became very difficult to make exact observations with the quick compass, either in the Firth of Clyde or out at sea on the Atlantic, unless when the sea was exceptionally smooth. The kinetic theory of forced oscillations is readily applied to calculate, whether for a wooden or an iron ship, the actual "rolling error" of the compass from the "kinetic equilibrium error," but the author remarks that it would extend the present communication too far to enter on details of this solution. For the present it is enough to say that no admissible degree of viscous resistance can make the rolling error small enough for practical convenience, unless also the period of the compass is longer than that of any considerable rolling to which the ship may be subjected. Probably a period of from fifteen to twenty seconds (such as an ordinary compass has) may be found necessary for general use at sea; and it becomes an important practical question how this is best to be obtained, consistently with the smallness of the compass needles necessary for a thoroughly satisfactory application of the system of magnetic correctors, by which the Astronomer Royal proposed to cause the compass on an iron ship to point correct magnetic courses on all points.

On the Spectrum of Coggia's Comet, by Dr. Huggins.—The new point noticed in this communication was that the bands of the comet were so far shifted as to indicate—supposing there really was carbon in the comet—that the relative motion of the approach of the comet to the earth was forty-six miles per second. The comet really, however, approached the earth at the rate of twenty-four miles per second; and it was therefore uncertain whether the whole or part of the difference in this velocity was due to the motion of matter within the comet. The brighter portion of the head of the comet was due evidently to a larger proportion of the matter giving a continuous spectrum. It seemed probable, therefore, to the author that the nucleus was solid, heated by the sun and throwing out matter which formed the coma and tail; and part of this was in a gaseous form, giving the spectra of bright lines. The other portion existed probably in small incandescent particles; the polariscope showing that certainly not more than one-fifth of the whole light was reflected solar light.

Further Experiments on Light with circularly ruled plates of glass, by Philip Braham, F.C.S.

Interposing plates of circularly ruled glass in the beam of light from a heliostat, the rings of colour are in the same order by reflection and refraction, the red in both cases being outward.

Observing the rings of reflected colour when the unruled surface of the glass is away from the heliostat, dark bands make their appearance concentric with the coloured rings, if the surface of the rulings is at right angles to the direction of the beam, and on altering the angle of the ruled plate the dark bands expand until they intersect the coloured circles, and also appear considerably beyond them.

Placing a polished plate of speculum metal in contact with the ruled surface of the glass increases the intensity of the dark bands, and by adjustment shows that according to the distance of the reflecting surface from the ruled, the number and thickness of the dark bands are increased or diminished.

A description was given of the heliostat used, the reflector being a rectangular glass prism.

SECTION B—CHEMICAL SCIENCE

The Chemical Composition of Jute Fibre, by Prof. Hodges.—The jute plant belongs to the family Tiliaceæ. The *Corchorus capsularis* and *C. olitorius* are both cultivated.

The structure of the fibre is different from that of other textile fibres, the central space being very irregular, varying from the thickness of a line to a considerable width.

By the action of aniline sulphate, jute fibre becomes of a golden yellow colour, whereby it is distinguished from hemp and flax. The following is the analysis of jute fibre:—

Wax and fatty matter soluble in ether	0·235
Tannic acid and colouring matter soluble in alcohol	1·135
Sugar, pectine, &c.	2·427
Soluble nitrogenised matters	0·512
Insoluble „ „	2·433
Inorganic matter combined with fibre	1·010
Cellular fibre	92·248
	100·000
Nitrogen in original fibre	0·291
Nitrogen in fibre after treatment with solvents ...	0·210

Methyl-thetine, by Prof. Crum Brown and Dr. E. A. Letts.—By the action of bromacetic acid on methyl-sulphide, methyl-thetine hydrobromate is produced. By the action of moist silver oxide on this hydrobromate, silver bromide is found, and by the further cautious addition of the hydrobromate, the silver remaining in solution is removed. By evaporation, crystals of the base methyl-thetine are formed with one molecule of water. This crystallised base might be represented by the structural formula:—

$$\left.\begin{array}{c} S(CH_3)_2 \\ | \\ H-C-COO \\ | \\ H \end{array}\right\} + H_2O.$$

By the decomposition of the sulphate of methyl-thetine by means of barium carbonate, the base may also be prepared.

This substance, methyl-thetine, has both a basic and an acid character; with hydrochloric acid it forms a hydrochloride, from which the double platinum chloride has been prepared. A double lead compound containing $2PbBr_2$ has also been prepared.

The action of iodacetic acid on methyl-sulphide does not give rise to the formation of methyl-thetine hydriodate, as might have been expected; but various substances are formed, among which is trimethyl-sulphine iodide.

Experiments on High Pressures, by Dr. Andrews, F.R.S.—The author entered into full details of the methods of preparing and using his well-known tubes for the production of high pressures. If a mixture of nitrogen and carbonic acid be subjected to high pressures (to 290 atmospheres), no trace of liquid is produced.

On the Latent Heat of Liquefied Gases, by J. Dewar, F.R.S.E.—The author has deduced a formula for calculating the latent heat of a gas from the known tension of that gas. The results of this investigation have already been communicated to Section A.

On Spontaneous Generation from a Chemical Point of View, by Dr. Debus, F.R.S.—To the question, "Has Nature ever produced organic substances from strictly inorganic materials?" Chemistry (according to the author) answers, "No!"

On the Estimation of Phosphoric Acid in Pyrophosphate of Magnesia, by Mr. Ogilvie.—The author's experiments lead him to conclude that this process cannot be relied upon unless taken in conjunction with some other, such as the Molybdate process. The influence of a great excess of magnesia, of ammonic oxalate,

* Generally no adjusting counterpoise for the compass is required when a ship goes from extreme north to extreme south magnetic latitudes.

of citric acid, and of alumina or iron oxide, introduces sources of error.

On an Improved Form of Filter Pump, by W. Jesse Lovett.—This pump, which is very simple and appears to give good results, has already been described in the *Chemical News*.

On Sulphur-Urea, by Prof. Emerson Reynolds.—By heating dry ammonium sulphocyanate, sulphur-urea—as has been before shown by the author—is obtained. If the heat be maintained at 170°, about 26 per cent. of urea is obtained in one hour. By the action of metallic oxides in solution on sulphur-urea, metallic sulphides are obtained, together with cyanamide, which, by the prolonged action of water, is changed into dicyanamide.

On the Joint Action of Carbonic Acid and Cyanogen on Oxide of Iron, and on Metallic Iron, by Lowthian Bell, F.R.S.—The author shows that a mixture of carbonic acid (CO_2) and cyanogen exercises a powerful reducing action at a high temperature upon ferric oxide. With one volume of cyanogen and six volumes of carbonic acid at a temperature of 685° to 710° F., 79·9 per cent. of the oxygen existing in combination with iron was removed, 56·3 per cent. of metallic iron being produced; by increasing the proportion of carbonic acid to fifteen volumes, 6·5 per cent. of metallic iron was produced, while ·9 per cent. only was formed when the carbonic acid amounted to thirty volumes. A certain amount of carbon is simultaneously deposited in the reduced iron. The reducing and carbon depositing power of a mixture of cyanogen and carbonic acid is greater than that of a mixture of carbon monoxide and carbonic acid.

Electrolytic Experiments on Metallic Chlorides, by Dr. Gladstone, F.R.S., and Mr. Tribe.—The authors show that if plates of copper and platinum be immersed in a dilute solution of cupric chloride, a current is obtained from the copper to the platinum, the cupric chloride is broken up into cuprous chloride and chlorine, the former being deposited on the platinum, while the latter combines with some of the copper to form a new cupric chloride $Cu + CuCl_2 = 2\,(CuCl)$. By applying an external current the same action takes place; if, however, the strength of the current be increased, the free chlorine makes its appearance. By substituting zinc for copper a greater effect is obtained; with magnesium in the place of zinc, the effect is still greater. Analogously to the foregoing, a current may be obtained by acting on a solution of mercuric chloride with gold and mercury, whereby mercurous chloride is deposited on the gold.

Composition of certain kinds of Food, by W. J. Cooper.—The author drew attention to the nourishing properties of farinaceous foods, such as arrowroot, corn flour, &c. Such foods he believes very well suited for infants and invalids. He holds that we generally take too much nitrogenous substance in our dietaries.

SECTION C—Geology

Prof. Harkness, at the request of the Committee of the Section, described briefly the geological features of the North of Ireland. The relations of the Silurian rocks to the Lower Silurians of Sutherlandshire and Cumberland were discussed, and the later formations were noticed in succession.

Prof. H. A. Nicholson exhibited and described a silicified chip of wood from the Rocky Mountains. At the Brighton meeting the same specimen was shown, when the opinion was expressed that its wood-like appearance was due to mineral structure. The chip was then regarded by some members of the Section as a hornblendic mineral, known as "rock-wood." Subsequent examination has shown conclusively that the specimen is undoubtedly true silicified wood. The age of the chip and the circumstances of its production present many points of interest. The author considers it a prehistoric relic, produced by an axe, which was probably formed out of the native copper so frequent in various parts of North America.

Prof. Harkness accepted the views of the author, and withdrew his previous opinion that the specimen was merely a hornblendic mineral.

SECTION D—Biolo y

Department of Zoology and Botany

Mr. Gwyn Jeffreys read a paper *On additions to British Mollusca, and notices of rare species from the deep water off the western coast of Ireland.* As many as forty-seven species of molluscs new to science have been yielded as the results of the dredgings in the *Porcupine*, eighty-four new to the British Isles, and 124 new to Ireland, in addition to a number of other species hitherto considered to exist only in the fossil condition, some of them as low down as the Crag. Dr. Carpenter called attention to the enormous importance of these dredging expeditions, not so much from the number of new species discovered by them as from the light which they seem likely to shed on the question of the continuity of forms of life from one geological age to another. The dredgings off Ushant at a depth of nearly three miles have been especially prolific of results. Dr. Carpenter held out some hopes that the Government might be induced to undertake the expense of a dredging expedition in our own deep seas.

Mr. P. L. Sclater read a paper *On the distribution of the species of Cassowaries.* Until very recently there was supposed to be only one species of *Casuarius*; now at least seven species are known, each with a distinct and very limited area, the genus being entirely confined to Northern Australia, New Guinea, and the adjacent isles. A full exploration of New Guinea would probably lead to the discovery of a large number of most interesting new species.

On the cause of the potato disease and the means of its prevention, by Mr. J. Torbitt. The idea thrown out in the paper was that the disease is owing to the gradual natural decay of particular varieties which never have more than a limited length of life in a thoroughly healthy condition, a view which was combated by most of the gentlemen who took part in the discussion. Mr. Carruthers described the mode in which the spores of the *Peronospora* germinate in enormous numbers on the surface of the potato plant, the germinating filaments, however, only developing to a very limited extent and dying away unless abundantly supplied with moisture. It is only by this means that they are enabled to penetrate into the internal tissues through the stomates. Prof. Du Barry's recent researches seem to point to the possibility that we have in the *Peronospora* an instance of "alternation of generations," one generation only being at present known, the other generation possibly presenting an altogether different appearance, and germinating upon some totally different plant.

Prof. Macalister read *Notes on the specimen of Selache maximus lately caught at Innisboffin.*

Further Researches on Eozoön canadense, by Dr. Carpenter. After an historical account of the controversy respecting this organism, the author proceeded to give additional reasons, the results of recent investigations, for concluding the organic nature of the organism, in opposition to the views entertained by Profs. King and Rowney, of Galway. He took the opportunity of contradicting the assertion made by those gentlemen that Prof. Max Schultze had just before his death stated his conversion to their views. Mr. Gwyn Jeffreys, Prof. Macalister, and Prof. Percival Wright expressed their general concurrence in Dr. Carpenter's views.

SECTION G

Mechanical Science

Opening Address by the President, Prof. James Thompson, LL.D.

For a number of years past it has been customary in this and other sections of the British Association for the Advancement of Science, that the president should give an introductory address at the opening of each new session. In compliance with that usage, I propose now to offer to you a few brief remarks on various subjects of mechanical science and practice. These subjects have not been chosen on any systematic plan. I have not aimed at bringing under review the whole or any large number of the most important subjects at present worthy of special notice in engineering or in mechanics generally. I intend merely to speak of a few matters which have happened to come under my notice, or have engaged my attention, and which appear to me to be interesting through their novelty or through their important progress in recent times, or to merit attention as subjects in which amendment and future progress are to be desired.

In railway engineering, one of the most important topics for consideration, as it appears to me, is that which relates to the abatement of dangers in the conducting of the traffic. The traffic of many of our old railways has become enormously increased in recent years. With the construction of new lines the numbers of junctions, stations, and sidings have been greatly in

creased; and each of these entails some attendant dangers. As a natural consequence of the increased traffic on old railways, the additional traffic on new lines, and the increased complexity of the railway system as a whole, there have been during recent years more numerous accidents than in the earlier times of railways. It is to be recollected, however, that with a greater number of people travelling daily, more numerous accidents might be expected, and that their increased frequency, on the whole, does not necessarily indicate increased danger to the individual traveller. Referring to the statistics of railway accidents published by the Board of Trade in Capt. Tyler's Report for the year 1873, I find, for various periods during the last twenty-seven years, throughout the United Kingdom, the proportion of passengers killed from all causes beyond their own control, to the number of passengers carried, to have been, in round numbers:—

Proportion of number killed to number carried in the three years 1847, 1848, and 1849,	1 in	4,782,000
In the four years, 1856, 57, 58, and 59 .	1 in	8,708,000
In the four years, 1866, 67, 68, and 69 .	1 in	12,941,000
In the three years, 1870, 71, and 72 . .	1 in	11,124,000
And in the single year 1873	1 in	11,381,000

It is thus gratifying to observe, that in spite of the increased risks naturally tending to arise through the increased and more crowded traffic and the more complicated connections of lines, the danger to the individual traveller is now less than half what it was 26 years ago; at least this result is indicated, in so far as we can judge, from the statistics of deaths of passengers from causes beyond their own control. That the conducting of the traffic of railways still involves hazards far from inconsiderable, and that we have much to wish for towards abatement of dangers of numerous kinds, is proved by the fact that during the single year 1873 there have been killed of the officers and servants of the railway companies in the United Kingdom, 1 out of every 323: so that, at this rate, extended through a period of, for example, 20 years' service, there would be 1 out of every 16 of the officers and servants killed.

These deaths of officers and servants are not to be supposed to be caused in any large proportion by collisions, and by other accidents to trains in rapid motion. The great majority of them arise in shunting and other operations at stations and along the lines, and occur in numerous ways not beyond the control of the individuals themselves. In respect to the passengers, too, it ought to be known and distinctly recollected, that although collisions and other violent accidents to trains in rapid motion, together with other accidents beyond the control of the individuals, usually cause by far the deepest impression on the public mind; yet the numbers of these fatal accidents are small in comparison with others arising to passengers from causes more or less within their own control. For instance, it may be noticed that in last year, the year 1873, while the deaths of passengers arising from all causes beyond their own control, in the United Kingdom, were only 40 in number, there were four times as many killed, namely 160, in other ways; and of these there were as many as 62 killed in the simple way of their falling between carriages and platforms.

In respect to the conducting of the traffic of the trains in motion, it appears to me, on the whole, that when we consider the vast complexity of the operations involved in working many of our ramified and crowded railways, and when we consider the indefinitely numerous things which must individually be in proper order for their duty, and must be properly worked in due harmony by men far away from one another, some stationed on the land, and others rushing along on the engines or trains, the wonder is, not that we should have numerous accidents, but that accidents should not be of far more frequent occurrence. There can be no doubt, however, but that of the accidents which do occur, many arise from causes of kinds more or less preventible according to the greater or less degree in which due precautions may be adopted.

Gradually, during a period of 20 or 30 years past, a very fine system of watching, signalling, and otherwise arranging for the safety of trains, has been contrived and very generally introduced along our principal lines of railway. In saying this, I allude chiefly to the block system of working railways, with the aid of telegraphic signals and interlocking mechanisms for the working of the points and signals.

In former times it was customary to allow a certain number of minutes to elapse after a train passed any station, or junction, or level crossing, or other point where a servant of the company was stationed, before the succeeding train was allowed to pass the same place. Thus, at numerous points along the line a time interval was preserved between successive trains. It was quite possible, however, that the foremost of the two trains, after passing any of these places where signals were given, might become disabled, or might otherwise be made to go slowly, and that the following train might overtake it, and come into violent collision with it from behind. In order to provide against the occurrence of such accidents, a system was introduced called the *Block System*; and its main principle consists in dividing the line into suitable lengths, each of which is called a *block section*, and allowing no engine or train to enter a block section until the previous engine or train has quitted that portion of the line. In this way a space interval of at least the length of a block section is preserved between the two trains at the moment of the later train's passing each place for signalling, and the risk of this space interval becoming dangerously small by negligence or other accidental circumstances, as the later train approaches the next place for signalling, is almost entirely avoided.

Further, at each signalling station, the various levers or handles for working the points, and those for working the semaphore signals for guiding the engine-drivers, instead of being, as was formerly the case, scattered about in various situations adjacent to the signalling station, and worked often, some by one man and some by another, without sufficient mutual understanding and without due harmony of action, are now usually all brought together into one apartment called the signal cabin. This cabin, like a watch-tower, is usually elevated considerably above the ground, and is formed with ample windows or glass sides, so as to afford good views of the railway to the man who works the levers for the semaphores and points, and who transmits, by electricity, signals to the next cabins on both sides of his own, and, when necessary, to other stations along the line of railway.

The interlocking of the mechanisms for working the points and for working the semaphores which, by the signals they show, control the engine-drivers, consists in having the levers by which the pointsman works these points and signals, so connected that the man in charge cannot, or scarcely can, put one into a position that would endanger a train, without his having previously the necessary danger signal or signals standing so as to warn the engine-driver against approaching too near to the place of danger.

The latest important step in the development and application of the block system is one which has just now been made in Scotland, on the Caledonian Railway. Before explaining its principle, I have first to mention that a semaphore arm raised to the horizontal position is the established danger-signal, or signal or debarring an engine-driver from going past the place where the signal is given. Now, the ordinary practice has been, and still is, to keep the semaphore arm down from that level position, and so to leave the line open for trains to pass, except when the line is blocked by a train or other source of danger on the block section in front of that semaphore, and only to raise the semaphore arm exceptionally as a signal of danger in front. The new change, or improvement, now made on the Caledonian Railway consists mainly in arranging that along a line of railway the semaphore arms are to be regularly and ordinarily kept up in the horizontal position for prohibiting the passage of any train, and that each is only to be put down when an approaching train is, by an electric signal from the cabin behind, announced to the man in charge of that semaphore, as having entered on the block section behind, and when, further, that man has, by an electrical signal sent forward to the next cabin in advance, inquired whether the section in advance of his own cabin is clear, and has received in return an electrical signal meaning "*The line is clear: you may put down your debarring signal, and let the train pass your cabin.*" The main effect of this is, that along a line of railway the signals are to be regularly and ordinarily standing up in the debarring position against allowing any train to pass; but that just as each train approaches, and usually before it has come in sight, they go down almost as if by magic, and so open the way in front of the train, if the line is ascertained to be duly safe in front; and that immediately on the passage of the train they go up again, and by remaining up keep the road closed against any engine or train whose approach has not been duly announced in advance so as to be known at the first and second cabins in front of it, and kept closed, unless the entire block section between those two cabins is known to have been left clear by the last preceding

engine or train having quitted it; and is sufficiently presumed not to have met with any other obstruction, by shunting of carriages or waggons, or by accident, or in any other way.

This new arrangement, which appears to be a very important improvement, has already been brought into action with success on several sections of the Caledonian Railway; and it is being extended as rapidly as possible on the lines of the Caledonian Company, where the ordinary mode of working the block system has hitherto been adopted.

The mechanisms and arrangements I have now briefly mentioned are only a portion of the numerous contrivances in use for abatement of danger in railway traffic. It is to be understood that by no mechanisms whatever can perfect immunity from accidents be expected. The mechanisms are liable to break or to go wrong. They must be worked by men, and the men are liable to make mistakes or failures. We shall continue to have accidents; but, if we cannot do away with every danger, that is no reason why we should not abate as many dangers as we can.

Within the past twenty years very remarkable progress has been made in steam navigation generally, and more especially, I would say, in oceanic steam navigation. In this we meet with the realisation of great practical results from the combination of improved mechanical appliances, and of physical processes depending on a more advanced knowledge of thermodynamic science.

The progress in oceanic steam navigation is due mainly to the introduction jointly of the screw propeller, the compound engine, steam jacketing of the cylinders, superheated steam, and the surface-condenser.

The screw propeller, in its original struggle for existence, when it came into competition with its more fully developed rival, the paddle-wheel, met with favouring circumstances in the want then strongly felt of means suitable for giving a small auxiliary steam-power to ships arranged for being chiefly propelled by sails. For the accomplishment of this end the paddle-wheel was ill suited; and so the screw propeller got a good beginning for use on long oceanic voyages. Afterwards, in the course of years, there followed a long series of new inventions and improved designs in the adaptation of the steam-engine for working advantageously with the new propeller; and it has resulted that now, instead of the screw being used as an auxiliary to the sails, the sails are more commonly provided as auxiliaries to the screw. For long oceanic voyages it became very important or essential to get better economy in the consumption of fuel. In order to economise fuel, high-pressure steam, with a high degree of expansion and with condensation, was necessary. This led to the practical adaptation for the propulsion of vessels of the compound engine, an old invention which originated with Hornblower in the latter part of the last century, and was afterwards further developed by Wolff. The high degrees of expansion could not be advantageously used in cylinders heated only by the ordinary supply of steam admitted to them for driving the piston; and more especially when that steam was boiled off directly from water without the introduction of additional heat to it after its evaporation. The knowledge of this, which was derived through important advances made in thermo-dynamic science, led to the introduction into ordinary use in steam navigation of steam-jacketed cylinders, and to the ordinary use also of superheated steam. With increased efforts towards economy of space in the hold of the ship, which became the more essential when very long voyages were to be undertaken, and with the new requirement of greatly increased pressure in the steam, the old marine boilers, with their flues of riveted plates, were superseded by tubular boilers more compact in their dimensions and better adapted for resisting the high pressure of the steam. In connection with these various changes the old difficulty of the growth of stony incrustations in the boilers became aggravated rather than in any way diminished. As the only available remedy for this, there ensued the practical development and the very general introduction of the previously known but scarcely at all used principle of surface condensation instead of condensation by injection. A supply of distilled water from the condenser is thus maintained for feeding the boilers, and incrustations are avoided. The consumption of coal is often found now to be reduced to about 2 lbs. per indicated horse-power per hour, from having been 4 or 5 lbs. in good engines in times previous to about twenty years ago.

Before the times of ocean telegraph cables, very little had been done in deep-sea sounding; but when the laying of ocean cables came first to be contemplated, and when it came afterwards to be realised, the obtaining of numerous soundings became a matter of essential practical importance. In the ordinary practice of deep-sea sounding, as carried on, both before and since the times of ocean telegraph cables, until a year or two ago, a hempen rope or cord was used as the sounding line, and a very heavy sinker, usually weighing from two to four hundredweight, was required to draw down the hempen line with sufficient speed, because the frictional resistance of the water to that large and rough line moving at any suitable speed was very great. The sinker could not be brought up again from great depths; and arrangements were provided, by means of a kind of trigger apparatus, so that when the bottom was reached the sinker was detached from the line and was left lying lost on the bottom; the line being drawn up without the sinker, but with only a tube, of no great weight, adapted for receiving and carrying away a specimen of the bottom. For the operation of drawing up the hempen line with this tube attached, steam power has been ordinarily used, and practically must be regarded as necessary.

A great improvement has within the last two or three years been devised and practically developed by Sir William Thomson. Instead of using a hempen sounding line, or a cord of any kind, he uses a single steel wire of the kind manufactured as pianoforte wire. He has devised a new machine for letting down into the sea the wire with its sinker, and for bringing both the wire and the sinker up again when the bottom has been reached. With his apparatus, in its earliest arrangement and before it had arrived at its present advanced condition of improvement, he sounded, in June 1872, in the Bay of Biscay, in a depth of 2,700 fathoms, or a little more than three miles, and brought up again his sinker of 30 lbs. weight, after it had touched the bottom; and brought up also an abundant specimen of ooze from the bottom, in a suitably arranged tube attached at the lower end of the sinker.

An important feature in his machine consists in a friction-brake arrangement, by which an exactly adjusted resistance can be applied to the drum or pulley which holds the wire coiled round its circumference, and which, on being allowed to revolve, lets the wire run off it down into the sea. The resistance is adjusted so as to be always less than enough to bear up the weight of the lead or iron sinker, together with the weight of the suspending wire, and more than enough to bear up the weight of the wire alone. Thus it results that the arrival of the sinker at the bottom is indicated very exactly on board the ship by the sudden cessation of the revolving motion of the drum from which the wire was unrolling.

Another novel feature of great importance consists in the introduction of an additional hauling-up drum or pulley arranged to act as an auxiliary to the main drum during the hauling-up process. The auxiliary drum has the wire passed once or twice round its circumference at the time of hauling up, and is turned by men so as to give to the wire extending from it into the sea most of the pull requisite for drawing it up out of the sea, and it passes the wire forward to the main drum, there to be rolled in coils, relieved from the severe pull of the wire and sinker hanging in the water. Thus the main drum is saved from being crushed or crumpled by the excessive inward pressure which would result from two or three thousand coils of very tight wire, if that drum unaided were required to do the whole work of hauling up the wire and sinker.

The wire, though exposed to the sea-water, is preserved against rust by being kept constantly, when out of use, either immersed in or moistened with caustic soda. The fact that steel and iron may be preserved from rust by alkali is well known to chemists, and is considered to result from the effect of the alkali in neutralising the carbonic acid contained in the water, as the carbonic acid appears to be the chief cause of the rusting of steel and iron.

This new method of sounding, depending on the use of pianoforte wire, was first publicly explained by Sir William Thomson in the Mechanical Section of the British Association at the Brighton meeting two years ago; and in the interval which has since elapsed, it has come rapidly into important practical use.

I have to-day already brought under your notice a system of elaborately contrived and extensively practised methods of signalling and otherwise arranging for the safety of trains in motion on railways. These methods, in the aggregate, as we have them at present, may be looked on as the result of a gradual development, which, through design and intelligent

selection, has been taking place during the last twenty or thirty years, or more. In contrast with this I have now to mention a reform towards abatement of dangers at sea, which at present is only in an incipient stage of its practical application, but which I am sure must soon grow into one of the important reforms of the future. I refer to the provision of means whereby every important lighthouse shall, as soon as it is descried, not only make known to the navigator that a light is visible, but also that it shall give him the much more important information of what light it is; that, in fact, it shall distinguish itself to him from all other lights either stationed on land or carried by ships out at sea. The rendering of lighthouses each readily distinguishable from every other light, by rapid timed occultations, was urged on public attention by Charles Babbage about twenty or twenty-three years ago, in connection with a like proposal of his for telegraphic signalling by occulting lights. His admirable idea, however, so far as it related to the distinguishing of lighthouses, has unhappily been left almost entirely neglected until quite recently. Although I say it was almost entirely neglected, yet very important steps in the direction of the object proposed were taken many years ago by Messrs. Stevenson, engineers to the Commissioners of Northern Lights, and the flashing and intermittent lights introduced by them, and now used, although too sparingly, in various parts of the world, constituted a very great improvement in respect to distinctiveness. The first practical introduction of an intermittent extinction of a gaslight, which is a method now likely to become fruitful in important applications with further developments, was made many years ago by Mr. Wilson at Troon; and an admirable application of this plan by the Messrs. Stevenson to carry out the principle of rapid signalling is to be seen in the Ardrossan Harbour light, which is alternately visible for two seconds, and then for two seconds is so nearly extinguished as to be invisible. The whole period—four seconds—is, I suppose, the shortest of any lighthouse in the world. This light fulfils the condition of being known to be the light which it is, within five or ten seconds of its being first perceived; and thus, in respect to distinctiveness, I trust that I may without mistake say it is the best light in the world. Mr. John Wigham has succeeded in constructing large burners for the combustion of gas in lighthouses in general, including those of the first order, and embracing both fixed lights and revolving lights. He has also, in both these cases, applied with the most striking success the principle of occultation. Dr. Tyndall, in his reports to the Board of Trade, has dwelt frequently and emphatically on the ease with which gas lends itself to the individualisation of lights. By its application, he affirms that by simple arrangements it would be possible to make every lighthouse declare its own name. Within about the last two or three years the subject has been taken up energetically by Sir William Thomson. He has become strongly impressed with the enormous importance of the object in question. He has perseveringly laboured in making trials in various ways, both by the method of partially extinguishing gas flames and by the method of revolving screens; and I have pleasure in stating that, as a result of his efforts, a self-signalling apparatus is now constructed for the Belfast Harbour Commissioners, who are preparing to bring it into immediate use at the screw-pile lighthouse at the entrance of the harbour of Belfast. I shall not now enter on any description of this arrangement, as I understand that the apparatus, which has already been temporarily erected for trial in the lighthouse, and has shown good results, is to be exhibited and explained to this Section by Mr. Bottomley, who, as a member of the Board of Harbour Commissioners, has taken an active part in the promotion of the undertaking.

I wish next to make mention of the very remarkable works at present in progress in the harbour of Dublin, under the designs and under the charge of Mr. Bindon Stoney. In order to form quay walls with their foundations necessarily deep under water, he constructs on land gigantic blocks of artificial stone, or, as we may say, of concrete masonry, each of which is about 350 tons in weight, and which are accurately formed to a required shape. After the solidification of the concrete, he carries them away and deposits them on an accurately levelled bottom of sea, so that they fit closely together, and form so much of the quay wall in height as to reach above the low tide level; and so as to allow of the completion of the wall above by building in the usual manner by tidal work, and to allow of the whole structure being carried out without the use of coffer-dams. These operations are on a scale of magnitude far surpassing anything done before in the construction and moving of artificial stone blocks. They are carried out with machinery and other appliances for the removal and the placing of the blocks, and for other requirements of the undertaking, which are remarkable for boldness of conception and ingenuity of contrivance. The new methods of construction devised and applied in these works by Mr. Stoney are recognised as being admirably suited for the local circumstances of the site of the works in the harbour of Dublin, and their various arrangements form a very important extension of the methods of construction available to engineers for river and harbour works.

While progress has been made with gigantic strides in many directions, in engineering and in mechanics generally; while railways, steamboats, and electric telegraphs have extended their wonders to the most distant parts of the world; and while trade, with these aids, is bringing to our shores the produce even of the most distant places, to add to our comforts and our luxuries; yet, when we come to look to our homes, to the places where most of our population have to spend nearly the whole of their lives, I think we must find, with regret, that, in matters pertaining to the salubrity and general amenities of our towns and houses, as places for residence, due progress in improvement has not been made. Our house drainage arrangements are habitually disgracefully bad; and this I proclaim emphatically, alike in reference to the houses of the rich and the poor. We have got, since the early part of the present century, the benefit of the light of gas in our apartments; but we allow the pernicious products of combustion to gather in large quantities in the air we have to breathe; and in winter evenings we live with our heads in heated and vitiated air, while our feet are ventilated with a current of fresh, cold air, gliding along the floor towards the fireplace to be drawn uselessly up the chimney. A very few people have commenced to provide chimneys or flues to carry away the fumes of their more important gaslights, in like manner as we have chimneys for our ordinary fires. In mentioning this, however, as a suggestion of the course in which improvement ought to advance, I feel bound to offer a few words of caution against the introduction of flue pipes for the gas flames rashly, in such ways as to bring danger of their setting fire to the house. People have a strong tendency to require that such things as these should be concealed from view. In this case, however, special care should be taken against rashly placing them among the woodwork between the ceiling of the apartment and the floor of the room above or otherwise placing them in unsafe proximity to combustible materials. In many cases it would be better to place the flue exposed to view underneath the ceiling, and by introducing some accompanying ornamentation, to let the flue be regarded as a beneficent object not unpleasing to the eye.

The atmosphere of our large towns, where people live by hundreds of thousands all the year round, is not yet guarded against needless pollution by smoke, jealously, as it ought to be. Many of the wealthier inhabitants take refuge in living in the country, or in the suburbs of the town, as far away as they can from the most densely built and most smoky districts; but the great masses of the people, including many of all ranks, must live near their work, and for them at least greater exertions are due than have yet been made towards maintaining and improving the salubrity and the amenities of our towns. As to the abatement or prevention of smoke from the furnaces of steam-engines, the main requisites have long been very well known; but sufficient energy and determination have not yet been manifested towards securing their due application in practice. In too many cases futile plans have been tried, and on being soon abandoned have left a strong impression against the trying of more experiments; and this may account in part for the introduction of real improvements having been so slow. Smoke occurs when fresh coal is thrown suddenly, in too large quantity at once, upon a hot fire. By extreme care a fireman may throw coal into his furnace so gradually as to make very little smoke; but mechanical arrangements for introducing constantly and uniformly the new supply of fresh coal have been devised, and several of these have been such as to reduce the smoke emitted to almost nothing. I have seen in the neighbourhood of Glasgow, at a large manufacturing establishment at Thornliebank, one method which is applied to about thirty ordinary 40-horse-power boilers, in which upwards of 100 tons of coal are daily burned, and from the chimneys of which not more smoke is emitted than from many a kitchen fire. This method is under the patent of Messrs. Vicars, of Liverpool, and it seems to work very well. It has been about two years in work there. It was introduced at a time when coal was exceedingly high in price; as

much to effect economy in fuel as to prevent smoke; and although the first cost was somewhere about 130*l.* per boiler, the proprietor considers himself to be already more than recouped for his outlay, as a saving of fully 12 per cent. in the fuel consumed was effected. At the same works I have also seen in operation the method of Messrs. Haworth and Horsfall, of Todmorden, which has, I am told, in certain circumstances, some advantages over the other. In this, as in the other, the coal is fed in uniformly by mechanical arrangements. The mechanism is different in the two cases, but the result in the motion communicated to the coal is very much alike in both. The bed of coal, which is gradually supplied in front, is caused to travel along the bars towards the inner end of the furnace, and the combustion proceeds in a very uniform manner in conditions highly favourable to economy of fuel, and without the emission of almost any visible smoke.

These two methods I have mentioned because they appear both to work very successfully in practice, while they both bring into effect the principle of action of the fuel which has long appeared to me to be the best that can be adopted for ordinary cases of steam-engine boilers.

I have now occupied, I think, enough of your time, and so I will conclude. I have endeavoured to select out of the wide range of subjects which fall within the scope of the Mechanical Section of the British Association, a few which have come more particularly under my own notice, and on which I thought it was in my power to give intelligence that might be interesting as to past progress, and suggestions that might be useful towards extension of improvements in the future.

SCIENTIFIC SERIALS

Archives des Sciences Physiques et Naturelles, No. 198.—M. C. Marignac contributes a paper On the simultaneous diffusion of certain salts, and gives long tables of the results of his experiments.—M. Marc Micheli gives a note of eighteen pages in length, On the Onagraceæ of Brazil, of which the greater part is taken up with the genus Jussiæa. He sums up the distribution thus:—

		N. America.	Mexico.	Antilles.	Guyane.	Pacific States.	Brazil.
Eujussieæa	23	1	2	5	7	7	22
Oligospermum	12	2	3	4	5	4	10
Macrocarpon	4	1	2	2	2	2	4
		4	7	11	14	13	36

—M. Maurice de Tribolet gives a concise history of the study of the genus Nerinæa, and gives analytical tables showing the distribution of species in the Jurassic beds of the Jura. The meteorological observations made at Geneva, under Prof. Plantamour, during May, conclude the number.

SOCIETIES AND ACADEMIES

Paris

Academy of Sciences, Aug. 31.—M. Faye in the chair.—The following papers were read:—Astronomy at the Italian Spectroscopic Society, by M. Faye. This was a reply to some criticisms of P. Secchi. The author pointed out that P. Secchi's theory of sunspots was a return to the idea announced by Galileo in 1612, the clouds being buried in the body of the sun instead of floating above it. The theory advanced by the author on the other hand had been pronounced by Mr. Langley to be a *vera causa*. This *vera causa*, according to M. Faye, is nothing more than a law of hydrodynamics, perfectly established for terrestrial air and water currents.—Remarks on the fish of the Algerian Sahara, by M. P. Gervais. The remarks refer to species of *Coptodon* and *Cyprinodon*, the former of which had been cited by M. Cosson as proving the continuity of the sheet of water which extended over this region.—Note on the development of the contractile coat of the vessels, an anatomical paper by M. C. Rouget. New researches undertaken by the author on amphibian larvæ establish beyond doubt the contractibility of the ramified protoplasmic cells observed last year in the vessels of the hyaloid membrane of the adult frog.—On winged *Phylloxera* and its progeniture, by M. Balbiani. The author points out the complete analogy between *Phylloxera vastatrix* and the *Phylloxera* of the oak.—New observations on the migrations of *Phylloxera* to the surface of the soil and on the effects of the method of submersion, a letter from M. G. Bazille to M. Dumas. The letter contained a note, published in the *Messager du Midi.*—M. P. Mouillefert addressed also a letter containing observations on the employment of the chief insecticides from experiments tried in the laboratory at Cognac and on the vines of the neighbourhood.—M. P. Rohart addressed a letter on the action exercised by the soil on insecticide gases.—Other communications relating to *Phylloxera* were received from MM. Delfan, A. Richard, Gauthier, L. Rousseau, &c.—On a physiological phenomenon produced by excess of imagination, a letter from M. P. Volpicelli to M. Chevreul. Two experiments were made with magnets upon nervous subjects, to see if the effects produced were really magnetic or due to the imagination. In the first experiment a piece of unmagnetised iron was shown to the patient, who immediately fell into convulsions. In the next experiment a magnet was placed in the hand of a nervous subject, who at the end of a few seconds became so over-excited that the magnet was removed. That the effect thus produced was due to the sight of the magnet was proved by hiding several powerful magnets in the chair occupied by the same individual, who when thus unconscious of their presence experienced no ill effect. M. Chevreul made some remarks *à propos* of the foregoing paper on certain other illusions, such as the divining pendulum and divining ring.—Remarks on recent researches concerning the explosion of powder, by MM. Roux and Sarrau. The authors pointed out the agreement between certain of the results obtained by them and by MM. Noble and Abel in their recent communications to the Academy.—New note on the tail of Coggia's Comet, by M. A. Barthélemy. The theory of a repulsive force emanating from the sun requires, according to the author, that the axis of the tail should always be a prolongation of the radius vector. With Coggia's Comet, however, as observed by M. Heiss on July 5, the tail made an angle of 160° with the radius vector. The facts appear to the author to be simply explicable by the hypothesis of an interplanetary medium submitted to the attractive action of the sun, through which medium the comet travels with an increasing velocity; fans and jets are supposed to be the result of the sun's attraction on the denser portions of the cometary matter.—On a new theory of the formation of comets and their tails, by M. Virlet d'Aoust. In 1835 the author suggested the hypothesis that comets were nascent stars—the internal and still incandescent portions shining through cracks in the dark surface. This view was afterwards abandoned for Saigey's hypothesis, which considered the tails of comets as the result of the reflection of their light on an atmosphere which they drew after them. This opinion was again modified to meet the researches of Weiss, Schiaparelli, Klinkerfues, and Oppolzer, who showed the connection between the comets of 1862 and 1866, of Biela and Pogson, and the annular meteor streams which give us the August and November shooting stars. The author then asked whether comets did not equally belong to rings which had given rise to their existence, and if the light emitted by their tails did not simply result from the reflection of light from the nucleus on to the cosmical particles which constituted the rings on which they seemed to depend. The recent researches upon Coggia's Comet confirm this view in the author's opinion.—On a new model of prism for direct vision spectroscopes, by M. J. G. Hofmann.—On some points in the anatomy of the common mussel (*Mytilus edulis*), by M. Ad. Sabatier.

CONTENTS

THURSDAY, SEPTEMBER 17, 1874

THE EDUCATION OF WOMEN

NONE of the subjects discussed at the recent meeting of the British Association at Belfast were of greater practical importance than the one introduced to the notice of the Economic Section by Mrs. Grey in her paper on the Science of Education, and supplemented by the address afterwards delivered by her at a meeting held under the auspices of the National Union for Improving the Education of Women of all Classes. So much nonsense is talked and written on the theme of the higher education of women, the utterances even of some of those who are looked on as authorities on the question are too often so doctrinaire and unpractical on one side or the other, that it is a relief to read the well-considered and thoughtful reflections of one who has bestowed much labour and serious thought upon it, and who has given evidence that she is wedded to no preconceived views. The crowded attendance at the Section when Mrs. Grey's paper and the two which followed it—also by ladies—were read, and the lengthened and animated discussion to which they gave rise, sufficiently evince the wide interest felt in the subject by those who attended the meetings of the Association.

The branch which specially concerns us is the extent to which instruction in some or all of the various branches of science should enter into the liberal education of women; and this again is but a phase of the more general question as to the mode in which, if at all, the education of girls should differ from that of boys. We may set aside on the present occasion as a subject of too great importance to be discussed in a general article like this, the much-vexed question of the Medical Education of Women. With regard to the difference which has been established by general custom or prejudice between the ordinary curriculum of the studies of boys and girls, Miss Davies has pointed out with great force, in one of her Essays on the Higher Education of Women, what appear at first sight some glaring inconsistencies and absurdities. To boys who are destined for a mercantile life or a public career, an intimate acquaintance with French and German is now almost indispensable; Latin and Greek are therefore almost universally taught in boys' schools, while the modern languages are considered an essential part of the course of study of a girl, to whom they will be of much less service. A fair knowledge of the elements of physics and chemistry would be of immense advantage to a woman in the management of a household; but these are subjects considered by many to be decidedly unfeminine. Music is the most inexhaustible and harmless recreation for the mind overtasked with the burden of daily cares; but music hardly comes within the scope of a boy's education, at least in this country; while it is almost compulsory on girls, whether they have the talent for it or not, and who have at all events abundant other occupation, such as needle-work, for their leisure moments. The earliest years of a child's life are almost entirely regulated, for good or for evil, by the mother and her female dependents; but any knowledge of human physiology or hygiene has been till recently almost forbidden to the girl on the score of delicacy. May we not sum up by saying that few men have the leisure, after they arrive at manhood, for pursuing the studies of their youth; while an enormous number of women of the upper and middle classes would be most thankful for a rational substitute for the purposeless vacuity in which they are at present forced to spend a large portion of their time? And yet in the face of this it is still the orthodox creed that the education which any English gentleman gets or can get at a public school or University is too broad or too deep for the mass of women of the same class.

An almost ludicrous instance of the difficulty which is experienced practically in the attempt to frame a curriculum of studies which shall be specially adapted for girls, was brought out in the recent debate in the Convocation of the University of London on the desirableness of admitting women to degrees. When the existing General Examination for women was instituted, a Committee of the Senate was appointed to draw up a scheme which should meet all the requirements of the case. After long deliberation, the extent to which it was found possible to deviate from the ordinatry Matriculation examination was this: Greek was made optional; and girls were allowed to take Botany if they wished instead of Chemistry, and Italian if they preferred it instead of German; they were also exempted from all the books of Euclid except the first, if they took Geography instead! The first of these indulgences is now extended to boys; and the other differences are so trivial that we are glad to see that another Committee of the Senate has already recommended that the examination be altogether assimilated to that for Matriculation. When this is done, it may possibly occur to the Senate that there will be no object in keeping up a distinction of name between the two; and how will it then be possible to refuse to women examinations which shall be equivalent to those that admit men to degrees, at least in the Faculties of Arts, Science, and Laws? We do not propose here to discuss the expediency of nominally permitting women to take degrees in our universities; but there is one aspect of the question which has hardly been sufficiently considered by those who oppose the innovation. A university degree is the acknowledged hall-mark of a certain standard of education for men who make teaching their profession. A very large number of women are equally dependent on teaching as a means of livelihood; notwithstanding the many additional facilities given them of late years for acquiring knowledge, they have at present no equivalent test of their qualifications; and as long as this is the case the really competent governess or schoolmistress will always be subject to unequal competition from her incompetent sisters, and the rising generation of both boys and girls will be the sufferers.

The vision that frightens many from looking with candid and impartial mind at the problem of the higher education of women is the fear that the educated woman will be lifted out of what we are pleased to term her sphere, and rendered unfit for what man considers to be her duties. But the admirers of the uneducated woman may take comfort in the assurance given them by Prof. Fawcett at the Brighton meeting of the British Association, that whatever facilities are offered for improving their minds, there will still be left for many

years an ample supply of those who prefer to remain ignorant and uncultured to satisfy all demands. In the noble address delivered by Prof. Huxley at Belfast, he insisted, with all the force of his calm eloquence, on the folly of making a bugbear of logical consequences; and in no science is there more need for this exhortation than in that of education. Mrs. Grey well put it that no education is worthy of the name that does not at least aim at a right training of the three departments of the mind—the reasoning faculties to determine the right from the wrong, the emotional to follow the right when found, and the imaginative to conceive the perfect ideal of all goodness. In determining a course of education, whether for boys or girls, when we have once satisfied ourselves that our principles are sound, let us unhesitatingly follow them out, letting the possible consequences take care of themselves; and we may feel sure that the conclusions to which we shall be led will stand the test of experience.

The point which we think should be most prominently brought forward by the advocates of a reform in female education is not so much the desirableness of turning its future current in any one direction, as the necessity for removing all trammels and barriers raised by man's ignorance or prejudice. On this ground we sympathise most heartily in all the efforts now being made to widen the basis of the education of women, whether in the way of special colleges, university examinations, or courses of lectures involving severe study. Let us first of all—divesting ourselves of all preconceived theories on the subject, whether social, metaphysical, or physiological—give free scope to the faculties of woman before we begin to dogmatise on the extent to which these faculties will bear cultivation. Natural Selection will point out the occupations in which the female mind will excel; and the Survival of the Fittest will determine the professions in which woman can successfully compete with man. And every one who believes that faculties were originally endowed or gradually evolved for the purpose of being used, and powers for the sake of being exercised, must rejoice at every fresh extension of the field in which they may be employed.

DE BOISBAUDRAN ON SPECTRES LUMINEUX

Spectres Prismatiques et en Longueurs d'Ondes destinés aux Recherches de Chimie Minérale. Par M. Lecoq de Boisbaudran, avec Atlas des Spectres. (Paris: Gauthier-Villars, 1874).

THE spectrum maps of Kirchhoff, Huggins, Angström, and Thalen are so complete that little has been left for later observers except the filling up of some details. Angström's discovery that the bright lines which form the spectrum of the electric spark are partly due to the air or other gaseous medium traversed by the spark, partly to the vapour of the metallic poles, formed an epoch in the history of spectrum analysis; and the publication of the fine map of the solar spectrum by Kirchhoff (founded on the great original work of Fraunhofer), in which the positions of a large number of the metallic lines are carefully laid down, gave a great impulse to the pursuit of this branch of physical science. For the discovery of the new metals, cæsium, rubidium, thallium, and indium, we are indebted to spectroscopic analysis. In a paper communicated to the Royal Society in 1863, Mr. Huggins gave a valuable map of the bright lines of the metals, as seen through a system of prisms adjusted for a minimum deviation of the line D of Fraunhofer. This was followed by the works of Thalen and Mascart, in which the positions of the metal lines are given in wave-lengths. The results obtained by Thalen are incorporated in the great work of Angström on the solar spectrum.

To observe the metal lines, the method usually employed is to pass the spark from a Ruhmkorff's machine, having a condenser connected with the fine wire, between poles of different metals. The air lines which come into view at the same time are easily distinguished by well-known characters from the metal lines, and were used by Mr. Huggins to fix the positions of the latter. In some cases the metal lines were obtained by drawing sparks from solutions of the chlorides.

In the work of M. Lecoq de Boisbaudran, two methods are chiefly followed for obtaining the spectra of the elements and of certain compound bodies. The first is the ordinary method of heating the body in the flame of a Bunsen burner; the second is to pass short electrical sparks from a Ruhmkorff's coil, *without condenser*, between a solution of the chloride of the metal and a fine platinum wire suspended above the solution. In the latter case the following is the method of experimenting usually employed by him:—The metallic solution is contained in a short glass tube, into the lower end of which a platinum wire is hermetically sealed. Another wire of platinum, or, still better, of iridium, attached to an insulating support, is adjusted at a distance of two or three millimetres from the surface of the liquid. An essential condition to the success of the experiment is to make the free wire positive, and the liquid negative. If this condition is reversed, the spectrum of the solution seldom appears, but is replaced by the ordinary air spectrum. In some cases, as with the alkaline salts, a fine spectrum is obtained by passing sparks between a fused bead of the salt and a platinum wire heated to redness in a Bunsen or spirit flame. According to M. Lecoq de Boisbaudran, the spectrum produced in this way is not only more brilliant, but is richer in metallic lines than that of the solution. The method of taking sparks in air between metallic poles has been employed in the work before us only in the cases of aluminium and lead. The spectroscope employed was formed of a single prism of heavy glass, with a collimator, and telescope moveable on a graduated arc. An illuminated scale, projected from the anterior surface of the prism, was seen above the spectrum, and its indications were reduced to wave-lengths by comparison with the wave-lengths of certain solar and metallic lines, as determined by Fraunhofer, Mascart, Angström, and Thalen.

In a series of twenty-eight finely-executed engravings, M. Lecoq de Boisbaudran has given delineations of the spectra of a large number of bodies referred to the arbitrary scale of his spectroscope, and also in wave-lengths. Except in a few cases, he has not attempted to represent the feebly illuminated ground or continuous spectrum which in many instances extends over nearly the whole field of view. But the characters of the bright lines and

bands are carefully represented, and a full description of them is given in the body of the work. The whole is designed to facilitate the application of spectrum analysis to mineral chemistry; and although some of the details may hereafter require correction, the work is well executed, and cannot fail to be of great value to the scientific and practical chemist. The frequent reproduction of the comparatively simple spectra of the metals obtained at the low temperature of the gas flame in elementary works of chemistry, unaccompanied by sufficient explanation, has tended to give rise to partial and even incorrect conceptions of the grandeur and extent of this subject. How many persons believe that the spectrum of sodium consists solely of a pair of fine lines corresponding to the double line *D* of the solar spectrum? How few know that at the high temperature of the electrical spark it exhibits three other pairs of well-defined lines, one in the orange, another in the yellow, and another in the green, together with a nebulous band on the confines of the blue? (Huggins). All these lines may easily be seen by passing the electrical spark in a non-luminous flame between a fused bead of sulphate or chloride of sodium and a platinum wire, together with a few other feeble lines, especially in the violet (Lecoq de Boisbaudran). The vivid line in the red, with its faint companion in the orange, which forms the ordinary spectrum of the compounds of lithium in the gas flame, gives place to a very different spectrum, when sparks are drawn from a solution of the lithium salts. The red ray still continues vivid, but it is surpassed in intensity by the orange, which is now the most characteristic of the lithium rays, while two new rays or lines come into view (λ 497·0, 460·4). With a solution either of the ferrous or ferric chloride, the electrical spark gives the numerous lines with great sharpness and accuracy of detail, which constitute the spectrum of metallic iron.

M. Lecoq de Boisbaudran gives a delineation of what he considers to be the spectrum of oxide of barium, as it appears after a prolonged heating of the chloride in the gas flame, and also of the spectra proper of the chloride, bromide, and iodide of barium, as obtained by heating those salts in the gas flame charged with hydrochloric acid, bromine, and iodine vapours respectively. These spectra are all different. Thus, in the case of the chloride, only slight traces of the lines and bands due to the oxide are seen, while six new lines appear which are very intense (A. Mitscherlich). On the interesting subject of the bright lines which compose the spectrum of the earth erbia and its phosphate, the following observations are made in the work before us:—"According to Bunsen and Bahr, the addition of a little phosphoric acid to solid erbia gives to that earth a greater emissive power and renders the lines sharper, without modifying their number or position. On repeating this experiment, I find that erbia alone and erbia to which phosphoric acid has been added give very different spectra. On comparing the spectra, the red is more developed in the light of the phosphate, whilst the green and the violet-blue are more vivid in that of the oxide."

The limits of this notice do not permit the discussion of questions of great interest in spectrum analysis, many of which promise soon to be fully resolved. The observation of Roscoe and Upton, that the broad bands characteristic of certain metallic compounds at the low temperature of the gas flame disappear at the higher temperature of the electrical discharge, and the view they have set forth, that in the former case the spectrum is that of the compound, in the latter case that of the metal, have received confirmation from later researches. Lockyer, in his valuable contributions to spectrum analysis, has shown that what he designates the shortest lines disappear first on reducing the pressure, and that the difference between the spectrum of the chloride and the spectrum of the metal is that under the same spark condition all the short lines are obliterated in the former case. The same investigator has observed that metallic elements of low specific gravity, such as sodium, calcium, magnesium, and aluminium widen their lines by increase of vapour density, while metallic elements of high specific gravity, such as iron, cobalt, and nickel, increase under the same condition the number of their lines.

THOMAS ANDREWS

OUR BOOK SHELF

Comets and the New Comet of 1874. By the Author of "Astronomy Simplified for General Reading." (London: William Tegg and Co., 1874.)

THIS book purposes to be "a complete popular account of all that is known of these wonderful bodies which are so great a perplexity to science:" but the work consists of only 56 pages, and it is needless to say that even a popular account of these bodies to be complete must extend over a much larger space. We think that a work on any subject in science, to be popular, that is written to be read by the public at large and not by persons who are conversant with the subject only, should not refer to explanations or theories that are not generally known, without a very intelligible explanation; theories of the action of observed phenomena should not be given without a very strong probability of their truth, or without a caution against their acceptance; and in dealing with a subject like the present one, when our knowledge is limited, and when there are so many different modes of explaining appearances, it behoves an author to use more than ordinary caution against the mention of anything that is not strictly in accordance with ascertained physical laws. On both these points the present book is at fault. As an instance, the author mentions M. Faye's theory of the repulsive power of the sun in virtue of its heat, and then urges objections to the theory without a word of explanation of it. Now to a person not conversant with the experiments on the repulsion of gases and solids by heat rays, the theory would seem absurd and contrary to experience; and so the author carries the day with the theory that the effect of solar heat upon the cometary matter is electrical in its action. Again, he says: "For example, the matter of comets is not possessed of concentric attraction even with reference to itself, neither is it possessed of chemical affinity for itself. This is fully established by the eccentric forms of comets and through conspicuous variations of shape and size."' This is quite new to us. Again, after mentioning that Lexell's comet was entangled for about a month among the satellites of Jupiter, he says: "Is there another instance—a single analogy on record outside of cometary phenomena—of a body of dead matter under great velocity being actually barred and stopped in its path for four months, and then suddenly starting off again after being divested of its force for so long a period? What can the composition and resolution of forces do for us here? for here is the most wonderful problem ever submitted to their laws. What must be the amazing force of a body which, like an

unspent cannon-ball impeded by a bank of earth, keeps spinning and grinding in its bed for four months, and then suddenly goes off with unabated velocity as if it were merely ricochetting from its point of interruption?"

Did the writer never hear that the motion of this comet was in strict accordance with the laws of gravitation, and Laplace used it for corrrecting the value of Jupiter's mass? In these cases, and in many others, the author has gone sadly astray. The accounts of the appearance of the different comets are good and clear and are well worth reading, but one or two drawings of comets would have improved matters considerably. There is a plate at the beginning of the book, of the earth in a comet's tail, which draws somewhat on the imagination. A want of soundness with reference to mechanical laws appears throughout the book, for we read of the two parts of Biela's Comet having less mass to be acted upon by solar attraction than they had before separation, so that the original orbit must have been altered; and we hear of a comet altering capriciously its centre of gravity with reference to solar attraction. The words orbit*u*al and phosphor*o*us occur frequently, we hope for the last time. The book is spoilt by the endeavour to explain the appearances of comets without regard to the most fundamental physical laws which have so far been found to be rigorously exact. G. M. S.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Pollen-grains in the Air

MR. HUBERT AIRY's letter printed in your issue of Sept. 3 appears, to a great extent, to reconcile that gentleman's observations with my own. My set of drawings have been made entirely from pollen-grains in the *dry* state, and in this condition (in which of course it is wafted through the air) I find the pollen of plants fertilised by the wind, though belonging to the most widely dissociated natural orders, to be uniformly, as far as I have been able to observe, nearly or perfectly spherical, with no prominences or furrows visible on magnifying about 250. A very short immersion in glycerine would cause the protrusion of the intine through the weak spots of the extine, and would give to the grains of birch and hazel the spherically triangular appearance described by Mr. Airy, and represented in some of the plates by an old German writer. ALFRED W. BENNETT

Penmaenmawr, Sept. 9

Fossils in Trap

WHEN examining the great exposure of trap and associated Upper Silurian rocks at Cape Bon Ami, New Brunswick, I unexpectedly found fossils in the trap. I was at the time collecting agates and amygdals of calcite. One amygdal attracted my attention as singularly regular in shape. On detaching it from the rock and examining it with the magnifying glass, I found it to be a coral, *Favosites gothlandica*. The fossil is nearly circular. Its greatest diameter is $1\frac{7}{10}$ in., its smallest diameter $1\frac{5}{10}$ in., its greatest thickness is $\frac{1}{2}$ in. Notwithstanding the rubbing by exposure on the shore, many of the cells are quite distinct: the side attached to the trap is without cells. I found a second specimen of a similar coral in another part of the trap-rock. Of this the length is 1 in., the width $\frac{8}{10}$. The exposed part is a section having the structure perfect; it is slightly weathered. The fossil is indissolubly united with the trap, its sharp septa penetrating it: the trap of the specimen is very compact.

These fossils are derived from the associated strata of Niagara limestone: Wenlock limestone age.

The strata have been coral reefs: they are filled with corals, *Favosites* and *Cyathophylla*. I collected magnificent specimens of the former, also *Crinoid* joint, *Orthis* sp.? *Strophomena depressa*, *Atrypa reticularis*, *Rhynchonella* sp., *Athyris nitida*, *Orthoceras* sp.?

The fossils are easily detached from the strata.

I have no doubt that the notice of the occurrence of the fossils in trap will be new to many of your readers. In all my investigations I have not met with a similar occurrence. The first example proves that the trap was, at least, in a *plastic* state when the fossil dropped into it. The second proves that it was in a *fluid* state.

This is all very satisfactory to us, as proving that trap is a true *lava*, although the Wernerian might thereby infer that the trap was a sedimentary rock. The section of the coral in the trap is as perfect as sections of *Lithostrontion* in the Lower Carboniferous limestone of East River Picton in our museum collection.

By what process were these fossils preserved from destruction in the molten trap? D. HONEYMAN

Halifax, Nova Scotia, Aug. 27

[Our correspondent does not define in what sense he uses the vague word "trap." Fossils, both animal and vegetable, are of common occurrence in some kinds of "trap," *e.g.* in the different forms of tuff. We presume that the specimens he refers to were of true basalt, or some other form of crystalline, and once molten igneous rock. If so the fact is interesting, though possibly some of our readers may be able to adduce similar cases.—ED.]

Curious Rainbow

THREE or four days ago I observed a phenomenon which may possibly be interesting to some of your readers. I was standing on a hillside, about 200 ft. above the sea, and saw a rainbow of the ordinary description, very vivid and extending to the horizon at both ends of the arch; outside this was a secondary bow, also very distinct, and inside the primary bow was a series of coloured bands, to all appearance identical with the series in the primary bow from the green to the violet, so placed that the green of this third bow was next to the violet of the primary bow, and the violet of the third bow the innermost of all. There was no appearance of any superposition of colours, and the third bow was nearly as bright as the primary, and the interval between them was hardly appreciable. The whole series was concentric. I have not observed any notice, in works on the subject, of a phenomenon similar to this, or any hint that it might be expected according to the geometrical or physical theories of the rainbow, and therefore think the appearance may possibly be of rare occurrence. R. P. A. SWETTENHAM

Glen Caladh, Kyles of Bute, Sept. 5

Polarisation of the Aurora

IN answer to Mr. Procter's first question (vol. x. p. 355), I would refer him to NATURE, vol. vii., p. 201, where he will find an account of observations of the polarisation of the zodiacal light, and of the aurora, by Mr. Ranyard, who appears to have used a double image prism and Savart, during the great aurora of Feb. 4, 1872, and to have detected no polarisation. He refers also to some observations made upon the small aurora of Nov. 11, 1871, in which he could detect no polarisation. The only other account of observations that I have met with are contained in the report of Prof. Stephen Alexander on his expedition to Labrador, given in Appendix 21 of the United States Coast Survey Report for 1860, p. 30. He found strong polarisation with a Savart's polariscope, and, what is most remarkable, thought that the dark parts of the aurora gave the strongest polarisation. This was at the beginning of July. He was in latitude about 60°, and the observations appear to have been made near midnight. But he does not state whether there was twilight or traces of air polarisation at the time, nor does he give the plane of polarisation.

Cheltenham J. A. FLEMING

FRANCIS EDMUND ANSTIE, M.D., F.R.C.P.

ON Saturday, 12th inst., in his forty-first year, a[illegible] illness of only four days' duration, die[illegible] [illegible]ter an Anstie, from the consequences of a disse[illegible] [illegible] Dr. F. E. flicted while he was investigating the [illegible]tion-wound inand somewhat mysterious disea[illegible] causes of a serious time prevailed in a large sch[illegible] [illegible]se which had for some rapidly carried off sever[illegible] [illegible]ol at Wandsworth, and had [illegible] of the pupils. Thus he must

be enrolled in the list of those who have fallen in the cause of scientific investigation.

Dr. Anstie was a student of King's College, and took his doctor's degree at the University of London in 1858, since which time he has devoted much of his leisure to the investigation of therapeutical and pathological problems. His work on "Stimulants and Narcotics," published in 1864, first brought him into notice as an upholder of the value of alcohol as a nutritive agent, in contradistinction to the opinion of M. Lallemand, that its action is simply stimulant. In conjunction with Dr. Burdon-Sanderson he was one of the first in this country to direct attention to the Sphygmograph of his friend Prof. Marey, of Paris. Sanitary reform was another subject to which Dr. Anstie paid much attention, and with great success. His article on "Neuralgia" in Reynolds' "System of Medicine," and his important work on the same subject, made him well known as a physician, as did his papers in the *Practitioner*, of which he was the editor.

Dr. Anstie was physician to Westminster Hospital, where he was also lecturer on Medicine. The new physiological laboratory of that institution, which is to be opened next month, owes much to his energy; and no one, more than himself, looked forward to the opportunities it will afford for original investigation. Dr. Anstie's loss will be felt by a large circle of friends, whom he had an unusual power in making and retaining, on account of the genuineness and force of his character.

HIEROGLYPHIC TABLETS AND SCULPTURE IN EASTER ISLAND

EARLY last spring mention was made in NATURE (vol. ix. p. 351) of some photographs of inscribed tablets from Easter Island, which the Academy of Sciences at San Francisco had shortly before received from Mr. Croft, of Papeeti, Tahiti.

Up to that time only three tablets were known for certain to have been discovered in the island. From information, however, which has recently been received, it appears that there are now no less than five tablets at the Roman Catholic Mission in Tahiti; and one, obtained last year by the mate of a vessel wrecked on the island, is said to have been taken to San Francisco. Two others are in the National Museum at Santiago de Chili;* and casts from these, made under Mr. E. Reed's directions, were sent to England and Germany in 1873. This, however, is not all. Natives who are in the employ of planters at Papeeti inform Mr. Croft that incised tablets were formerly very numerous in Easter Island, but many were destroyed in intestine wars. Some are said to have contained descriptions of land and boundaries; others, directions for planting and fishing; many were connected with religion and mythology; and, more important than all, a few "contained the ancient history of the island, and its kings or ruling chiefs:" these, it was feared, might all have been destroyed, not by the natives themselves, but by direction of Roman Catholic priests, who, as in America at the time of the Spanish conquest, persuaded their first converts to burn and destroy a large number of records without discrimination. It is known, however, that a few remain in possession of the islanders, who are said to attach the greatest possible value to them.

Should no others prove to be historical, it is almost certain that one, at least, of those at Santiago, of which we have the plaster casts, answers this description. The tablet alluded to is fully described in the *Journal of the Anthropological Institute*,† where plates will be found of the hieroglyphics.

Some of the older natives of Easter Island are said still to possess the art of engraving tablets, and to be able to interpret them. But whether this refers to the ancient signs, or only to those which Señor G. de la Rosa found were used by the chiefs a hundred years ago, is at present doubtful. Dr. Philippi, of the University of Santiago, on the authority of Père Einaud, one of the French missionaries, says that the natives do not attach any meaning to the signs. Probably expert wood-carvers like the Easter Islanders would from time to time have replaced decayed tablets and multiplied others. They may also, very possibly, know from the general appearance of the hieroglyphics what they refer to, and yet not understand individual signs.

Before showing that it may prove an easy task for anyone acquainted with the Pacific to interpret the signs, provided he has some knowledge of the traditions of the Easter Islanders, it will be necessary to mention the legend of their origin as ascertained by Commodore Powell and Señor Gana from the missionaries on the spot (in 1868 and 1870). It is briefly this: that their ancestors arrived in two boats many years ago, each boat being under the command of a chief; and there is a distinct tradition that they had been expelled from Oparo, or Rapa-iti, an island 1,600 miles to the west.

Now there is a drift-current from that direction, that carries wood and other waifs to the shores of Easter Island; so that it is physically possible for a canoe or other vessel to have arrived by its aid. It is worth mentioning that the current turns round Easter Island, and then goes northwards.

Oparo, also, bears silent witness to the truth of the story. Though little more than seven miles in length, several of its hills are capped with stone forts; and there are platforms and stone houses as in Easter Island, as well as a fortress or temple in five stages (like the ruin of Pollanarrua, in Ceylon). It need scarcely be added that there are traditions of fierce wars and feuds in the island.* Unfortunately, little more than this is known about its antiquities and legends.

Passing by, with the bare mention, several symbolic practices of the Easter Islanders—for example, the enormous trouble that was taken by them to crown the great statues with huge tiaras of red tufa; the erection of effigies of their chiefs on platforms of squared stone, the masonry of which, Cook said, was "equal to any in England;" the peculiar form of the huts, like inverted boats; their moon-shaped shields, used only in dances (some with faces carved on the cusps, like the eagles' heads on the Phrygian peltas); the bi-fronted staffs or batons, which were held in the hands of the chiefs; and tattoo marks like those in Burmah and India,—all of which may possibly, by and by, aid us in discovering the land from which the mysterious chiefs of Easter Island originally came,—passing by these, we will confine our attention to the symbols which appear more immediately to relate to the arrival of vessels from Oparo, and seem to establish the tradition on an historical basis.

Few who have visited the Cnidus Shed at the British Museum can have failed to notice the emblematic carving on the back of one of the statues from Easter Island, at present deposited there. It was found under cover in the range of stone houses called "Taura Renga," in the centre of a chamber lined with wall slabs, and partly excavated from the cliff. The bas-reliefs faced the entrance, a small square door, with stone posts and lintel, in a rubble wall about 5 ft. in thickness. On the back of the head of the statue there is a bird, over which is a solar crown; and on either side a rapa, or steering paddle, with a human face on the spade-like blade.† A third but very much smaller rapa is carved on the back of the right ear of the statue, whilst four ovals are incised on the left. The lobes of both ears are greatly lengthened.

* Two more are reported to have been taken by a surveying ship to Russia a few years ago, and another to Germany.

† Journ. Anthro. Inst., Jan. 1874. Trübner and Co.

* Captain Vine Hall, who spent a few hours there a year or two ago, gives the above particulars.

† There are wooden rapas in Easter Island, which are used only in the native dances.

Lower down on the back of the statue there are two herronias—symbolic animals, with albatross-like beaks, which are turned, not ungracefully, towards the bird. Immediately above the waist-belt of the statue—its only dress—there is a circle.

The explanation of these hieroglyphics is at once suggested by the story of the arrival of the chiefs. The two rapas, or steering paddles, were dedicated to the gods, and symbolise the vessels of the two chiefs. They were doubtless carved on the statue to commemorate their safe arrival. The two herronias may represent the chiefs themselves. The circle is the accepted emblem of life.

The same symbolism, though of a more realistic kind, may be recognised in the curious wooden images which are peculiar to Easter Island. They are mostly anatomical; that is, figures in which the ribs, vertebræ, and other bones are distinctly shown, as they would appear in a person suffering from extreme emaciation. They were styled by La Pérousse "squelettes." Nearly all of them have strongly marked Semitic features, a tuft on the chin, and highly symbolic carvings on the scalp; *e.g.*, herronias, double-headed birds, and a solar deity with rays round the head. The legs of these little images are uniformly short, and the ear-lobes enlarged. There is also very generally, if not always, a circle on the lower part of the back. It can hardly be doubted, in view of the symbolism which pervades almost everything in Easter Island, that these squelettes are connected with the story of the voyage from Oparo, and represent the half-starved condition in which it may well be conceived that the crews arrived.

In one of these images, in the Ethnographical Room at the British Museum, the head is perfectly smooth, which appears to intimate that it was shaven. It perhaps represents a priest; for we are informed that Roggewein, the discoverer of Easter Island in 1720, noticed a native with his head shaved, who had large "white balls" in his ears, and appeared very devout: the Dutch judged him to be a priest.

Returning to the tablets, of which casts are in the museum of the Anthropological Institute, it will be sufficient to mention that they are engraved with hieroglyphics on both sides, every part being covered with minute signs, apparently intended as actual representations of various forms of animal and vegetable life; as well as scenes and incidents such as were likely to have been met with among the islands in the Pacific. On the bottom line of what is considered to be the front face of the smaller tablet there is a procession of bird-headed men, who are approaching or standing before a pillar, or stone,* with two discs, or circles, on each side. Immediately before the first figure, which it is presumed is a chief, from his holding a staff in his hand, are two curved lines, the hieroglyphic for a boat or canoe. Behind the chief another bird-headed man is represented as kneeling down, and holding up his hands; he is probably a priest.† A third bird-headed figure follows without a staff. Then, after two small curves high up in the line of hieroglyphics—perhaps a sign for the moon,—there is a character with a bird's head and beak, of a different shape from those of the bird-headed men. It has a crest on its head, and short wings, and is probably intended for a domestic fowl—the only land bird in Easter Island. It appears to be a victim about to be sacrificed. Two more bird-headed men, without staffs, follow in a certain stately order. Then there is a second sign or hieroglyphic for a boat, followed by another chief; and then a third sign for a boat, with a waved or zigzag line before it, which is perhaps intended to signify that the vessel which follows it was lost or driven away in some other direction by a storm. This last boat is followed by a bird-headed man without a staff.

The signs for the chiefs' vessels, it will be seen, agree in number with the large rapas, or steering paddles, upon the back of the stone statue; and the bird-headed chiefs answer to the two herronias. The diminutive steering paddle, represented apart from the others on the ear of the statue, may symbolise the same casualty that appears to be signified by the waved line, viz., that there was a third boat, which did not reach Easter Island. The small carving of a rapa would thus have been erected merely *in memoriam*. However this may be, taken in conjunction with the tradition, there can be little doubt that the hieroglyphics on the tablet and the carvings on the statue relate to a more important matter than the arrival of the chiefs.

As regards the signs generally, a considerable number have been identified as conventional representations of birds and animals which are not found in Easter Island; weapons, also, and other objects are introduced (*e.g.*, an Eastern bow), which belong to regions far to the west. Some of the identifications that have been suggested may be doubtful; but amongst those that will perhaps meet with general acceptance, by no means the least important are the hieroglyphics of three distinct types of men: (1) Tall, bird-headed men, with short legs, as in the wooden images. (2) Men with large ornaments or projections on each side the head, scarcely exaggerating the practice of enlarging the ear-lobes by inserting in them discs, or plugs of wood and other materials, which prevails in certain islands in the Pacific, as well as amongst the older races in India and Burmah. (3) Dog-faced men, or Negritos, with strangely shaped heads, which, from plates in the "Cruise of the *Curaçoa*," appear to be characteristic of the natives of the Solomon Islands, as well as the more westerly islands of the Fiji group. They squat like the dog-faced men in the tablets, whilst the large-eared men sit in the Eastern manner. The peculiar appearance of the head is explained by the custom of dressing and plastering the hair. Several of these Negritos are represented about the middle of the tablet as celebrating a fish-fête; the men dancing by themselves on one side, and the women in couples on the other. Two of the men with enlarged ear-lobes stand by as spectators.

Enough has perhaps been said to suggest the great importance of an early and systematic exploration, above and below ground, of Easter Island and Oparo, as almost unworked mines, abounding in matter of the greatest ethnological and anthropological interest.

J. PARK HARRISON

* Compare the legend of the "Emigration of Turi," Pol. Myth. p. 214. "Amongst the chiefs who landed there was one called Porua . . . the second (dog) they cut up raw as an offering for the gods . . . and built a second place, *and set up pillars for the spirits*."

† See Pol. Myth. p. 136, where a priest is mentioned as accompanying a boat expedition.

ON THE DISTRIBUTION OF THE HEAT DEVELOPED BY COLLISION *

MANY of our colleagues who have become aware of a fact in thermodynamics which it has been in our power recently to observe, think it possessed of so great an interest that I ought immediately to announce it to the Academy. It is as follows:—

During the forging, which has been very successful, of the ingot of platino-iridium for the standard metre, I at first remarked that it sometimes produced, under the action of the hammer, luminous streaks, having an oblique direction upon the lateral faces of the piece, when this, while cooling, was yet at the temperature of a dull red. I showed some of these effects to M. Fizeau, but they were then incomplete, and I have only lately succeeded in obtaining a good observation of the phenomenon, and in defining its character with perfect certainty.

* A paper read by M. Tresca before the Paris Academy of Sciences June 8.

It is known that when a bar of metal is lengthened by means of a powerful hammer on an anvil of the same form as the head of the latter, each blow produces, above and below, a symmetrical contraction, the effect of which is to give to the bar the aspect of a series of projections separated by small level spaces.

At the time of the collision, these spaces, which are formed before and behind the impress of the hammer, upon the upper and the lower face of the bar, are connected, at a certain moment, upon the lateral faces, by luminous lines passing from the one to the other, and presenting altogether the appearance of an X written in lines of fire. The phenomenon is only visible for a certain temperature of bar which is being wrought, but then each blow invariably produces its effect, and, in consequence of the confused mingling of the imprints, we see the entanglement of these crossed lines which encroach upon each other. These brilliant bands appear at the same moment as the collision, but they do not disappear with it, and their continuance was sufficiently prolonged to enable us to count six luminous cross-bars visible at one time, although developed by six successive blows of the hammer.

I have been able, moreover, to get this persistence confirmed by several persons in the foundries of M. Farcot, who, with the greatest kindness, placed his services at the disposal of the Metric Commission for the execution of the work.

Although the lines of the cross-bars appeared to us all rectilinear, and although we could not compare them to anything better than two series of straight lines, parallel and intercrossed, we think it will be indispensable to determine their form more exactly by appropriate processes, and to discuss it with the greatest care.

It is well known that hammering develops heat in the bodies hammered; thermodynamics teaches us that these thermal effects ought to be regarded as the result of mechanical work or of *demi-force vive* exerted during the collision, but the precise place in which the calorific development is produced has not yet been noticed.

For ourselves, we do not hesitate to affirm that the zone which becomes luminous is that along which the matter mainly flows, at the moment when the change of form takes place, according to a law which we were enabled to discover in our previous researches in molecular displacements. If this first indication should be confirmed, there would be thus obtained a more exact knowledge of the mode of distortion determined by the forging, and the phenomenon which we describe would evidently form a new scientific connection between thermodynamics and the question with which we ourselves are personally occupied under the title of "Flowing of Solid Bodies."

The phenomenon ought to be the same for all metals, and we have already ventured to hazard some considerations of the particular causes of the brightness which it presented in the case of platinum, and which has not, so far as we know, been yet observed in any other forging.

The exceptional hardness of the platino-iridium, cooled to a dull red heat, requires, for an equal distortion, an amount of work at least equivalent to that of the forging of steel, and in consequence of the relative smallness of the calorific capacity of this alloy, this same work ought to be converted into calorific phenomena, more localised and more intense. Moreover, the material is more homogeneous than iron, and is notable for a kind of remarkable translucency which makes one believe that the eye can follow the shade of red to a certain depth. The effects, whatever they may be, are thus rendered more manifest, more especially as they are not accompanied by any exudation of foreign matter nor by any oxidation of the surface. All these circumstances are eminently favourable to the observation which chance permitted us to make, and which, once confirmed in the case of platinum, may certainly be renewed with other metals, although possibly in a more restricted manner than in the case of the alloy of MM. Deville and Debray.

We confine ourselves for the present to a summary indication of the principal fact, which appears to us to have a certain importance, and which consists in this appearance of luminous bands which arise from collision, and the position of which enables us to fix the precise place where is developed the heat which represents under another form the work done by motion: this fact is, perhaps, of a nature to open some new path for the researches, so carefully made, of the physicists of our epoch on all that touches on molecular mechanics and on the calorific actions which are connected with them.

The ingot of platinum has already been brought into the form of a bar with a square section of 4·50 m. in length; there will be a chance of continuing the same observations in the new operations of forging to which it will be submitted; the chance of renewing them may perhaps not again be offered.

SUBJECTS FOR PRIZES PROPOSED BY THE HAARLEM SOCIETY OF SCIENCES

THE following subjects for prizes are proposed by the Haarlem Society of Sciences:—

I. Competition of 1875, the limit of which is fixed on Jan. 1, 1875.

1. To give for ten sorts of glass of known chemical composition—(*a*) The coefficients of dilatation between 0° and (at the most) 100°, having regard to the influence of the tempering and the state of tension; (*b*) The coefficients of elasticity with exact indication of the temperatures; (*c*) The indices of refraction for at least ten points distributed over the whole extent of the spectrum, also with precise indication of the temperature.

2. Does the coefficient of dilatation of steel vary with the degree of tempering, and can we establish empirical laws on the subject of the connection between these two elements?

3. Can there be established by experiment a connection between the diffusion of liquids through porous partitions and other phenomena, such as capillarity, &c.?

4. Determine the coefficient of dilatation for at least three liquids of simple composition, according to the process by which the absolute dilatation of mercury has been established.

5. Researches are sought on the origin of sensitive organs, especially of the visual organ, among some of the inferior animals; this origin being considered, as far as possible, in relation to the conditions in which the animal is found, and the external influences to which it is subject.

6. In terrestrial magnetism, what are the periods known with sufficient accuracy, and how far have these periods been proved to be connected with cosmical or telluric phenomena?

7. New experiments and observations are wanted to clear up the following question:—How are albumenoid matters formed and removed in plants?

8. Determine exactly the density, the coefficient of dilatation, the point of fusion, the point of ebullition, the specific heat, the index of refraction, and the specific rotatory power of at least twenty organic combinations, pairs of which are isomeric and whose chemical composition is known.

9. The experiments of M. Regnault on the specific heat of certain terpenes, and those of M. Berthelot on diamylene and triamylene, having shown that the specific heat of polymeric bodies of one combination may be equal to that of the fundamental matter from which they originate, it is desired that these researches be extended to as great a number as possible of other combinations having between them the same relations, for the purpose of deciding if the observed fact may or may not be raised to the rank of a general law.

10. New researches are sought on tetraphenol and its derivatives, for the purpose of deciding on the value of the hypothesis of M. Limpricht concerning the existence of a series of aromatic matters with a nucleus composed of four atoms of carbon.

11. Give a critical sketch of experiments and observations concerning the existence of *Bacteria* in contagious diseases, followed by original researches on the same question investigated in one or more of these maladies.

12. New experiments are asked on the mode of growth of bone, of such a kind as to abolish the differences of opinion founded upon results apparently contradictory, announced in recent years by various experimenters.

13. A thorough investigation is wanted of some of the species of Linnæus, chosen from among those which present more or less of varied forms. These species ought to be wild (*spontanées*) plants, to the number of ten at least, and of twenty or more, belonging to two natural families at least, and inhabiting well-explored countries, such as Europe, the United States, &c. The author ought to discover, describe, and classify all the forms more or less distinct, and more or less hereditary, which are included in the Linnean species, being careful to intimate their habitat, their station. He ought to study their mode of fecundation, and to judge how far certain forms may be attributed to crossing. The classification of forms into species, races, varieties, and other subdivisions as may be necessary, ought to be based at once upon the external forms and on the more intimate affinities demonstrated by fecundation and grafting.

II. For competition in 1876, for which the limit is fixed on Jan. 1, 1876.

1. Exact researches are asked for concerning the dissolving power of water, and of water charged with carbonic acid, for gypsum, chalk, and dolomite, at different temperatures and pressures, and in the case of the simultaneous presence of marine salt and other common soluble salts.

2. The same is asked for silex and the most common natural silicates.

3. To submit to a new investigation the structure of the kidneys of Mammalia, specially in reference to the epithelial lining of the different parts of the renal tubes.

4. A critical examination of recent researches from which it would appear to result that the peptones of different albumenoid matters are mixtures of substances in part already known and partly yet unknown. This critical examination should be completed by personal researches.

5. To determine exactly in Weber units, the resistance of a column of mercury of one metre in length and of one square millimetre in section, at 0°.

6. To make better known, by careful experiments, the relation between the two kinds of electrical units, electro-magnetic units and electro-static units.

7. New experiments tending to determine the influence of pressure on chemical action.

The prize offered by the Society for each of these questions consists (at the choice of the competitors) either of a gold medal bearing the ordinary stamp of the Society, along with the name of the author and the date, or a sum of 150 florins. A supplementary premium of 150 florins may, moreover, be awarded if any memoir is deemed worthy of it. The memoirs sent for competition ought to be written in one of the following languages:—French, Dutch, English, Italian, Latin, or German (but not in German character). They ought to be accompanied by a sealed envelope containing the name of the author, who ought not to make himself otherwise known.

COMMON WILD FLOWERS CONSIDERED IN RELATION TO INSECTS *

At the close of the last century, Conrad Sprengel published a most valuable work on Flowers, in which he pointed out that their forms and colours, their scent, honey, and general structure, have reference to the visits of insects, which are of importance to Flowers in transferring the pollen from the stamens to the pistil. Sprengel's admirable work, however, did not attract the attention it deserved, and remained comparatively unknown until Mr. Darwin devoted himself to the subject. Our illustrious countryman was the first to perceive that insects are of importance to Flowers, not only in transferring the pollen from the stamens to the pistil, but in transferring it from the stamens of one flower to the pistil of another. Sprengel had, indeed, observed in more than one instance that this was the case; but he did not appreciate the importance of the fact. Mr. Darwin's remarkable memoir on Primula, to which I shall again have occasion to refer more than once, was published in 1862; in this treatise the importance of cross-fertilisation, as it may be called, was conclusively proved, and he has since illustrated the same rule by a number of researches on Orchids, Linum, Lythrum, and a variety of other plants. The new impulse thus given to the study of Flowers has been followed up in this country by Hooker, Ogle, Bennett, and other naturalists, and on the Continent by Axell, Delpino, Hildebrand, and especially by Dr. H. Müller, who has published an excellent work on the subject, bringing together the observations of others and adding to them an immense number of his own.

Everyone knows how important flowers are to insects; everyone knows that bees, butterflies, &c., derive the main part of their nourishment from the honey or pollen of flowers; but comparatively few are aware, on the other hand, how much the flowers themselves are dependent on insects.

Yet it is not too much to say, if flowers are very useful to insects, insects, on the other hand, are in many cases absolutely necessary to flowers; that if insects have been in some respects modified and adapted with a view to the acquirement of honey and pollen; flowers, on the other hand, owe their scent and colours, nay, their very existence in the present form, to insects. Not only have the brilliant colours, the smell, and the honey of flowers been gradually developed under the action of natural selection to encourage the visits of insects, but the very arrangement of the colours, the circular bands and radiating lines,* the form, size, and position of the petals, are arranged with reference to the visits of insects, and in such a manner as to ensure the grand object which renders these visits necessary. Thus the lines and bands by which so many flowers are ornamented have reference to the position of the honey; and it may be observed that these honey-guides are absent in night-flowers, where of course they would not show, and would therefore be useless, as, for instance, in *Lychnis vespertina*, or *Silene nutans*. Night-flowers, moreover, are generally pale; for instance, *Lychnis vespertina* is white, while *Lychnis diurna* which flowers by day is red.

That the colour of the corolla has reference to the visits of insects is well shown by the case of flowers, which—as, for instance, the ray or outside florets of *Centaurea cyanus*—have neither stamens nor pistils, and serve, therefore, exclusively to render the flower-head more conspicuous. The calyx, moreover, is usually green; but when the position of the flower is such that it is much exposed, it becomes brightly coloured, as, for instance, in the Berberry.

If it be objected to me that I am *assuming* the existence of these gradual modifications, I should reply that it is not here my purpose to discuss the doctrine of Natural Selection. I may, however, remind the reader that Mr. Darwin's theory is based on the following considerations:—1. That no two animals or plants in nature are identical in all respects. 2. That the offspring tend to inherit the peculiarities of their parents. 3. That of those which come into existence only a certain number reach maturity. 4. That those which are, on the whole, best adapted to the circumstances in which they are placed, are most likely to leave descendants.

No one of these statements is, or can be, disputed, and they seem fully to justify the conclusions which Mr. Darwin has deduced from them, though not all those which have been attributed to him by his opponents.

Now, applying these considerations to flowers, if it is an advantage to them that they should be visited by insects (and that this is so will presently be shown), then it is obvious that those flowers which, either by their larger size, or brighter colour, or sweeter scent, or greater richness in honey, are most attractive to insects, will, *ceteris paribus*, have an advantage in the struggle for existence, and be most likely to perpetuate their race.

There are, indeed, other ways in which insects may be useful to plants. Thus, a species of acacia mentioned by Mr. Belt,† if unprotected, is apt to be stripped of its leaves by a species of leaf-cutting ant, which uses the leaves, not directly for food, but, according to Mr. Belt, to grow mushrooms on.

The acacia, however, bears hollow thorns, and each leaflet produces honey in a crater-formed gland at the base, and a small, sweet, pear-shaped body at the tip. In consequence it is inhabited by myriads of a small ant, *Pseudomyrma bicolor*, which nests in the hollow thorns, and thus finds meat, drink, and lodging all provided for it. These ants are continually roaming over the plant, and constitute a most efficient bodyguard, not only driving off the leaf-cutting ants, but even in Mr. Belt's opinion rendering it less liable to be eaten by herbivorous mammalia.

* Address by Sir John Lubbock, Bart., F.R.S., at the Belfast meeting of the British Association, August 1874.

* I did not realise the importance of these guiding marks until, by experiments on bees, I saw what difficulty they experience if honey, which is put out for them, is moved even slightly from its usual place.

† F. Müller has observed similar facts in Sta. Catharina. (NATURE, vol. x. p. 102)

We are now, however, more immediately concerned with bees and flowers.

Many flowers close their petals during rain, which is obviously an advantage, since it prevents the honey and pollen from being spoilt or washed away. Everybody, however, has observed that even in fine weather certain flowers close at particular hours. This habit of going to sleep is surely very curious. Why should flowers do so?

In animals we can understand it; they are tired and require rest. But why should flowers sleep? Why should some flowers do so and not others? Moreover, different flowers keep different hours. The daisy opens at sunrise and closes at sunset, whence its name "day's-eye." The dandelion (*Leontodon taraxacum*) is said to open at seven and close at five, *Arenaria rubra* to be open from nine to three, *Nymphæa alba* from about seven to four: The common Mouse-ear Hawkweed (*Hieracium pilosella*) is said to waken at eight and go to sleep at two; the scarlet pimpernel (*Anagallis arvensis*) to wake at seven and close soon after two; while *Tragopogon pratensis* opens at four in the morning, and closes just before twelve, whence its English name, "John go to bed at noon." Farmers' boys in some parts are said to regulate their dinner-time by it. Other flowers, on the contrary, open in the evening.

Now, it is obvious that flowers which are fertilised by night-flying insects would derive no advantage from being open by day; and, on the other hand, that those which are fertilised by bees would gain nothing by being open at night. Nay, it would be a distinct disadvantage, because it would render them liable to be robbed of their honey and pollen, by insects which are not capable of fertilising them. I would venture to suggest, then, that the closing of flowers may have reference to the habits of insects, and it may be observed also in support of this that wind-fertilised flowers never sleep;* and that some of those flowers which attract insects by smell emit their scent at particular hours: thus, *Hesperis matronalis* and *Lychnis vespertina* smell in the evening, and *Orchis bifolia* is particularly sweet at night.

I now pass to the structure and modification of flowers. A perfect flower consists of (1) an outer envelope or *calyx*, sometimes tubular, sometimes consisting of separate leaves, called *sepals*; (2) an inner envelope or *corolla*, which is generally more or less coloured, and which, like the calyx, is sometimes tubular, sometimes composed of separate leaves, called *petals*; (3) of one or more *stamens*, consisting of a stalk or *filament*, and a head or *anther*, in which the pollen is produced; and (4) a *pistil*, which is situated in the centre of the flower, and consists generally of three principal parts—one or more *carpels* at the base, each containing one or more seeds; the stalk or *style*; and thirdly the *stigma*, which in many familiar instances forms a small head at the top of the style or ovary, to which the pollen must find its way in order to fertilise the flower. In some cases the stigma is sessile. Thus it will be seen that the pistil is normally surrounded by a row of stamens, and it would seem at first sight a very simple matter that the pollen of the latter should fall on the former.

This in fact does happen in many cases, and flowers which thus fertilise themselves have evidently one great advantage—few remain sterile for want of pollen. Everyone, however, who has watched flowers and has observed how assiduously they are visited by insects, will admit that these insects must often deposit on the stigma, pollen brought from other plants, generally of the same species. For it is a remarkable fact that in most cases bees confine themselves in each journey to a single species of plant, though in the case of some very nearly allied forms this is not so; for instance, it is stated on good authority that *Ranunculus acris*, *R. repens*, and *R. bulbosus* are not distinguished by the bees, or at least are visited indifferently, as is also the case with two of the species of clover, *Trifolium fragiferum* and *T. repens*. Now, it is clear, both from the structure of flowers and also from direct experiment, that as a general rule it is an advantage to flowers to be fertilised by pollen from a different plant.

I will not now enter on the large question why this confertilisation should be an advantage; but that it is so has been clearly proved. It has long been known that hybrids between different varieties are often remarkably strong and vigorous; Kolrenter speaks with astonishment of the "*statura portentosa*" of some plants thus raised by him; indeed, says Mr. Darwin,* all experimenters have been struck with the wonderful vigour, height, size, tenacity of life, precocity, and hardiness of their hybrid productions. Mr. Darwin himself, however, was, I believe, the first to show that if a flower is fertilised by pollen from a different plant, the seedlings so produced are much stronger than if the plant is fertilised by its own pollen. I have had the advantage of seeing several of these experiments, and the difference is certainly most strtiking. For instance, six crossed and six self-fertilised seeds of *Ipomœa purpurea* were grown in pairs on opposite sides of the same pots; the former reached a height of 7 ft., while the others were on an average only 5 ft. $4\frac{1}{2}$ in. The first also flowered more profusely. It is also remarkable that in some cases plants are themselves more fertile if supplied with pollen from a different flower, a different variety, and even as it would appear in some cases, as in the Passion Flower, for instance, of a different species. Nay, in some cases it would seem that pollen has no effect whatever unless transferred to a different flower. In Pulmonaria, for instance, the pollen is said to be entirely without effect on the stigma of the same plant. Fritz Muller has made a variety of experiments on this interesting subject, which seem to show that in some cases, pollen, if placed on the stigma of the same flower, has no more effect than so much inorganic dust; while, which is perhaps even more extraordinary, in others the pollen placed on the stigma of the same flower acted on it like a poison. This he observed in several species: the flower faded and fell off; the pollen masses themselves, and the stigma in contact with them, shrivelled up, turned brown, and decayed; while other flowers on the same branch, which were left unfertilised, retained their freshness.

We will now pass to the consideration of the means by which self-fertilisation is checked, and cross-impregnation is effected, in plants. In some cases the pollen is simply wind-borne, in others it is carried by insects. These are attracted partly by the pollen itself, partly by the honey; while the bright colour and the scent serve to indicate the spot where the pollen and honey can be found. The calyx, which is not generally brightly coloured, probably serves as a protection to the honey, and tends to prevent bees and other insects from obtaining access to it by force.

In many cases self-fertilisation is prevented by the separation of the stamens and pistils, either in the place they occupy, or the time of their maturity. They are frequently situated, either in different flowers of the same plant, as in Euphorbia, or in different plants, as in the Hop; in other cases, although the stamens and pistils are situated in the same flower, they do not mature at the same time, the anthers in some cases producing their pollen before the pistil is ready to receive it, as was first observed in *Epilobium angustifolium* by Sprengel, in the year 1790;* while in others the reverse is the case, and the pistil, on the contrary, comes to maturity before the pollen is formed. But even when the stamens and pistils are situated in the same flower and ripen at the same time, they are sometimes so placed that it is difficult for the pollen to reach the stigma.

Moreover, it appears that if a supply of pollen from another plant is secured, it is comparatively unimportant to exclude the pollen of the plant itself, for in such cases the latter is neutralised by the more powerful effect of the former.

It is also interesting to notice that the contrivances by which cross-fertilisation is favoured, or ensured, are probably of very different geological antiquity. Thus, as Müller has pointed out,† the special peculiarities of the Umbelliferæ and Compositæ have been inherited respectively from the ancestral forms of those orders; those of Delphinium, Aquilegia, Linaria, and Pedicularis, from the ancestral forms of the respective genera; those of *Polygonum fagopyrum*, *P. bistorta*, *Lonicera caprifolium*, &c., from the ancestors of those species; while in *Lysimachia vulgaris*, *Rhinanthus cristagalli*, *Veronica spicata*, *Euphrasia odontites*, and *E. officinalis*, we find that differences have arisen even within the limits of one and the same species.

The transference of the pollen from one flower to another, as I have already mentioned, is effected principally, either by the wind or by insects. In the former case the flower is rarely conspicuous; indeed, Mr. Darwin finds it "an invariable rule that when a flower is fertilised by the wind it never has a gaily-coloured corolla." The conifers, grasses, birches, poplars, &c., belong to this category.

In such plants a much larger quantity of pollen is required than where the fertilisation is effected by insects. Everyone has observed the showers of yellow pollen produced by the Scotch fir. Again, it is an advantage to these plants to flower before the leaves are out, because the latter would greatly interfere with

* Sprengel, "Das entdeckte Geheimniss der Natur," p. 291.
† Animals and Plants under Domestication, ch. xvii.

* "Das entdeckte Geheimniss der Natur,"
† Müller, p. 44.

the access of the pollen to the female flower. Hence such plants as a rule flower early in the spring. Again, in such flowers the pollen is less adherent, so that it can easily be detached by the wind,* which would manifestly be a disadvantage in the case of most of those flowers which are fertilised by insects.

Such flowers generally have the stigma more or less branched or hairy, which evidently must tend to increase their chances of catching the pollen.

It is an almost invariable rule that wind-impregnated flowers are inconspicuous, but the reverse does not hold good, and there are many flowers which, though habitually visited by insects, are not brightly coloured. In some cases flowers make up by their numbers for the want of individual conspicuousness. In others the insects are attracted by scent; indeed, as has already been mentioned, the scent, as well as the colours of flowers, has no doubt been greatly developed through natural selection, as an attraction to insects.* But though bright colours and strong odours are sufficient to attract the attention of insects, something more is required. Flowers, however sweet smelling or beautiful, would not be visited by insects unless they had some more sub-

Fig. 1.

Fig. 2.

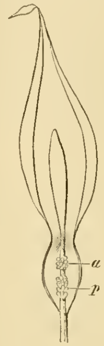


Fig. 3.

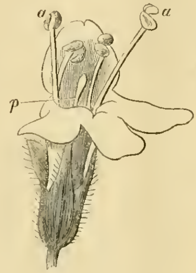


Fig. 4.

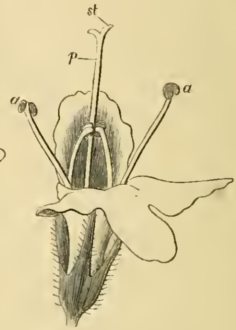


Fig. 5.

stantial advantages to offer. These advantages are the pollen and the honey; though it appears that some flowers beguile insects by holding out the expectation of honey which does not really exist, just as some animals repel their enemies by resembling other species which are either dangerous or disagreeable.

The pollen, of course, though very useful to insects, is also essential to the flower itself; but the scent and the honey, at least in their present development, are mainly useful to the plant in securing the visits of insects, and the honey also sometimes in causing the pollen to adhere to the proboscis of the insect. Among other obvious evidences that the beauty of flowers is useful in consequence of its attracting insects, we may adduce those cases in which the transference of the pollen is effected in different manners in nearly allied plants, sometimes even in different species belonging to the same genus.

Thus, *Malva sylvestris* and *Malva rotundifolia*, which grow in the same localities, and therefore must come into competition, are nevertheless nearly equally common. In both species the young flowers contain a pyramidal group of stamens which surround the as yet immature pistil, and produce a large quantity

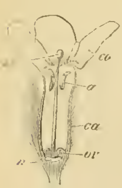


Fig. 6.

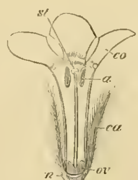


Fig. 7.

Fig. 8.

Fig. 9.

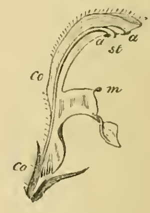


Fig. 10.

of pollen, which cannot fail to dust any insect which may visit the flower for the sake of its honey. In *Malva sylvestris* (Fig. 1), where the branches of the stigma are so arranged that the plant cannot fertilise itself, the petals are large and conspicuous, so that the plant is visited by numerous insects; while in *Malva rotundifolia* (Fig. 2), the flowers of which are comparatively small and are rarely visited by insects, the branches of the stigma are elongated and twine themselves among the stamens, so that the flower can hardly fail to fertilise itself.

Another remarkable instance occurs in the genus Epilobium, which is, moreover, specially interesting, because in *E. angustifolium*, as I have already mentioned, the curious fact was first noticed that the pistil did not mature until the stamens had shed their pollen. *E. angustifolium* has conspicuous purplish-red

* On the other hand, it is an advantage to wind-borne seeds to be somewhat tightly attached, because they are then only removed by a high wind which is capable of carrying them some distance.

* In confirmation of this it is stated that when insects are excluded, the blossoms last longer than is otherwise the case; that when flowers are once fertilised, the corolla soon drops off, its function being performed.

flowers, in long terminal racemes, and is much frequented by insects; *E. parviflorum*, on the contraiy, has small solitary flowers, and is seldom visited by insects. Now, to the former species the visits of insects are necessary, since the stamens ripen before the pistil, and the flower has consequently lost the power of self-fertilisation. In the latter, on the contrary, the stamens and pistil come to maturity at the same time, and the flower habitually fertilises itself. It is, however, no doubt sometimes crossed by the agency of insects; and indeed I am disposed to believe that this is true of all flowers which are either coloured or sweet scented. The degree in which flowers are dependent on insects differs very much, and it seems to be a general rule that in any genus where the flowers differ much in size, the largest ones are specially dependent on insects.

As already mentioned, the self-fertilisation of flowers is in other cases still more effectually guarded against by the fact that the stamens and pistils do not ripen at the same time.

In some cases the pistil ripens before the stamens. Thus the Aristolochia has a flower which consists of a long tube with a narrow opening closed by stiff hairs which point backwards, so that it much resembles an ordinary eel-trap. Small flies enter the tube in search of honey, which from the direction ot the hairs they can do easily, though on the other hand, from the same cause, it is impossible for them to return. Thus they are imprisoned in the flower; gradually, however, the pistil passes

FIG. 11

maturity, the stamens ripen and shed their pollen, by which the flies get thoroughly dusted. Then the hairs of the tube shrivel up and release the prisoners, which carry the pollen to another flower.

Again, in the common Arum (Fig. 3), we find a somewhat similar mode of fertilisation. The well-known green leaf encloses a central pillar which supports a number of pistils near the base, and of anthers somewhat higher. Now, in this case nothing would at first sight seem easier or more natural than that the pollen from the anthers should fall on and fertilise the pistils. This, however, is not what occurs. The pistils (*p*) mature before the anthers (*a*), and by the time the pollen is shed have become incapable of fertilisation. It is impossible, therefore, that the plant should fertilise itself. Nor can the pollen be carried by wind. When it is shed it drops to the bottom of the tube, where it is so effectually sheltered that nothing short of a hurricane could dislodge it; and although Arum is common enough, still the chances against any of the pollen so dislodged being blown into the tube of another plant would be immense.

As, however, in Aristolochia, so also in Arum, small insects which, attracted by the showy central spadix, the prospect of shelter or of honey, enter the tube while the stigmas are mature, find themselves imprisoned, as the fringe of hairs, while permitting their entrance, prevents them from returning. After a while, however, the period of maturity of the stigmas is over, and each secretes a drop of honey, thus repaying the insects for their captivity. The anthers then ripen and shed their pollen, which falls on and adheres to the insects. Then the hairs gradually shrivel up and set the insects free, carrying the pollen with them, so that those which then visit another plant can hardly fail to deposit some of it on the stigmas. Sometimes more than a hundred small flies will be found in a single Arum. In these two cases there is obviously a great advantage in the fact that the stigmas arrive at maturity before the anthers. Generally, however, the advantage is the other way, and the stamens ripen before the pistil.

Of this we may take the thyme or the marjoram as an illustration. The flowers are crowded together, and as the stigmas do not come to maturity until all the anthers in the same head have shed their pollen, it is obvious that bees creeping over the

FIG. 12.

flowers must transfer the pollen from the anthers of one head to the pistils of another.

Fig. 4 represents a flower of the thyme (*Thymus serpyllum*), and shows the four ripe stamens, and the short, as yet undeveloped pistil. Fig. 5, on the contrary, represents a somewhat older flower, in which the stamens are past maturity, while the pistil, on the other hand, is considerably elongated, and is ready for the reception of the pollen.

Here it is at once obvious that insects alighting on the younger (male) flowers would dust themselves with pollen, some of which, if they subsequently alighted on an older flower, they could not fail to deposit on the stigma. It should also be mentioned that in this genus there are likewise some small flowers which contain no stamens. In some cases flowers which are first male and then female, are male on the first day of opening, female on the second. In others the period is longer. Thus

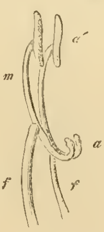


FIG. 13.

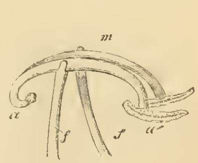


FIG. 14.

Nigella, according to Sprengel, is male for six days, after which the stigma comes to maturity and lasts for three or four.*

Fig. 6 represents a flower of *Myosotis versicolor*, a species often known as the Forget-me-not, when just opened. It will be observed that the pistil projects above the corolla and stamens, so that it must be first touched by any insect alighting on the flower. Gradually, however, the corolla elongates, carrying up the stamens with it, until at length they come opposite the stigma, as shown in Fig. 7. Thus, if the flower has not already been fertilised by insects, it is almost sure to fertilise itself.

I will now call attention in more detail to some of our common wild flowers, in order to show how beautifully they are adapted to profit by the visits of insects, and how the various parts are arranged so as to favour not only the transfer of pollen from one flower to another, but also its deposition on that part of the

* "Das entdeckte Geheimniss der Natur," p. 287.

pistil which is especially prepared for its reception. Wherever the pistil projects beyond the stamens, it is obvious that a bee alighting on the flower would come in contact first with the former and subsequently with the latter. In flying from flower to flower, therefore, she would generally fertilise each with the pollen of one which had been previously visited.

Fig. 8 represents the common Berberry. *ff* represent the stamens, which lie close to the petals and almost at right angles to the pistil (*st*), as shown in the figure. The honey-glands (*n n*) are twelve in number, situated in pairs at the base of the petals, so that the honey runs down into the angle between the bases of the stamens and of the pistil. The papillary edge of the summit of the pistil (*s t*) serves as the stigma. In open flowers of this kind it is of course obvious that insects will dust themselves with the pollen and then carry it with them to other flowers. In Berberis, however, both advantages, the dusting and the cross-fertilisation, are accomplished by a very curious contrivance. The bases of the stamens are highly irritable, and when an insect touches them the stamens spring forward (Fig. 9) and strike the insect. The effect of this is not only to shed the pollen over the insect, but also in some cases to startle it and drive it away, so that it carries the pollen, thus acquired, to another flower.

In few flowers is the adaptation of the various parts to the visits of insects more clearly and beautifully shown than in the common white Dead Nettle (*Lamium album*), Fig. 10. The honey occupies the lower contracted portion of the tube (Fig. 10, *c a*), and is protected from the rain by the arched upper lip and by a thick rim of hairs. Above the narrower lower portion the tube expands and throws out a broad lip (Fig. 10, *m*), which serves as an alighting place for large bees, while the length of the narrow tube prevents the smaller species from obtaining access to the honey, which would be injurious to the flower, as it would remove the source of attraction for the bees, without effecting the object in view. At the base of the tube, moreover, there is a ring of hairs, which prevent small insects from creeping down the tube and so getting at the honey. Lamium, in fact, like so many of our other wild flowers, is especially adapted for humble-bees. They alight on the lower lip (Fig. 10, *m*), which projects at the side so as to afford them a leverage by means of which they may press the proboscis down the tube to the honey; while on the other hand the arched upper lip, in its size, form, and position, is admirably adapted not only as a protection against rain, but also to prevent the anthers (Fig. 10, *a a*) and pistil (Fig. 10, *s t*) from yielding too easily to the pressure of the insect, and thus to ensure that it presses the pollen which it has brought from other flowers against the pistil.

The stamens do not form a ring round the pistil, as is so usual. On the contrary, one stamen is absent or rudimentary, while the other four lie along the outer arch of the flower, on each side of the pistil. They are not of equal length, as is usual, but one pair is shorter than the other; sometimes the inner pair, and at others the outer pair being the longest. Now, why is this? Probably, as Dr. Ogle has suggested, because if the anthers had lain side by side, the pollen would have adhered to parts of the bee's head which do not come in contact with the stigma, and would therefore have been wasted; perhaps also partly, as he suggests, because it would have been deposited on the eyes of the bees, and might have so greatly inconvenienced them as to deter them from visiting the flower. Dr. Ogle's opinion is strengthened by the fact that there are some species, as for instance the Foxglove, in which the anthers are transverse when immature, but become longitudinal as they ripen.

But to return to the Dead Nettle. From the position of the pistil which hangs down below the anthers, the bee comes in contact with the former before touching the latter, and consequently generally deposits upon the stigma pollen from another flower. The small processes (Fig. 10, *m*) on each side of the lower lip are the rudiments of the lateral leaves with which the ancestors of the Lamium were provided. Thus, then, we see how every part of this flower, is either, like the size and shape of the arched upper lip, the relative position of the pistil and anthers, the length and narrowness of the tube, the size and position of the lower lip, the ring of hairs and the honey, adapted to ensure the transference, by bees, of pollen from one flower to another; or, like the minute lateral points, is an inheritance from more highly developed organs of ancestors. If we compare Lamium with other flowers we shall see how great a saving is effected by this beautiful adaptation. The stamens are reduced to four, the stigma almost to a point; how great a contrast with the pines and their clouds of pollen; or even with such a flower as the Nymphæa, where the visits of insects are secured, but the transference of the pollen to the stigma is, so to say, accidental. Yet the fertilisation of Lamium is not less effectually secured than in either of these.

In this flower it would appear, as already mentioned, that the pistil matures as early as the stamens, and that cross-fertilisation is obtained by the relative position of the stigma, which, as will be seen in the figure, hangs down below the stamens, so that a bee bearing pollen on its back from a previous visit to another flower would touch the pistil and transfer to it some of this pollen before coming in contact with the stamens.

In other species belonging to the same great group (Labiatæ) the same object is secured by the fact that the stamens come to maturity before the pistils have shed their pollen, and shrivelled up before the stigma is mature.

Fig. 11 represents a young flower of *Salvia officinalis* * in which the stamens (*a*) are mature, but not the pistil (*p*), which moreover from its position is untouched by bees visiting the flower. The anthers as they shed their pollen gradually shrivel up; while on the other hand the pistil increases in length and curves downwards, until it assumes such a position that it must come in contact with any bee visiting the flower, and would touch just that part of the back on which pollen would be deposited by a younger flower. In this manner self-fertilisation is effectually provided against. There are, however, several other points in which *S. officinalis* differs greatly from the species last described.

The general form of the flower indeed is very similar. We find again, as generally in the Labiates, the corolla has the lower lip adapted as an alighting board for insects, while the arched upper lip covers and protects the stamens and pistils.

In the present species, however, the back of the upper lip shows a deep arch at the part *x*, and the front portion of the lip, containing the stamens, is loftier than in Lamium, and does not therefore come in contact with the back of the bee. In evident correlation with this arrangement we find a very remarkable difference in the stamens (Figs. 13 and 14). Two of the stamens are minute and rudimentary. In the other pair the two anther cells (Fig. 14, *a a*), instead of being as usual close together, are separated by a long connection. Moreover, the lower anther cell contains very little pollen, sometimes indeed none at all. This portion of the stamen, as shown in Fig. 13, hangs down and partially stops up the mouth of the corolla tube. When, however, a bee thrusts its head into the tube in search of the honey, this part of the stamen is pushed into the arch, the connectives of the two large stamens revolve on their axis, and consequently the fertile anther cells are brought down on to the back of the bee, as shown in Fig. 12.

(*To be continued.*)

NOTES

THE German Government has determined upon the erection of a Sun Observatory ("*Sonnen-Warte*") upon a large scale at Potsdam. Drs. Spoerer and Vogel have already been appointed to undertake the telescopic and spectroscopic observations, and the directorship has been offered to Prof. Kirchhoff, who, however, has declined it, as he is unwilling to leave Heidelberg.

THE International Congress of Orientalists was opened in London on Monday, by an address from Dr. Birch. We hope to give an account of the proceedings in our next number.

WE are glad to see that a contemporary not specially devoted to science—the *Morning Post*—in an article on Dr. Hooker's address at Belfast, points out to its readers that the majority of the observations referred to could be made "by any intelligent person without any scientific training," and expresses a hope that "people who have the opportunities for cultivating, and leisure for observing, will make collections of plants . . . . and add to our stock of knowledge." At the same time it suggested these as interesting subjects for observation:—"How much can plants eat in twenty-four hours? When do they eat most? Under what conditions of weather? &c. Indeed, the whole field is one that

* The *Popular Science Review* for July 1869 contains a very clear and interesting paper by Dr. Ogle on this genus.

is almost unexplored." May this hint, which will reach many who are not readers of scientific papers, not be without result! We would draw attention to the fact that plants of *Drosera rotundifolia* are advertised for sale at ninepence each, and we hope that before long some enterprising dealer may make a speciality of all known carnivorous plants for suitable observations.

AT the Botanic Garden, Oxford, the Mexican *Dasylirion arcotrichum* recently threw-up a flower stem which, when 12 ft. high, grew at the rate of six inches in twenty-four hours. The *Nelumbium luteum* (the sacred bean) is reported this season as producing perfect seeds.

AN *Annuaire de l'Horticulture Belge* is announced as soon to appear.

THE last number of the *Gardener's Chronicle* gives a drawing of four lopped elms growing near Datchet, the tops of which have naturally grown with the outline of a horse.

THE Academy of Sciences in Copenhagen announces the subject for a prize essay, to be addressed to it through its secretary by the end of October 1875. It desires a memoir that shall collect in chronological order the various determinations of constant quantities that have been used in spherical and theoretical astronomy from the time of the Ptolemies down to the end of the eighteenth century. It will not be necessary to submit to any critical discussion the intrinsic value of the various constants, but simply to give them in as complete a manner as possible. Special researches respecting the proper motions of stars and parallaxes of stars will be excluded, as also will be those relating to the satellites of the exterior planets, and the elements of orbits of comets. It is desired principally to obtain a complete collection of those numbers that have served as the basis of earlier astronomical researches. The memoir may be written in either Latin, French, German, Swedish, or English; and the medal to be awarded will be of gold, of the value of 320 Danish crowns.

PROF. SILVESTRI reports that a transversal fissure about a mile long has appeared on the northern side of Mount Etna. Twenty fresh craters situated upon one long line have been thrown up. The first crater opened forms a cone 75 ft. high. Prof. Silvestri believes that the force of the eruption is at present spent, and that only a few slight earthquake shocks will now be felt.

M. N. RAUÏS, Assistant Secretary of the Belgian Royal Academy of Sciences (Brussels), proposes to publish a work having for its title "Dictionnaire universel des académies, sociétés savantes, observatoires, universités, musées, archives, bibliothèques, jardins botaniques," &c.,—a methodical catalogue of all establishments which contribute to the progress of science, letters, and the arts. M. Rauïs, to enable him to carry out his praiseworthy scheme, requests the managing officials of institutions of the kind indicated to furnish him with the needful information in the form indicated by the following questions:—1. Title of the establishment. 2. Date of foundation, creation, &c. 3. Its aim. 4. Titles of the directorate. 5. Seat of the Institution, with its exact address. 6. Meetings, prizes, &c. 7. Does the establishment possess a library, archives, museum, cabinet of medals or antiquities, observatories, laboratories? 8. Publications:—Number and nature (bulletin, reviews, annals or memoirs); number of volumes published from the commencement; the easiest way of procuring these publications, whether by purchase or exchange. 9. All other useful information not comprised in the preceding questions. We hope all our British scientific institutions, societies, and clubs, will aid M. Rauïs in his important undertaking.

AN exhibition of photographs, &c., in connection with the Photographic Society will be opened on October 13, at the Suffolk Street Gallery. Specimens will be received up to October 7. We have on former occasions pointed out that photography has a scientific as well as a purely artistic interest, and the present opportunity should not be allowed to pass without illustrations of what photography has done to advance pure science. Mr. John Spiller, F.C.S., has been elected President, and Mr. R. J. Friswell, F.C.S., Hon. Sec. of the Society, so that the interest of science will have a good chance of being in future attended to.

WE have received the prospectus of the Owens College School of Medicine for Session 1874-5, the professorate of which has recently been completed by the appointment of Dr. M. Watson to the chair of Anatomy. The new buildings will be opened by Prof. Huxley, F.R.S., on Friday, Oct. 2, at 3 P.M.

THE Exhibition of useful and noxious insects in Paris, which we announced (vol. x. p. 295), was opened last week in the Tuileries Gardens, and promises to be highly interesting and useful.

PROF. VON RATH, of Bonn, in *Poggendorff*, describes under the name *Foresite* a new mineral of the Zeolite family, from the granite of Elba. It is named in honour of its discoverer, Sig. Foresi, of Portoferrajo, in Elba, who found it in druses which were covered with felspar, oligoclase, quartz, lithia, and tourmaline, on which, along with Desmin [stilbite] and Stilbite [Heulandite] it forms incrustations. Foresite belongs to the prismatic system; has a similar appearance to Desmin, with surfaces bright as mother-of-pearl. The angular measurements, like the faces, indicate that it is isomorphous with Desmin. Its water, which amounts to 15·31 per cent., is entirely driven off at a red heat under the blowpipe. It decomposes with difficulty in hydrochloric acid, and its silica does not gelatinise. A mean of three analyses shows it to consist of—

Silica	49·96
Alumina	27·40
Lime	5·47
Magnesia	·40
Potash	·77
Soda	1·38
Water	15·07
	100·45

Von Rath regards its chemical formula as—

$$Na_2O,\ 3CaO,\ 8Al_2O_3,\ 24SiO_2,\ 24H_2O,$$

and thus it makes a further approximation to Desmin. It differs from all known Zeolites in the small proportion of lime to alumina and silica.

AN International Exhibition is to be opened at Chili on Sept. 16, 1875.

THERE has been started at Mevagissey, Cornwall, a manufactory of "Cornish sardines," the sardines being pilchards preserved in oil, immense quantities of which have hitherto been used as manure, or returned to the sea as of no use. We believe these Cornish sardines are at least equal to the sardines commonly imported into this country.

THE *Times* Alexandria correspondent, under date Sept. 6, states that Mr. H. M. Stanley passed through Egypt a few days previously on his way to Zanzibar. An ingeniously constructed boat, built for Mr. Stanley's expedition, was recently tried on the Thames.

WE have received the programme of the many-sided Birmingham and Midland Institute for 1874-75. Sir John Lubbock, Bart., F.R.S., delivers the inaugural address on Nov. 5, and among the other special lectures announced are two on "Cor l

Animals and Coral Islands," by Prof. W. C. Williamson, F.R.S.; "Assyrian Mythology," by Mr. George Smith; two on "The Education of the People," by Prof. W. K. Clifford; "Vitality in Men and in Races," by Dr. B. W. Richardson, F.R.S.; "A Night at Lord Rosse's Telescope," and "The Pendulum," by Prof. Ball, F.R.S.

THE following candidates have been successful in obtaining Royal Exhibitions of 50*l.* per annum, each for three years, and free admission to the course of instruction at the following institutions:—(1) To the Royal School of Mines, Jermyn Street, London: Charles W. Folkard, Lawrence J. Whalley, Alfred N. Pearson. (2) To the Royal College of Science, Dublin: Thomas Bayley, William Fream, Archibald N. McAlpine.

MR. RAMSAY WRIGHT, M.A., B.Sc., Assistant to the Professor of Natural History, Edinburgh University, has been appointed to the Chair of Natural History, University College, Toronto. Mr. Wright succeeds Prof. Alleyne Nicholson, now of the Newcastle College of Science.

PROF. E. S. HOLDEN, U.S. Navy, forwards us a letter from Mr. H. G. Wright, dated San Bernardino, Cal., Aug. 2, 1874, describing a small lake or pond in New Hampshire having two outlets, and with which he has been perfectly familiar from boyhood. "Neither of the outlets," the writer states, "ever dries up, and each of them discharges more water than enters through the only visible feeder. The pond covers, say, fifteen acres; it is shallow, with muddy bottom, with boulders in places, the surrounding land being largely made up of granite ledges and boulders. The outlets are at opposite ends of the pond—one descending rapidly 150 feet soon after leaving the pond, the other passing through a boggy swamp and then a meadow, after which it also descends rapidly. The only feeder is very small, and quite dries up in summer."

UNDER the title of "Society for the Publication of Tracts relating to the History and the Geography of the Latin East," an association has been formed in France to supplement the work of the Academy of Inscriptions. Notwithstanding the labours of the latter body, there still exists in the public depositories of various European countries, a large mass of unedited materials relating to the "Latin East,"—the kingdoms of Jerusalem, Cyprus, and Armenia, the principalities of Antioch and Achaia, and the Latin Empire of Constantinople. It is for the purpose of unearthing and publishing such material that the French society has been formed. It will be composed of forty titular members and 350 subscribing associates; from among the former a committee of publication will be selected, and the members of both classes may be either French or foreign. Two volumes will be published annually, along with a phototypographic reproduction of very rare or unique matter; to the latter titular members alone are entitled. The collection will be entitled "Bibliothèque de l'Orient Latin," and will consist of a Historic Series, a Geographical Series, and a Poetical Series. They will be published after the style of the "Chronicles and Memorials of Great Britain." Titular members pay fifty francs a year, and subscribers only fifteen.

THE additions to the Zoological Society's Gardens during the past week include a Serval (*Felis serval*) from West Africa, presented by Mr. Spencer Shield; a Cinereous Sea Eagle (*Haliaëtus albicilla*) from Norway, presented by Mr. W. J. Sadler; two Peregrine Falcons (*Falco peregrinus*) from Europe, presented by Mr. Herbert Wood; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. P. T. Wharton; a Crested Pigeon (*Ocyphaps lophotes*), two Graceful Ground Doves (*Geopelia cuneata*), hatched in the Gardens; two Green Fruit Pigeons (*Carpophaga sylvatica*) deposited.

NOTES ON THE NEW EDITION OF MR. DARWIN'S WORK ON THE STRUCTURE AND DISTRIBUTION OF CORAL REEFS (1874.)

MR. DARWIN, in the new and much improved edition of his work on Coral Reefs, mentions some points in the subject, on which he still finds reason to differ from the writer. I think that with regard to one or two of these points he has not fully understood my views; and, as to the others, that the arguments and facts which I have brought out have not received all the consideration they may deserve. A review of some statements in his work may, therefore, be profitable. I follow the order of his criticisms as briefly stated in the first half of his Preface.

I. The second sentence of the Preface is as follows:—

"In this work [Dana's Corals and Coral Reefs] he [the author] justly says that I have not laid sufficient weight on the mean temperature of the sea in determining the distribution of coral reefs; but neither a low temperature nor the presence of mud-banks accounts, as it appears to me, for the absence of coral reefs throughout certain areas; and we must look to some more recondite cause."

The first two clauses of this sentence are true—the *but* between them being removed, as it may lead some readers to suppose the alternative mine. Yet Mr. Darwin's work does not show that even now he appreciates the influence of oceanic temperature on the distribution of coral reefs. In his discussions on the distribution of reefs, and the causes limiting the same, this agency, the chiefest with marine life, both for depth and surface, according to all zoologists, is scarcely mentioned. There is one allusion to the subject on page 81. Mr. Darwin says: "I at first attributed this absence of reefs on the coasts of Peru and of the Galapagos Islands to the coldness of the currents from the south, but the Gulf of Panama is one of the hottest pelagic districts in the world;" and a note is added, giving some sea temperatures of the region referred to. Thus the cause is set aside even for the seas along the Peruvian coast, although the mean winter temperature of the water there is lower than exists in any reef region in the world, and is therefore sufficient of itself to exclude reefs. The fact that there are only small patches at Panama, where the temperature is tropical, does not annul the fact that the seas of Peru and the Galapagos are too cold for corals. Where temperature excludes, there is no use in discussing other unfavourable conditions.

The causes limiting the growth and distribution of reef-making corals and coral reefs, which I have discussed and applied in my work, are *seven* in number:—

(1.) Marine temperature.

(2.) Fresh and impure waters from the entrance of large rivers and muddy bottoms.

(3.) Deposition of sediment borne by rapid tidal currents.

(4.) The depth of water along coasts exceeding 100 feet, that is, exceeding the depth to which reef-corals may grow—a common condition along bold coasts, and often explaining, as I have found, the contrasts between the reef-bordered and open coasts of the same island.

(5.) Exposure to the heat of submarine volcanic eruptions (pp. 299, 317).

(6.) The progressing coral island subsidence too rapid for the polyps to keep the reef well at the surface, if at all (p. 270): which cause may lead, in atoll seas, to very narrow fringing reefs; to small sizes in coral atolls, and a more or less complete obliteration of the lagoon; and to a submerging of the coral island beneath the surface; or finally, to a complete disappearance of the island (pp. 332, 369).

(7.) The direction and temperature of oceanic currents (p. 112): this cause accounting for the non-distribution of Central Pacific species of corals to the Panama coast, and the paucity of species there, with the absence of the large Astræa group and the Madrepores.

On this last point I say in explanation, on page 112: "Owing to the cold oceanic currents of the eastern border of the Pacific—one of which, that up the South American coast, is so strong and chilling as to push the southern isocryme [the line passing through points of equal mean oceanic temperature for the coldest month of the year] of 68°, the coral sea boundary, even beyond the Galapagos, and north of the equator—the coral-reef sea, just east of Panama, is narrowed to 20°, which is 36° less of width than it has in mid-ocean; and this suggests that these currents,

by their temperature, as well as by *their usual westward direction*, have proved an obstacle to the transfer of mid-ocean species to the Panama coast." For the same reason the transfer of corals —warm-water species—from the West Indies or the Bermudas, eastward, to *Western Africa*, is impossible. The width of the coral reef region on the African side of the Atlantic is only 15°, while it is 48° toward the American coast, and the tropical current is *eastward*.

A proper understanding of the action of the various causes influencing the growth and distribution of polyps and reefs, which have been mentioned in the preceding paragraphs, may leave much less than has been imagined for that "more recondite cause."

I did not think to include among the causes a too rapid *upward* change of level—on which Mr. Darwin lays much stress. But I recognised the fact that when a rise, like that which has occurred at the island of Oahu [putting an extended range of reef thirty feet out of water] takes place, and so divides the area of reef into an elevated and non-elevated portion, the latter will be, on this account, narrower than it would have been had the land been stationary. But the cause does not appear to me to have very many examples.

II. The third sentence of the Preface reads thus :—

"Professor Dana also insists that volcanic action prevents the growth of coral reefs much more effectually than I had supposed ; but how the heat or poisonous exhalations from a volcano can affect the whole circumference of a large island is not clear." And this is followed by the remark : "Nor does this fact, if fully established, falsify my generalisation that volcanoes in a state of action are not found within the area of subsidence, whilst they are often present within those of elevation."

In my discussion of this subject I have attributed the destruction here referred to about islands of active, or recently active, volcanoes, not to aërial eruptions, as might be suspected from Mr. Darwin's words, but to *submarine*; and I happen to have said nothing about "exhalations." I have drawn my conclusions especially from four examples (pp. 302, 305, 306) : the island of Hawaii (Sandwich Islands), about which recent eruptions, and partly submarine, have taken place on the east, south-east, south, and west slopes of the island, or through more than half of its circumference ; Savaii, the largest of the Samoan or Navigator Islands, and the last of the group to become extinct, as its lava streams show ; the eastern half of Maui, whose great crater must have been recently in action, while the western half bears the fullest evidence of long extinction ; and the northern extremity of the Ladrones. I state that reefs often occur on favoured parts of even such volcanic islands, as they well might if submarine eruptions were the cause, and I mention examples ; thus agreeing with Mr. Darwin's criticism that "the existence of reefs, though scantily developed, and, according to Dana, confined to one part of Hawaii, shows that recent volcanic action does not prevent their growth." My statement about that Hawaiian reef is worded thus : "the only spot of reef *seen* by us was a submerged patch off the southern cape of Hilo Bay." Mr. Darwin cites an observation with regard to the occurrence also of reefs on the northern coast of Hawaii, which accords precisely with the principle I have laid down, since the northern part of the island is, as I state in my Geological Report of the island, that which was earliest extinct, and is oldest in all its features, and therefore that which would not have been reached by the submarine eruptions. The western peninsula of Maui, or the old part, has its coral reefs, while the eastern, or part recently active, has almost none. Savaii, in like manner, has coral reefs on its western and northern shores, while elsewhere without them.

I failed to find evidence in the case of either of these volcanic regions that they are situated within areas of elevation rather than subsidence. *Only ten miles* west of Savaii lies the large island of Upolu, having very extensive reefs—on some parts of the north side three-fourths of a mile wide ; and it has not seemed safe to conclude that, while Upolu thus bears evidence of no movement or of but little subsidence, Savaii was one of elevation ; or that the north and west sides of Savaii have differed in change of level from the rest of the island. In the island of Maui, having reefs on its old western half, it can hardly be that the eastern peninsula has changed its level quite independently of the western. In the near group of the Ladrones the active volcanoes are at the north end ; the islands of the group are very small at that end, without coral reefs, while large at the other, and with broad reefs. One of them, Assumption Island, near which our Expedition passed, is only a small, steep, cinder cone, the vent of a submerged volcanic mountain. Such facts afford, therefore, some reason for my statement that the Ladrones appear to have undergone their greatest subsidence at the northern extremity of the range ; and no observations yet made suggest the contrary view.

The general proposition, that active volcanoes are absent from areas of subsidence, appears to me to need better proof than it has received. As regards the Pacific Ocean, I have found nothing to sustain it. The subsidence of the coral island area of the ocean was one of so vast extent—the breadth 4,000 miles, according to Mr. Darwin—that the sinking could have been no obstacle to the existence and contemporaneous working of volcanoes.

III. The next point in the Preface is a right correction of a misunderstanding on my part of one of Mr. Darwin's statements. It says : "Professor Dana apparently supposes (p. 320) that I look at fringing reefs as a proof of the recent elevation of the land, but I have expressly stated that such reefs, as a general rule, indicate that the land has either long remained at the same level, or has been recently elevated. Nevertheless, from upraised recent remains having been found in a large number of cases on coasts which are fringed by coral reefs, it appears to me that, of these two alternatives, recent elevation has been much more frequent than a stationary condition."

When my work passes to a second edition, I shall make the needed correction.

But I still hold that, while barrier reefs, as Mr. Darwin urges, are proofs of subsidence, small or fringing reefs are in themselves no certain evidence of a stationary level, and are often evidence of subsidence, even a greater subsidence than is implied by barrier reefs. I have already stated that one cause limiting distribution of reefs is bold shores, a wall of rock of even a hundred and fifty feet producing a complete exclusion. If Tahiti were to subside two thousand feet, it would be an island of precipitous shores all around, and with deep indentations, like the Marquesas, instead of one with broad shore planes. Such bold shores are evidence of subsidence ; and as only very small reefs, if any, could find footing about such an island, the narrow reef would be another consequence of the subsidence, and no evidence of a stationary condition. Again, the gradual sinking of an atoll, like the Gambier group, or of a Tahiti with its barrier reefs, at a rate a little fast for the growing corals, would necessarily contract the reef region, reduce the barrier reefs of a Tahiti to narrow fringing reefs ; and make an atoll, however large, a small atoll with the reef-border narrow and the lagoon perhaps obliterated. An atoll thus reduced to a sand-bank is an example of the effects of subsidence, and affords no evidence of elevation or of a long stationary condition of the region : and the same may be true of a region of narrow fringing reefs. I landed on two of the small coral islands of the equatorial Pacific which are in just the condition here described ; and my book contains descriptions of others from a good observer—J. D. Hague—who resided on them several months "for the purpose of studying the character and formation of the guano deposits." I found the depression of the old lagoon, in one case partly, in the other wholly, dry ; and I found also that the living reefs around were narrow. Mr. Darwin inclines to regard islands of this kind as either evidence of no movement, or, of elevation. On the contrary, since the coral islands of the South Pacific diminish in size toward the region of these small islands, and since the region just beyond, to the north and north-east, is free from islands, and since all the features are such as would come to them from a continuation of the coral-island subsidence to its nearly fatal end, I believe still that I was right in considering the ocean bottom in this part to have undergone a general subsidence greater than that to the south, south-west, and west, where the atolls and barrier reefs are large.

Again, if submarine eruptions are destructive, narrow reefs may exist about volcanic islands that are undergoing a subsidence. Making a reef is slow work ; and, judging from the eruptions of the present century about Hawaii, reefs would have had a poor chance in the past to form, except along the coasts that were out of reach of the submarine action.

With so many causes for the existence of narrow or fringing reefs, or of small patches of corals, it is assuredly unsafe to make them, without other corroborating testimony, evidence of a stationary condition of a region, or of an elevating movement rather than a subsiding.

IV. The next point in the Preface is stated as follows :—

* His article is contained in the *American Journal of Science*, 2nd series, xxxiv. 224 ; 1862.

"Prof. Dana further believes that many of the lagoon islands in the Paumotu or Low Archipelago and elsewhere have recently been elevated to a height of a few feet [elsewhere stated, two or three feet] although formed during a period of subsidence; but I shall endeavour to show, in the sixth chapter of the present edition, that lagoon islands which have long remained at a stationary level often present the false appearance of having been slightly elevated." And, in the body of the work, where the subject is taken up (p. 168), Mr. Darwin remarks that my belief in these small local elevations is grounded chiefly on the shells of Tridacnas embedded, in their living positions, in the coral rock at heights where they could not now survive.

The catalogue of such elevations which I give (p. 345)—after a dozen pages devoted to a discussion of the evidence respecting each—is as follows :—

Paumotu Archipelago	Honden	2 or 3
,, ,, ...	Clermont Tonnerre ...	2 or 3
,, ,, ...	Nairsa or Dean's ...	6
,, ,, ...	Elizabeth	80
,, ,, ...	Metia or Aurora ...	250
,, ,, ...	Ducie's	1 or 2?
Tahitian Group	Tahiti...	0?
,, ,, ...	Bolabola	?
Hervey and Rurutu Groups..	Atiu	12?
,, ,, ,,	Mauke ... somewhat elevated.	
,, ,, ,,	Mitiaro ... ,,	,,
,, ,, ,,	Mangaia	300
,, ,, ,,	Rurutu	150
,, ,, ,,	Remaining Islands ...	0?
Tongan Group	Eua	300?
,, ,, ...	Tongatabu	50 to 60
,, ,, ...	Namuka and the Hapaii	25
,, ,, ...	Vavau	100
Savage Island	... ...	100
Samoan or Navigator Islands	... ...	0
North of Samoa	Swain's	2 or 3
,, ,, ...	Fakaafo, or Bowditch	3
,, ,, ...	Oatafu, or Duke of York's	2 or 3
Scattered Equatorial Islands	Washington	2 or 3?
,, ,, ,,	Christmas	?
,, ,, ,,	Jarvis's	8 or 10
,, ,, ,,	Malden's	25 or 30
,, ,, ,,	Starbuck's	?
,, ,, ,,	Penrhyn's	35
,, ,, ,,	Flint's and Staver's ...	?
,, ,, ,,	Baker's	5 or 6
,, ,, ,,	Howland's	?
,, ,, ,,	Phœnix and McKean's	0
,, ,, ,,	Enderbury's	2 or 3?
,, ,, ,,	Newmarket	6 or 8?
,, ,, ,,	Gardner's, Hull's, Sydney, Birnie's	0?
Feejee Islands	Viti Levu and Vanua Levu, Ovalau ...	5 or 6?
	Eastern Islands ...	0?
North of Feejees	Horne, Wallis, Ellice, Depeyster	0?
Sandwich Islands	Kauai...	1 or 2
,, ,, ...	Oahu...	25 or 30
,, ,, ...	Molokai	300
,, ,, ...	Maui	12
Gilbert Islands	Taputeuea...	2 or 3
,, ,, ...	Nonouti, Kuria, Maiana, and Tarawa	3 or more.
,, ,, ...	Apamama	5
,, ,, ...	Apaiang or Charlotte.	6 or 7
,, ,, ...	Marakei	3 or more.
,, ,, ...	Makin	?
Carolines	McAskill's	60
Ladrones	Guam...	600
,, ...	Rota	600
Feis	... ...	90
Pelews	.. ..	0?
New Hebrides, New Caledonia, Salomon Islands	... ...	none ascertained.

Of the cases of elevation here included, in *only two* are shells of Tridacnas mentioned; these are Honden Island and Clermont Tonnerre, in the Paumotus. It is not necessary to go over the evidence for the several cases, as it is stated at length in my work.

Mr. Darwin, while speaking on the subject of local elevations, on p. 176, and discussing the facts as regards the Samoan (Navigator) Islands, adds that "in another place he [Mr. Dana] says (p. 326) that some of the [Samoan] islands have probably subsided." From the remark the reader would infer that this Samoan subsidence was a local subsidence, like the elevations under consideration. But in fact my statement is in a chapter on the general coral-island subsidence, and, on the page there referred to (p. 326), I cite Mr. Darwin's conclusions as to the Gambier Island subsidence, and put with it my own from the width of the reefs of Upolu and other reef bordered islands. At the same place I allude to the greater subsidence of Tutuila—the island next to the west, as proved by its bold shores and small reefs.

In conclusion, if I differ widely, for the reasons above stated, from Mr. Darwin, as to the limits of the areas of subsidence and elevation in the Pacific, and believe that the new edition of his work shows little appreciation of some of the most important causes that have limited the distribution of coral reefs, I have, as I say in my work, the fullest satisfaction in his theory for the origin of atoll and barrier forms of reefs, and in the array of facts of his own observation which illustrate the growth of coral formations.

JAMES D. DANA

THE BRITISH ASSOCIATION

REPORTS

Report of the Committee on the Teaching of Physics in Schools, by Prof. G. C. Foster.

In view of the very great diversities in almost all respects of the conditions under which the work of different schools has to be carried on, the committee considered that in any suggestions or recommendations that they might make it would be impossible for them, with any advantage, to attempt to enter into details. They have therefore, in the recommendations which they have agreed upon, endeavoured to keep in view certain principles which they regard as of fundamental importance, without attempting to prescribe any particular way of carrying them out in practice.

They have assumed as a point not requiring further discussion, that the object to be attained by introducing the teaching of physics into general school-work is the mental training and discipline which pupils acquire through studying the methods whereby the conclusions of physical science have been established. They are however of opinion that the first and one of the most serious obstacles in the way of the successful teaching of the subject is the absence from the pupil's mind of a firm and clear grasp of the concrete facts and phenomena forming the basis of the reasoning processes they are called upon to study.

They therefore think it of the utmost importance that the first teaching of all branches of physics should be, as far as possible, of an experimental kind. Whenever circumstances admit of it, the experiments should be made by the pupils themselves and not merely by the teacher, and though it may not be needful for every pupil to go through every experiment, the committee think it essential that every pupil should at least make some experiments himself. For the same reasons they consider that the study of text-books should be entirely subordinate to attendance at experimental demonstrations or lectures, in order that the pupil's first impressions may be got directly from the things themselves, and not from what is said about them. They do not suppose that it is possible in elementary teaching entirely to do without the use of text-books, but they think they ought to be used for reviewing the matter of previous experimental lessons rather than in preparing for such lessons that are to follow.

With regard to the order in which the different branches of physics can be discussed with greatest advantage, considering that all explanation of physical phenomena consists in the reference of them to mechanical causes, and that therefore all reasoning about such phenomena leads directly to the discussion of mechanical principles, the committee are of opinion that it is desirable that the school teaching of physics should begin with a course of elementary mechanics, including hydrostatics and pneumatics, treated from a purely experimental point of view. The committee do not overlook the fact that very little progress can be made in theoretical mechanics without considerable familiarity with the processes of mathematics, but they believe that by making constant appeal to experimental proofs the study of mechanics may be profitably begun by boys who have acquired a fair knowledge of arithmetic, including decimals and proportion,

and as much geometry as is equivalent to the first book of Euclid. They believe that it will be found sufficient to impart such further geometrical knowledge as may be required, such, for instance, as a knowledge of the properties of similar triangles—in the first instance, during the course of instruction in mechanics.

In reference to the order in which the other departments of physics should be studied, the committee do not think it possible to prescribe any one order that is necessarily preferable to others that might be adopted; but they consider it desirable that priority should be given to those branches in which the ideas encountered at the outset of the study are most easily apprehended, and illustrations of which are most frequently met with in common experience. On these grounds they suggest that the elementary parts of the science of heat may advantageously follow mechanics; that elementary optics (including the laws of reflexion and refraction, the formation of images, colour, chromatic dispersion, and the construction of the simple optical instruments) should come next, and afterwards the elements of electricity and magnetism.* When it is found possible to include in the work of a school a fuller or more advanced course of physics than that here indicated, the committee are of opinion that the discretion of the master, guided by the circumstances of the case, will best decide in what direction the extension shall take place; they suggest, however, that an early place in the course should be given to elementary astronomy, both because it furnishes the grandest and most perfect examples of the application of dynamical principles, and because it promotes an intelligent interest in phenomena which, in the most superficial aspects at least, cannot fail to arrest the attention and familiarise the mind with the wide range of application of physical laws.

The committee are strongly of opinion that no very beneficial results can be looked for from the general introduction of physics into school teaching, unless those who undertake to teach it have themselves made it the subject of serious and continued study and have also given special attention to the best methods of imparting instruction in it. They therefore suggest that with a view to affording facilities to persons desirous of becoming teachers of physics for familiarising themselves with the most efficient methods and gaining experience in them, the Council of the British Association should invite the leading teachers of physics in the universities, colleges, and schools of the United Kingdom, to allow such persons, under suitable regulation, to be present at the instructions given by them, and, when practicable, to act as temporary assistants. The committee do not hereby mean that aspirants to the teaching function should be encouraged to drop in at random to hear any lecture by any established teacher who happened to be within reach; the kind of attendance they have in view would be systematic and continued for not less than some moderate period of time, such perhaps as two or three months, agreed upon at starting.

They believe that the benefits which might result from the adoption of such a plan are very great; the advantages to those who might avail themselves of it are obvious, and while teachers of established success would have a chance of spreading widely their methods of instruction, and in fact of founding schools of discipline, the stimulus to exertion afforded by the consciousness that they were being watched by men who were preparing themselves to occupy positions similar to their own would be of the most efficient kind.

* It should be stated that one member of the committee did not approve of the order of the subjects suggested in the text.

SECTIONAL PROCEEDINGS

SECTION A—MATHEMATICS

On the application of Kirchhoff's Rules for Electric Circuits to the solution of a Geometrical Problem, by Prof. Clerk-Maxwell, F.R.S.

The geometrical problem is as follows:—Let it be required to arrange a system of points so that the straight lines joining them into rows and columns shall form a network such that the sum of the squares of all these joining lines shall be a minimum, the first and last points of the first and last row being any four points given in space. The network may be regarded as a kind of extensible surface, each thread of which has a tension in each segment proportioned to the length of the segment. The problem is thus expressed as a statical problem, but the direct solution would involve the consideration of a large number of unknown quantities.

This number may be greatly reduced by means of the analogy between this problem and the electrical problem of determining the currents and potentials in the case of a network of wire having square meshes, one corner of which is kept at a unit potential, while that of the other three corners is zero. This problem having been solved by Kirchhoff's method, the position of any point P in the geometrical problem with reference to the given points A B C D, is by finding the values of the potentials $p_a\ p_b\ p_c\ p_d$ of the corresponding point in the electric problem when the corners a b c d respectively are those of unit potential. The position of P is then found by supposing $p_a\ p_b\ p_c\ p_d$ placed at A B C D respectively, and determining P as the centre of gravity of the four masses.

On the Apparent Connection between Sun-spot and Atmospheric Ozone, by T. Moffat, M.D., F.G.S., &c.

At the last meeting of the British Association, Mr. Smith, of Birmingham, gave me a record of the number of new groups of sun-spots which appeared in each year for a number of years, and he asked me to compare the mean daily quantity of ozone in each year with the number of groups. I have done so, and in the following table I have given the mean daily quantity of ozone for nineteen years (1851-1869) with the number of groups.

Years.	Total number of new groups of spots which have appeared in each year.	Mean daily quantity of ozone.	Maximum actual number of groups.	Mean of ozone.
1851	141	2·6	141	2·6
1852	125	1·9	125	1·9
1853	91	2·0	202	1·5
1854	67	3·4	205	2·2
1855	28	·8	211	2·1
1856	34	·7	204	1·9
1857	92	1·1	166	2·6
1858	202	1·5	124	3·5
1859	205	2·2	130	2·0
1860	211	2·1	101	1·7
1861	204	1·9	224	1·9
			Mean, 166	Mean, 2·2
			Minimum.	Mean of ozone.
1862	166	2·6	91	2·0
1863	124	3·5	67	3·4
1864	130	2·0	28	·8
1865	93	2·4	34	·7
1866	45	1·7	98	1·1
1867	25	1·5	93	2·4
1868	101	1·7	45	1·7
1869	224	1·9	25	1·5
			Mean, 60	Mean, 1·7

It would appear from these figures that the maximum of sun-spot gives a maximum of ozone, and that the minimum of sun-spot gives the minimum of ozone. The years 1854 and 1863 appear to be exceptional. In 1854, however, ozone observations at Hawarden were suspended for three months, which may account for the irregularity in that year. There is, I think, in these results, sufficient to induce others to observe.

On the employment of Charts on Gnomonic Projection for the general purposes of Navigation, by G. J. Morrison.

The object of this paper is to recommend the adoption for the general purposes of navigation of charts on gnomonic projection, instead of on Mercator's projection, for the following reasons:—

1. The great circle course or shortest distance between any two points on the earth's surface is shown by a straight line on the chart. By means of a ruler, therefore, it is easy to find out in one moment the position of the great circle track along the whole course from point to point, and thus to see at a glance if there be any obstacles in the way, whereas the plotting of a great circle track on a Mercator chart involves the expenditure of a great deal of time and trouble.

2. When it is impossible to adopt the great circle course on account of obstacles in the way, it is easy, in a few moments, to lay down the best practicable course, whereas it is very difficult to do so on a Mercator chart.

3. The measurement of distances on a Mercator chart is somewhat difficult, whereas on these maps distances can be measured with a transparent scale, or a pair of compasses, in a few moments.

4. The relative position of the various points on the earth's surface is more correctly shown on these maps than on those of Mercator.

The great circle course appears to be the shortest and natural route, whereas, on an ordinary chart, it appears to be much longer than the Mercator route, and seamen get a bettter idea from these charts of the proper route to follow than they do from a Mercator's chart.

1. It may be objected that only a small portion of the earth can be got on one sheet, and there is a difficulty in drawing a great circle course between points situated on separate sheets. This is true; but by taking some pains in arranging the maps, as has been done in this case, and by repeating portions of the earth on two or more sheets, matters have been so arranged that scarcely any voyage can be named in which the ports of arrival and departure cannot be found either on the same sheet or on opposite sheets, in either of which cases the course can be laid down instantly; and even in the rare case of two ports being found on adjacent sheets only, the course can be laid down infinitely more easily than on a Mercator chart.

2. It is impossible to find the bearing of one point from another as can be done on a Mercator chart by a compass and a parallel ruler. This really is no disadvantage; no one ought to sail along a curved course, and no one need care to know anything about such a course. If this objection be seriously urged, it only proves that Mercator's charts have put false ideas into people's heads, and that other charts are required to replace them.

SECTION C—GEOLOGY

On the discovery of Microzoa in the Chalk Flints of the North of Ireland, by Joseph Wright.

The author observed that until 1872 only one rhizopod had been found in the Cretaceous rocks of Ireland, viz., *Ortitolina concava*, recorded by Mr. R. Tate, as occurring in the greensand. In November 1872, Prof. Rupert Jones read a paper before the Geological Society of Ireland, in which he announced the discovery of nine species of Foraminifera in the chalk and chalk flints of the North of Ireland.

Mr. Wright has examined the soft powdery material which often lines cavities in the chalk flints of Ireland, and has found 69 species of Foraminifera, 11 of Ostracoda, and sponge-spicules in abundance. A full list will appear as an appendix to the next Report of the Belfast Naturalists' Field Club.

Some observations on the "paramoudras" were added. The author considers that these originated in most cases by the deposit of flint around a nucleus of sponge. A microscopic examination shows that some are charged with spicules, whilst others are nearly free from them.

Prof. H. A. Nicholson exhibited and described specimens of three new species of *Cystiphyllum* from the Corniferous limestone of Canada and Ohio. Of these, *C. Ohioense*, Nich., is distinguished by its small size, deep, pointed calice, and small number of septa; *C. squamosum*, Nich., is remarkably flattened, the calice being very shallow and oblique; *C. fructicosum*, Nich., is a compound form, composed of numerous cylindrical, straight or slightly flexuous corallites.

The next paper, by the same author, was devoted to the definition of several species from the Lower Silurian of Ohio. *Alecto inflata* of Hall was regarded as an undoubted *Hippothoa*.

Description of new species of Polyzoa from the Lower and Upper Silurian rocks of North America, by Prof. H. A. Nicholson.—In this communication the author described the following new species of Polyzoa:—1. *Ptilodictya falciformis*, Nich.; 2. *P. emacerata*, Nich.; 3. *P. flagellum*, Nich.; 4. *P. ? arctipora*, Nich.; 5. *P. fenestelliformis*, Nich.; 6. *Fenestella nervata*, Nich. 7. *Ceramopora Ohioensis*, Nich.

Prof. Nicholson also read a paper on species *Favistella*. The type of the genus *F. stellata*, Hall, he regarded as identical with Goldfuss' *Columnaria alveolata*. A new species *Favistella* (*Columnaria*) *calicina*, Nich., was described.

These papers were illustrated by numerous and beautiful examples of the species referred to.

Note on the so-called "Crag" bed of Bridlington, by J. Gwyn Jeffreys, F.R.S.

In consequence of a request made by the late Prof. Phillips, not long before his lamented death, the author examined all the known collections of fossil shells from the celebrated "Crag" beds at Bridlington, and had furnished the Professor with a *catalogue raisonnée* for the new and forthcoming edition of his work on the Geology of Yorkshire. Dr. Jeffreys was lately at Bridlington with Mr. Leckenby, and ascertained that the "Crag" bed underlay the boulder-clay, and rested conformably on a bed of oolite shale of a purplish colour, which in one place appeared to have been triturated and redeposited in the form of clay. In this purplish clay they found a specimen of *Turritella erosa*, Couthouy (an arctic and North American shell), besides many other species which were common to the boulder-clay and Bridlington bed. All the species of shells found in the Bridlington bed, 64 in number, were high northern and now living. The author suggested that this deposit of shells might have been caused either by a deviation of the great arctic current in ancient times or by glacial conditions. It had clearly no relation to the Norwich Crag, as was formerly imagined to be the case.

SECTION D—BIOLOGY

DEPARTMENT OF ANATOMY AND PHYSIOLOGY

This department was not distinguished by any communication which excited such popular interest as that of Prof. Ferrier last year, but it was fully up to the average of the last few meetings in the solidity of the papers and of the discussions. The President, Prof. Redfern, opened the Section with the address printed in full in NATURE, vol. x. p. 327, which was no less admirable in style and elocution than in matter. If this was a model of a professorial lecture, the address of Dr. Hooker, also delivered before the entire Section, was equally one of a popular exposition of new and difficult scientific observations. The excellent series of illustrations and the actual specimens of the plants described, which were sent by Dr. Moore from the houses of the beautiful Botanical Gardens in Dublin, completed the interest of this admirable address.

The only report made to the department was from the committee appointed to investigate the conditions of intestinal secretion. It contained details of about sixty experiments, which confirmed, in the case of cats, Moreau's observation of the effect of division of the mesenteric nerves, showed that the secretory nerve fibres did not pass through the splanchnics, and ascertained the local effect of various neutral salts on intestinal secretion, as well as the interference of chloral, morphia, and other drugs with the local action of magnesian sulphate. The committee* was reappointed for the present year to continue these researches on the secretion and the movements of the intestines.

The most important communication on the first day was from Prof. Cleland, *On the Development of the Brain and the Morphology of the Auditory Capsule*. Beside many characteristically ingenious suggestions, the author maintained that the fourth ventricle is roofed in by nervous matter at an early period in the embryo, of which the ligula and the choroid plexus are the permanent vestiges. He also attempted to draw a parallel between the flocculus with the portio mollis and the optic lobes, tracts, and nerves. Prof. Huxley criticised these views at some length, dwelling particularly on the comparatively late development of the optic tracts, and denying that the roof of the primitive nervous canal is ever completed in the region of the bulb. A certain Goodsirian transcendentalism which appeared in Prof. Cleland's remarks has become rare among the younger school of morphologists, and probably stimulated his critic to attack what must have seemed like the revival of a thrice-slain foe; but apart from interpretations and views, there were several important observations in the paper which, it is hoped, will be given in detail with the necessary drawings.

A paper by Mr. Thomson followed, *On the Decomposition of Eggs*, in which the purely chemical changes, the penetration of bacteria, and the growth of fungi were severally described;† and Dr. Macalister exhibited a human skull with the rare abnormality of a lacrymo-jugal suture.

After the crowded audience which listened to Dr. Hooker's

* Dr. Brunton and Dr. Pye Smith.

† This paper will be found reported in the *London Medical Record* for Sept. 9.

address on Friday had dispersed, it seemed as if the room would have been left to anatomists and physiologists; but the arrival of blacksmiths, who began to erect a large black canvas, attracted popular interest, and the visitors who flocked in were rewarded by hearing and seeing Mr. Waterhouse Hawkins discuss the true character of the so-called clavicles of Iguanodon. His account of the difficulty he experienced in building his model with these bones in the position at first assigned them by Prof. Owen, of his finally hanging them up in front of it to be fitted in after each spectator's taste, and of the shameful destruction of the results of his skill and labour at New York, was no less graphic than the illustrations with which he proceeded to cover the canvas, showing the great reptile in every posture which would consist with the disputed bones being clavicles, ossa pubis, or marsupial bones. Mr. Hawkins advocated the last as the true character; but though in the discussion which followed, some anatomists were disposed to admit this approximation of the highest of reptiles to the marsupial (or rather to the monotreme) mammals, others refused to admit any reason for rejecting the identification of the bones in dispute with the long bird-like ossa pubis of allied reptilian forms, which was made several years ago by Prof. Huxley. So at least the professor himself must have thought, for he only appeared at the conclusion of the discussion in time to hear Mr. Balfour's remarkable paper *On the Development of Sharks*. This will doubtless appear elsewhere in full. It was crowded with facts, well observed, well stated, and well illustrated; and will prove of first-rate importance, not only for ichthyology but for the general doctrines of vertebrate development. Of many new facts ascertained, perhaps the most startling is the development of the notochord by direct cellular proliferation from the hypoblast. Whether it will ultimately be found that this is its normal mode of formation among Vertebrata, or that it may be developed from different layers in different animals, the effect of this observation will be almost equally important. Those anatomists who examined the beautiful series of sections on which Mr. Balfour founded his conclusions were satisfied of the accuracy of his histological facts. Prof. Huxley congratulated the author of the paper in terms of high commendation, though he inclined to believe that the apparent development from the lower embryonic layer might really be a secondary process. Mr. Lankester and Dr. Foster spoke of the service rendered to biology by Dr. Dohrn's Institute at Naples, where Mr. Balfour's observations were made, an institute to the success of which the British Association had the honour to contribute.

The following paper by Prof. Redfern, *On Food in Plants and Animals*, has been well reported in the *British Medical Journal* for August 29, p. 285. It was illustrated by a striking series of specimens of plants growing on different soils, and the laws of nutrition in organised beings generally were applied with great force to the practical question of the food of the labouring classes in the north of Ireland. Well delivered, and clearly expressed, it appeared to be understood as well as applauded by a full audience.

The first paper read in the department on Monday was by Prof. Macalister, *On the Tongue of the Great Anteater*, including an account of its enormous retractile muscles and of the salivary glands. In a discussion which followed, reference was made to the original dissection of *Myrmecophaga* by Prof. Owen, and also to the observations of Mr. Flower on the same parts, of which a summary was published in the *Medical Times and Gazette* of last year.

The next paper, by Dean Byrne, was an attempt to connect the functional development of thought with the structural development of the brain, in their gradual evolution throughout the Vertebrata, as well as in their growth from the infant to the adult. Many interesting facts of animal psychology were related, and many acute comments offered, but unfortunately the works from which the author drew his facts of anatomy, pathology, and development were either antiquated or otherwise imperfect representations of the present state of knowledge on the points in question.

Though the paper which followed was also by an outsider, the Professor of Chemistry in Edinburgh has had the advantage of a medical training, and his anatomy and histology were as accurate as his physics. Nothing could be more interesting than the way in which Dr. Crum Brown described the methods he employed to ascertain the exact position of the semi-circular canals of the ear, and the experiments he made on the sense of rotation. The substance of the communication will be found in the last number of the *Journal of Anatomy and Physiology*. Notwithstanding some criticisms offered by Mr. Charles Brooke on the acoustics of the paper, both its anatomical facts and its conclusion as to the function of the canals appeared to find general acquiescence; and this research may be regarded as another proof of how rich a field lies on the border-ground between the artificial territories into which we have divided the world of science.

Before the department rose, Dr. Caton exhibited a new adaptation of a microscope on the Hartnack model, for the purpose of examining the tissues in living mammals. It was a cheaper, and, as the author believed, a more readily applicable modification of the apparatus exhibited by Professors Stricker and Sanderson, at the Edinburgh meeting of the Association.

Prof. Huxley opened the last day of session with an account of his recent observations on the development of the *Columella auris* in Amphibia. While fully confirming the position of the quadratum (or malleus) in the mandibular arch of vertebrates, and of the incus in the hyoidean, these investigations appear to show conclusively that in the amphibian, at least, the columella (or stapes) begins as an outgrowth from the periotic capsule, and is therefore unconnected with any visceral arch; although, as the speaker was careful to state, it might yet be possible that the hyoid arch had, at a very early period, left some of the tissue of its topmost extremity adherent to the ear-capsule, and that this might afterwards give rise to the stapes. In the absence of Mr. Parker there was no one competent to criticise the paper from personal knowledge; but a word dropped as to the many changes in the accepted homologies of the ossicula auditus, elicited a masterly and characteristic exposition of the series of new facts, and the modifications of theory they have led to, from Reichert's first observations down to the present time. The embryonic structures grew and shaped themselves on the board, and shifted their relations in accordance with the views of successive observers, until a graphic epitome of the progress of knowledge on the subject was completed.

Mr. Lankester's paper which followed was also embryological. He described his observations on the development of the eye of Cephalopoda, made like those of Mr. Balfour in the Dohrn Institute at Naples. After correcting several of the statements made in text-books on the authority of Prof. Kölliker, the author pointed out the relation of the eye in the Dibranchiata to the less specialised organ of Nautilus, and showed how the ontogenesis of this structure in the highest mollusk corresponds with its gradually increasing complexity from its first appearance in the group, thus meeting one of Mr. Mivart's objections.

The session was appropriately concluded by a paper from the President, describing experiments made several years ago on the effects of ozone. The animals used were rabbits, and Prof. Redfern found them much less injuriously affected by breathing highly oxygenated air than has been supposed, while ozone in moderate amount (·4 per cent. and upwards) proved rapidly fatal, producing spasms, and death by apnœa. The lungs were found extensively emphysematous and congested, with engorgement of the right side of the heart.

Thus ended a busy and not uneventful meeting of the department. Comparing it with recent years, the room was never so crowded as it sometimes was at Bradford, nor so empty as it usually was at Brighton and Edinburgh. The most important paper last year, that of Prof. Burdon-Sanderson on the electrical changes which accompany the contraction of Dionæa, excited little popular interest, and the discussions at Edinburgh on various points of Cetacean anatomy, though carried on by Turner, Flower, Macalister, Struthers, and Murie, were caviare to the general. This year a corresponding importance may be fairly assigned to the embryological papers contributed by Prof. Huxley, Mr. Ray Lankester, Mr. Balfour, and Prof. Cleland. With a fair proportion of more popular expositions, the solid contributions which have been made during the last five or six years should attract a more constant attendance of anatomists and physiologists to this department. There were several distinguished Irish members of the Association whose presence was greatly missed at Belfast; and considering its nearness to Scotland, there was a remarkable lack of representatives from the northern universities. Apart from the intrinsic value of the papers read, there is so much to be gained from personal contact and discussion with men working at the same objects, that few probably feel at the conclusion of a meeting that they have not been rewarded for the sacrifice of time and convenience, and the scientific value of the Association entirely depends on its power of attracting those who are seriously engaged in the prosecution or communication of the subjects which form its several branches.

SCIENTIFIC SERIALS

Geological Magazine, September.—This number contains four original articles :—(1) The grouping of the Permian and Triassic rocks, by H. B. Woodward, F.G.S. The object is to show that the supposed break between the subdivisions of the Triassic rocks in England rests on unsatisfactory evidence; that in the Permian beds there are evidences of unconformity; and that probably future researches will lead to the resumption of the term "Poikilitic" to embrace both the Permian and Trias.—(2) On the Pleistocene deposits yielding Mammalian remains in the vicinity of Ilford, Essex, by Messrs. Woodward and Davis. This article consists partly of references to previous numbers of the magazine, the chief feature of interest in it being a letter by Mr. Searles Wood. He formerly believed the Ilford brick earths were older than the main sheet of the Thames gravel; a view which he now corrects.—(3) On the remains of *Rhinoceros leptorhinus*, Owen, from the Pleistocene of Ilford, by the editor. This is a reprint of Mr. Davis's description of the skull, as given in Sir Antonio Brady's catalogue (privately printed), together with an extract from Dr. Falconer's palæontological memoirs.—(4) On West Indian Tertiary Fossils, by R. J. Lechmere Guppy; a first instalment of descriptions which are to be continued.—Mr. J. W. Barkas, in a letter, announces that he has found a jaw of *Amphicentrum*, in sub-carboniferous limestone near Richmond, and suggests that it must have lived both in fresh and salt waters, like some modern fishes.

Astronomische Nachrichten, No. 2,005.—L. Seidel contributes a paper on the estimation of the most probable value of a number of varying observations of the same phenomenon, as the value of a number of observations of the position of a double star. There are also a quantity of position observations on Coggia's comet, by C. H. Davis, Ant. Aguilar, and Alexander Gromadzki, and the following elements of this comet are found by W. Fabritius:—

$$
\begin{aligned}
T &= \text{July } 8{\cdot}90006 \\
\text{Log. } q &= 9{\cdot}829699 \\
\Omega &= 118^\circ\ 44'\ 9''{\cdot}6 \\
i &= 66^\circ\ 23'\ 1''{\cdot}0 \\
\omega &= 152^\circ\ 21'\ 42''{\cdot}4
\end{aligned}
$$

The opposition ephemeris of the planet Hecate (100) is contributed by Dr. J. E. Stark for each day from Sept. 17 to Oct. 27.—Prof. Spoerer sends a table of his observations on solar spots and protuberances for June. Capt. Herschel writes to ask for letters of Sir J. Herschel, stating that a collection is being made.

SOCIETIES AND ACADEMIES

Paris

Academy of Sciences, Sept. 7.—M. Frémy in the chair.—M. Resal presented the Academy with the second volume of his "Traité de Mécanique Générale," and made some remarks thereon.—M. P. Volpicelli addressed a letter to the president, stating that in 1854 Melloni had communicated a note to the Academy, entitled "Researches on Electrostatic Induction." Fifteen days afterwards the Italian physicist died of cholera at Naples, and since that time the author (M. Volpicelli) had submitted fifteen communications to the Academy on the same subject, all of which confirmed Melloni's theory of electrostatic induction. M. Volpicelli now begs the Academy to appoint a commission to report on these experiments, and expresses a hope of being permitted to repeat them before it. MM. Becquerel, Faye, Fremy, Edm. Becquerel, and Jamin were named commissioners.—Sixth note on the electric conductivity of ligneous bodies, by M. Th. du Moncel.—Presence of zircosyenite in the Canary Isles, by M. Stan. Meunier. The mineral was found in a collection made by M. Webb on the Pena Mountains.—On some laboratory experiments concerning the action of toxic gases on *Phylloxera*; actual state of the malady in the Charente provinces; extract from a letter from M. Maurice Girard to M. Dumas. The gas tried was that liberated from a sulphocarbonate. Pieces of brick saturated with the solution of the salt were placed in the bottoms of flasks; above the solution and saturated brick some strong paper was supported on which were placed phylloxerised roots. The roots thus escaped direct contact with the solution and received only the gases evolved (CS_2 and H_2S). At the end of twenty-four hours nearly all the insects were dead, with the exception of some small larvæ and some eggs; at the end of two days all the insects and the greater part of the eggs were dead; while at the end of four days complete death of the eggs took place. During the experiment the flasks were kept in the dark, and some control flasks containing phylloxerised roots only placed with the others: nearly all the insects and eggs survived in these last flasks.—On some new points in the natural history of *Phylloxera vastatrix*; a letter from M. Lichtenstein to M. Dumas. The author thus sums up the life history of the insect so far as at present known:—(1) Colonising females appearing probably in August and September; (2) small uniform progeny hybernating; (3) Oval, pyriform, testudiniform types, reproducing by parthenogenesis all the summer; (4) Pupæ of two forms, oval and narrow at the waist, specially found on the nodosities of the rootlets in June and July; (5) *Swarming* takes place in August: the insects emerge from the earth in myriads exactly as in a formicary when the winged insects escape; (6) Laying of eggs on the leaves of *Quercus coccifera*, end of August; (7) Birth of sexual apterous individuals. Copulation and production of colonising females.—On some processses for destroying *Oidium* and *Phylloxera*; extract from a letter from M. Desforges to M. Dumas.—Employment of the lime from gas purifiers to check *Phylloxera*; extract from a letter from M. L. Petit to M. Dumas.—Observation of an extraordinary passage of corpuscles across the sun; a telegram from M. Gruey, of the Toulouse Observatory, to the president. The passage took place on the 5th, 6th, and 7th of the present month.—On some applications of Abel's theorem relating to elliptic functions to curves of the second degree, by M. H. Léauté.—Note on magnetism, by M. F. M. Gaugain; a continuation of former researches.—Note on the nature of the sulphurising compound mineralising the thermal waters of the Pyrenees, by M. E. Filhol.—Note on chlorophyll, by M. E. Filhol. The chlorophyll of monocotyledons (Graminæ, Cyperaceæ, Liliaceæ, &c.) treated with a small quantity of hydrochloric acid becomes turbid, and the solution, on filtration, leaves a black crystalline compound on the filter. This substance has been examined in some detail. It is remarkable that a solution of chlorophyll from dicotyledons yields, under the same treatment, a dark compound which is amorphous.—On some phenomena of localisation of mineral and organic substances in Mollusca, Gasteropoda, and Cephalopoda, by M. E. Heckel. Specimens of *Helix aspersa* and *Zonites algirus* were fed with white lead, or with acetate of lead mixed with wheat flour. An accumulation of metal was found in the liver and also in the cerebral ganglia *Loligo vulgaris*, *Sepia officinalis*, and *Octopus vulgaris* were fed during two months with garancine (mixed with meat). In no case was the internal shell coloured, but the cephalic cartilage and all the cartilaginous portions of the skeleton of these Mollusca were coloured after an experiment of three months' duration. The author points out the necessity of distinguishing clearly the hard parts belonging to the skeleton from those belonging to the shell.—On the storm of the night of 1st to the 2nd of Sept. 1874, observed at Versailles; a note by M. Ad. Berigny. 17·59 mm. of rain fell during the storm, and the lightning struck four points in Versailles.

CONTENTS

Erratum.—P. 379, col. 2, line 8 from bottom, for *or* read *on*.

THURSDAY, SEPTEMBER 24, 1874

THE MIGRATION OF BIRDS

THE "silly season" has this year been marked by some discussion in the newspapers on the migration of birds. The various letters published have shown the normal want, if not of knowledge, yet of profundity; and I fear lest the subject, which really deserves the best attention from naturalists, should suffer in repute by the absurdities lavished upon it.

The discussion began, if I am not mistaken, with a theory of migration set forth by a Scandinavian poet, which treated that wonderful movement as an attempt on the part of birds to attain "more light." It proceeded on the hypothesis that the birds which are summer-visitors to northern climes, finding that the days grow shorter as summer advances, retire southwards to find "more light," and that the same desire prompts their return northwards in spring. To show the fallacy of this hypothesis it is sufficient to observe that the southward movement not only begins, but is with many species in great part accomplished, long before the autumnal equinox, when consequently the birds are journeying to increasingly shorter days; and in like manner their northward movement is set on foot before the vernal equinox, with of course the same result. Whether this theory was ever intended in earnest or was only a poetic fancy I do not know, nor is it really worth while to inquire. It is enough that it contains its own refutation.

I have no intention of commenting upon the whole discussion. Few, if any, of the letters which followed contain anything to the purpose either way. But one published in the *Times* of Friday, Sept. 18, seems to require special notice, since it professes to give "the latest accepted theory" on the subject; and the writer, without actually saying that it is received by a very great authority, whom he names, intimates that it does not meet with his disapproval. Of this "latest accepted theory" I must confess I never before heard; and now that it is before me, it seems to be not only unsupported by facts, but to amount to no explanation at all. After briefly touching upon the difficulty which the shorter-winged Birds of Passage must have in effecting their voyages, the writer says:—

"I believe it was only some twenty or thirty years ago that anything like a practical solution of the difficulty was arrived at. The birds congregating about the south coast are seized with a sudden impulse or mania to fly upwards. This is caused by some atmospheric change coinciding with a warm south wind moving in a high stratum, into which the birds soar with an involuntary motion of their wings. This motion (involuntary like that of the heart) is continued for many hours, and the birds fly blindly along until the paroxysm passes off, when they at once begin to descend, making many a fatal drop into the sea.

"The same phenomenon occurs in Africa and southern countries, where the migratory birds congregate for a northern flight about April. Experiments were tried here and in Africa which tended to corroborate the above facts. Migratory birds were kept in cages along the coast, and it was found that each was seized with a prolonged paroxysm coinciding with the time that the wild birds disappeared. Cages were constructed with silk at top and bottom to prevent the birds from killing themselves; and it was noticed that after the paroxysm had passed away, the birds began to look about them, to plume themselves, and eat and drink, apparently with a notion that they had arrived at their new home."

On reading these wonderful paragraphs, some questions naturally arise. How does the writer account for his "birds congregating about the south coast?" What brings them there, that they may be "seized with a sudden impulse or mania to fly upwards?" Who has ever observed the "atmospheric change" and coincident "warm south wind moving in a high stratum?" Do these remarkable meteorological phenomena occur but once in the whole season of migration, or is there a succession of them to suit the convenience of each migratory species? Who, moreover, has seen the birds soar into this peculiar current of air? and who of such fortunate persons knows that the motion of their wings under such conditions is "involuntary like that of the heart?" Finally, what is the cause of the "paroxysm"? for, without knowing that, to attempt to explain the observed facts of migration is an attempt to explain *obscurum per obscurius*.

When a satisfactory answer is given to these questions, it will be time to inquire whether this "latest accepted theory" of migration sets the matter in any clearer light, or whether it is not as arrant nonsense as was ever foisted upon an innocent public, even at the height of the "silly season." The last paragraph of the writer's letter, I may remark, has nothing in it of consequence. Granting that the migratory impulse is instinctive, it is, like other instinctive practices, followed as far as circumstances will allow.

Permit me now to point out to those interested in the solution of this mystery of mysteries the chief matters to which the attention of observers and theorisers should be directed.

I. *The original Cause or Causes of Migration.*—In some cases scarcity of food would seem to be a sufficient cause, and it is undoubtedly the most obvious one that presents itself to our mind. As food grows scarce towards the end of summer in the most northern limits of the range of a species, the individuals affected thereby seek it in other countries. Thus doing, they press upon the haunt of other individuals; these in like manner upon that of yet others, and so on, until the movement which began in the far north is communicated to the individuals occupying the extreme southern range of the species at that season; though, but for such an invasion, these last might be content to stay some time longer in the enjoyment of their existing quarters. When we consider, however, the return movement, at the end of winter, it is doubtful, I think, whether scarcity of food can be assigned as its sole or sufficient cause. But here we feel the want of knowledge. At present we are far too little acquainted with the physical peculiarities of those more equatorial regions, which in winter are crowded with emigrants from the north, to come to any final decision. It seems not too violent an assumption to suppose that though such regions are well fitted for the winter resort of the bird-population of the north, they may be deficient in certain necessaries for the nursery; and it seems still less of an assumption to suppose that even if such necessaries are not wanting, yet that the

regions in question would not supply food sufficient for both parents and offspring—the latter being, at the lowest computation, twice as numerous as the former—unless the numbers of both were diminished by the casualties of travel. But another point must not be overlooked. The most sedentary of birds year after year occupy the same quarters in the breeding season. In some instances this may be ascribed, it is true, to the old haunt affording the sole or the most convenient site for the nest in the neighbourhood, but in so many instances such is not the case, that we are led to believe in the existence of a real partiality, while there are quite enough exceptions to show that a choice is exercised. The same may equally be said of the most migrant of birds, and perhaps the strongest instance that has ever come to my knowledge refers to one of the latter. A pair of Stone Curlews (*Œdicnemus crepitans*)—a very migratory species, affecting almost exclusively the most open country—were in the habit of resorting for many years to the same spot, though its character was entirely changed. It had been part of an extensive rabbit warren, and was become the centre of a large and flourishing plantation. It seems to me, therefore, that among the causes of migration the desire of returning to old haunts must be included.

II. *The Mode or Modes of Migration.*—This heading is capable of much subdivision. The means of transition are of course found in the bird's wings, but do all birds migrate in the same manner? Nay, more, does the same species of bird migrate in the same manner at all times? And how is its return to the old haunt accomplished with a degree of certainty that in most cases may be called unerring?

That all birds do not migrate in the same manner is pretty plain. Some, as the swallows, conspicuously congregate in vast flocks, and so leave our shores in a large company, while the majority of our summer visitors slip away almost unobserved, each apparently without concert with others.

It is also pretty nearly certain that the same species of bird does not migrate in the same manner at all times. Mr. St. John tells us of the arrival of skylarks on the coast of Norway:—"They come flitting over in a constant straggling stream, not in compact flocks." Yet it is notorious that a little later these same birds collect in enormous flocks, which prosecute their voyage in company. As tending to the same conclusion, I need hardly do more than refer to the excellent observations of Mr. Knox on the movements of the Pied Wagtail ("Ornithological Rambles," third edition, pp. 81—86) and, indeed, to the whole of his remarks on migration, because they must or ought to be known to everyone who takes an interest in the subject. But more than this, it is pretty nearly certain that of the majority of northward migrants in spring the males take the lead, and anticipate the advent of their mates by some days, not to say weeks—a fact which may possibly indicate the existence of another cause of migration to which I have not before alluded—while this peculiarity has never been observed in the autumnal movement.

Then comes the question, How is it that birds find their way back to their old home? This seems to me the most inexplicable part of the whole matter. I cannot even offer an approach to its solution. There was a time when I had hopes that what is called the "homing" faculty in pigeons might furnish a clue, but my good friend Mr. Tegetmeier has cruelly deprived me of that consolation, declaring that knowledge of landmarks obtained by sight, and sight only, is the sense which directs these birds, with which he is so conversant; while sight alone can hardly be regarded as much of an aid to birds—and there is some reason to think that there are several such—which at one stretch transport themselves across the breadth of Europe. Here I have no theory to advance, no prejudice to sustain. I should be thankful indeed for any hypothesis that would be in accordance with observed facts. They leave no room for chance and not much for counteracting forces. Occasionally the return of the nightingale, the swallow, or other land birds, may be somewhat delayed, but most sea-fowl can be trusted as the almanack itself. Were they satellites revolving around this earth, their arrival could not be more surely calculated by an astronomer. Foul weather or fair, heat or cold, the puffins repair to some of their stations as regularly on a given day as if their movements were timed by clock-work. Whether they have come from far or from near we know not, but other birds certainly come from a great distance, and yet they make their appearance with scarcely less exactness. Nor is the regularity with which certain species disappear much inferior; every observer knows how abundant the swift is up to the time of its leaving its summer home, and how rarely it is seen after that time is past. Yet all this, marvellous as it may seem, is far less marvellous than the instinct, or whatever else we may call it, which guides the birds in their voyages, and gives them the power of directing their flight year after year to the same spot. The solution is probably simple in the extreme—possibly before our eyes at this moment if we could but see it—but whosoever discovers it will assuredly deserve to have his name remembered among those of the greatest discoverers of this or any age.

ALFRED NEWTON

COMPETITIVE EXAMINATIONS

IN so universally substituting Competitive Examination for the much less perfect systems of patronage and favouritism previously adopted for filling appointments and distributing emoluments, no doubt the step has been in the right direction; but as with all novel systems, the necessary details of its working have not been fully mastered, and we have complaints,—such as from many who have no other recommendations upon which to make selections in scientific appointment, and from the India Civil Service,—that the results are not, in the long run, so successful as could be wished. Many of the objections which were at the outset thought to be insurmountable, have been proved to be insignificant and remediable; whilst others, unforeseen and more difficult to overcome, are daily becoming more and more conspicuous.

The most important of these objections depends on the fact that it is impossible, from the list of successful candidates, even when they are classed according to the number of marks they have obtained, to determine whether they belong to the one or the other of two very different qualities of mind. There are certain students whose chief capacity consists of a very excellent memory

in combination with a power of discriminating what is, and what is not, important in an examination point of view. These, in the hands of an experienced teacher, an able "crammer," or with well-selected books at their disposal, are able, by dint of hard work, so far to make up for their own deficiency in originating power, as to appear, in an examination conducted on ordinary methods, indistinguishable from those who, by accurate observation and much less reading than themselves, have from their superior capacity been able to obtain the same amount of information. What is the result? Taking an instance in which one of each of these classes competes, one against the other, perhaps the former has come out senior and the latter second in the examination list. The latter knows that he might have done better without much effort, and is in no way injured by being beaten. But the former is in a very different position. He finds himself placed above a man of acknowledged great ability, and from this in his smaller mind he infers that he is greater still, considering that he has beaten all. He goes forth into the world with a conscious and unfounded feeling of power; sets up for being a genius; and though his capacities may be anything but inconsiderable, he completely over-estimates himself. If he is a man who has to get his living entirely by his own work he most probably attempts the highest things; to become a barrister or a physician rather than to follow the routine of a solicitor or a general practitioner, for which in reality he is more suited. When the struggle for life commences in earnest he has the continual mortification of seeing others, to whom he has been led by his examination results to think himself superior, passing him on account of their greater ability. This sours his disposition, depresses him unwarrantably, compels him ultimately to relinquish his higher aspirations, and, as a despondent cynic, makes him take to the more humble line of action which at the time of his success he despised so thoroughly.

This is not an overdrawn picture, its counterpart may be seen on all sides, and many more like it will be forthcoming if some radical change is not made in the method of examination now in vogue. What that change must be deserves the serious consideration of all interested in the progress of every branch of social economy, as well as of those who have the responsibility of filling posts of scientific importance. In this respect we think that the older Universities, Oxford and Cambridge, in their more venerable honour examinations, set by far the best example. How accurately, in many of the colleges, the exact mental capacities of those of its undergraduates who are candidates for honours are known, is also more than surprising to the uninitiated. The reason of this is that the examiners are men of acknowledged ability, and what is as much to the point, they have themselves gone through the same training, with the same objects in view, as those whom they are comparing. The ultimate object of work has no doubt a very important bearing on the manner in which it is undertaken; and it is hardly to be wondered at that in a competition like that for the India Civil Service, in which so painfully large a number of subjects is frequently included by some of the candidates, specialist examiners find it extremely difficult to judge, from the undigested mass of answers they have to compare, which is the least bad of the candidates before them. In institutions like the University of London, the system of offering scholarships to be competed for in special "honours" examinations, which follow those for simply obtaining the degree, has, in many cases we could refer to, had the same injurious effect of giving men a false estimate of their own practical power of getting on in life; and whether in the long run the older method of conferring degrees after a pass examination only, without any associated pecuniary reward, is not the best is still a subject quite *sub judice*. In Medical Science this is particularly the case, for in it, more than or as much as in any other, a purely theoretical knowledge of any department of Chemistry, Physics, or Biology, is but of slight value in comparison with the experience of the bed-side, when the commencing practitioner is called upon to diagnose and prescribe without any assistance from others.

In the Universities of Oxford and of Cambridge we have an opportunity of watching the working of the two different systems of examining competing candidates. In the former the lists appear with the names in each arranged alphabetically in three or four classes, and not according to the actual merit in each class. The public are therefore told by this method the average standard to which a man has risen, and no more; for the rest they are left to judge by other entirely independent and perfectly voluntary performances by which he has the opportunity of exhibiting the quality of his ability. In Cambridge the tripos lists place each man in exactly his place with regard to the other men of his year who have taken up the same subject as himself, and every attempt is made to maintain all the triposes at such a standard that corresponding classes indicate similar ability. From the remarks with which we commenced it is evident that the Oxford system has many advantages; and that the other is liable to lead to the injurious result we have mentioned, which in that particular case it does not, on account of the antiquity of the system and the extremely careful way in which the examinations are conducted.

It is the fashion in most modern examinations to include a large number of subjects, many of which may be taken up by each candidate. This, no doubt, is a mistake in many instances. It is not so much information that is wanted in a young man—that will come when the stimulus for showing it becomes greater, but the exhibition of mental capacity; and with examiners of any worth, who have had any experience, it is not at all difficult to estimate the powers of candidates from a very few answers in a very few subjects, especially if any *vivâ voce* and practical questions are included.

A competitive examination should therefore have for its object the estimation of the power of the candidate, and that only. It should be so conducted as to place him on a standard table in such a position that if it were possible from a physical examination of his brain to judge of his brain capacity, the results of the two methods would coincide. This can be best attained by restricting the examination to a few subjects; by asking questions which call for method in their answers rather than fact; and by having able examiners who are acquainted with future work to be expected of the candidate. Candidates thus selected in the long run must certainly be found more satisfactory than those chosen by any other method.

METEOROLOGY IN MAURITIUS

Results of Meteorological Observations taken in 1872 *at Mauritius; Monthly Notices of the Meteorological Society of Mauritius*, 1873; pp. 23 to 53.

THE work of meteorological observation and discussion at this important station continues, as shown by these papers, to be prosecuted under Mr. Meldrum's direction with marked energy and success. The observations at the observatory, which are made five times daily, embrace atmospheric pressure, temperature, humidity, cloud, rainfall, wind, thunder, lightning, and meteors, of which the "Results" present us with a full and carefully prepared summary. We observe with much satisfaction that a barograph is in operation at this important observatory, and very earnestly hope that future annual publications will give meteorologists what is greatly desiderated, viz., the data for the determination of the hourly barometric fluctuations of that region. It is stated that the monthly means of the dry and wet bulb thermometers have been derived from the observations at 6 and $9\frac{1}{2}$ A.M. and $3\frac{1}{2}$ and $9\frac{1}{2}$ P.M.; but those of the barometer from the observations at $9\frac{1}{2}$ A.M., $3\frac{1}{2}$ P.M., and $9\frac{1}{2}$ P.M. The formula employed in each case should in future be explicitly stated. We infer from an examination of the table that the barometric means are derived from the formula $\frac{9\frac{1}{2} + 2 \times 3\frac{1}{2} + 9\frac{1}{2}}{4}$; but as regards the thermometers, we have no means of knowing how the observations at the four hours were combined in deducing the mean temperature, since the means of temperature at these hours are not printed. Considering the hours at which the observations are made, the best formula for the mean temperature would be $\frac{9\frac{1}{2} + 3\frac{1}{2} + 9\frac{1}{2} + \text{min.}}{4}$. But the most satisfactory course would be to give the averages at the observed hours, leaving it to each to deduce from these the approximate mean temperatures. In all published annual results the simple averages of actual observations ought to be given, and these should in no case be made to give way to averages hypothetically deduced.

The rainfall has long occupied the attention of the Mauritius meteorologists, and a table is given showing the results of the rainfall at thirty-five stations. The annual amounts vary greatly, from an annual average of 33 in. at Gros Cailloux to 146 in. at Cluny. The important bearing of the rainfall on the products and health of the island has been ably pointed out by Mr. Meldrum. It is much to be desired that this very energetic society should establish stations at suitable points over the island, at which observations of pressure, temperature, wind, &c., would be made. The position of the island, its peculiar physical configuration, and variety of vegetable covering, afford remarkable facilities for the investigation of not a few meteorological problems, such as the influence of forests on climate, and the daily march and phases of the pressure, temperature, and humidity of the air as influenced by height, exposure, and the character of the vegetation in the immediate neighbourhood of the instrument.

The paper drawn up by Mr. Meldrum for the Vienna Meteorological Congress regarding the practicability and utility of storm warnings is of considerable value, the subject having long received full and able investigation at Mr. Meldrum's hands, and the correctness of his deductions been abundantly tested by the success attending the warnings issued by him. The chief, and indeed only difficulty, in the way of the complete success of the system of warnings at Mauritius is the uncertainty as to when and where an advancing cyclone may recurve.

But the most valuable article in these papers is the one by Mr. Meldrum "On a rainfall periodicity corresponding with the sunspot periodicity." The article is a fine instance of a broad and comprehensive discussion of the question dealt with through its details, and of an extreme caution in constant exercise in drawing the conclusions. The result arrived at is this:—Whether we take the annual rainfall over the largest possible portion of the globe for short periods, or over a smaller portion for a longer period, we arrive at the same result, viz., an increase of rain at or near the epochs of maximum sun-spot area, and a decrease of rain at or near the epochs of minimum sun-spot area. The exceptions are few and trifling, being only such as might be expected in this as in other questions of physical research, and they all gradually and inevitably disappear from the results as the inquiry is made to cover more extended portions of the earth's surface and a longer interval of time.

Much interest attaches to the prosecution of the inquiry regarding the relations of solar and atmospheric changes into other branches of meteorology, such as the pressure, temperature, humidity, electricity, and motions of the air. Does the temperature fluctuate with the sun-spot period? and if so, is the increase and decrease uniform and simultaneous over the globe, or do the warm and cold periods differ widely in different regions? How is the distribution of atmospheric pressure affected? Are the inequalities intensified or reduced, or does the difference find expression chiefly in a greater or less disturbance of the atmosphere, resulting in an increase or decrease of the daily fluctuation as measured by the observed differences in the readings made, say at 9 A.M. from day to day? In the further development of "the meteorology of the future," these are some of the more important questions that will be first inquired into.

OUR BOOK SHELF

A Manual of Metallurgy. By W. H. Greenwood, F.C.S., Associate of the Royal School of Mines. (London and Glasgow: W. Collins, Sons, and Co., 1874.)

THE author states that the work is "primarily designed" for the use of students preparing for the advanced stage of the examinations of the Science and Art Department This, the first volume, contains 250 pages, of which 150 are devoted to iron and steel. And it may be observed that as there is an excellent treatise on the Metallurgy of Iron, by Bauermann, in Weale's Series, this part is less needed by students than the second, in which the metallurgy of copper, lead, zinc, silver, gold, mercury, nickel. cobalt and aluminium, will be described.

Mr. Greenwood has availed himself of his notes of Dr. Percy's lectures at the Royal School of Mines, and has spared no pains in gathering materials for the work from original memoirs, as well as from the few well-known French and German metallurgical works. The chapters on fuel and fire-clays are necessarily brief; but those

relating to iron are satisfactory. The author has described the recent improvements made with a view to supersede manual labour in puddling—such as the rotative furnaces of Siemens and Danks. Siemens' process for the production of wrought iron direct from the ore is also given, and the excellent researches of Bell, Snelus, and Dr. W. M. Watts are duly noticed. In the rest of the book, the metallurgy of tin, antimony, arsenic, bismuth, and platinum are somewhat briefly treated. The various processes are illustrated by fifty-nine well-chosen engravings.

The book contains some curious verbal errors; but, viewed as a whole, we have no hesitation in saying that the work is good, and may be recommended to the class of readers for whom it is intended.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Fossils in Trap

THE occurrence of fossils in the volcanic rocks of our Scottish carboniferous series is by no means uncommon. A conspicuous example was described by me in the "Transactions of the Geological Society of Glasgow," vol. ii. p. 97.

The plant remains thence derived were afterwards figured and described by Mr. Binnie of Manchester, and Mr. Carruthers of the British Museum, and in the latter institution are deposited large polished slabs of entire trees, together with specimens of the enclosing rock.

At a later period a tooth of *Ctenodus cristatus* was also discovered in the same beds. The analysis of the rock was made by the late Mr. John Wallace Young, and given by him in the *Chemical News*, vol. xiii. p. 73.

The rock enclosing these remains is so heavy and compact, so completely devoid of any signs of stratification when fractured, that all previous investigators, from Prof. Buckland in 1819, down to Dr. Bryce in 1865, dismissed it with a conclusive click of the hammer as simply *trap rock* not likely to contain fossils.

The condition in which the fossils are found may be described in the precise words of your Nova Scotia correspondent (NATURE, vol. x. p. 398), as "*indissolubly united with trap;*" nevertheless, there is every probability that originally the enveloping matrix must have reached the fossils in the shape of volcanic ash, or, more likely still, in the shape of a thick fluid sediment enveloping the trunks of the trees as they stood erect, with their broken branches, leaves, and fruit scattered around them. We have numerous instances of ash-beds overlying limestone beds containing corals, and I suspect Mr. Honeyman's "*trap rock in a fluid state*" would resolve itself into a rock of the nature above indicated; at all events, it would be very interesting to geologists on this side to receive specimens for closer examination. With regard to the possibility of fossils being enclosed and preserved in fluid lava, I may mention that when at Catania in 1867, I was informed by Prof. Sylvestri that oak trees on Mount Etna when overtaken by lava streams are not actually annihilated, but the lava forms a sort of hollow cylinder around the trees, in which they are carbonised, and the silex contained in the wood collects in a fused mass at the bottom of the trunk. Such fused masses I met with at the foot of some of the stems of trees excavated by me at Arran, and numerous pebbles, evidently derived from the same source, are to be picked up on the shore between the Fallen Rocks and the Scriden at the north end of Arran. E. A. WÜNSCH

Loch Ranza, Arran, Sept. 19

Chrysomela Banksii

IN answer to Mr. Moggridge (NATURE, vol. x. p. 355), his conjecture as to *Chrysomela Banksii* is correct; though whether the fluid it emits is irritating or not I cannot say. It is a habit possessed by the allied generæ Linæ and Timarchæ.

Camberwell Road, Sept. 16 H. POWER

Meteor

THE following is an account of a brilliant meteor which appeared at 8.53 P.M. on Wednesday, Sept. 16:—

Size: about four times that of Jupiter.

Colour: blue, with a red tail.

Brightness: throwing a shadow deeper than that of a full moon.

Angular measurement of tail: from 12° to 15°.

Duration: about 15″.

Direction of course: N.W.

Zenith distance of point of disappearance: 75°.

The brilliancy of the tail threw a red light on the surrounding landscape. G. H. HOPKINS

Bisterne Close, Burley, Hants, Sept. 16

THE INTERNATIONAL CONGRESS OF ORIENTALISTS

THE second meeting of students of Oriental Literature and Science has been brought to a successful termination under the presidency of Dr. Samuel Birch, Keeper of the Oriental Antiquities in the British Museum. On Monday, the 14th inst., the Congress was opened at the Royal Institution, 21, Albemarle Street, when the president delivered a brilliant and highly interesting address upon the scope and value of these annual meetings.

"Our century," said Dr. Birch, "has seen a striking revival of Orientalism, and the discoveries in Mesopotamia, Egypt, India, and Persia have brought again into light, ancient and almost forgotten monarchies, religions, and tongues, as they existed 4,000 years ago. Modern travellers have left no accessible monument uncopied, and immense material is now at the student's disposal—for the first time, a contemporary history of recorded events in these old times. In Egypt only the other day, M. Mariette discovered fresh inscriptions at Karnak recording the conquest of Thothmes III. These enabled him, in a paper just read before the French Academy of Inscriptions, to propose important reforms in our Egyptian geography. Mr. George Smith's excavations at Kouyunjik have brought to light new Assyrian texts; whilst in India, General Cunningham's labours promise very important results. Every facility should be given for excavations in the East, especially for such as follow up the hints afforded by monumental information. Two monumental discoveries made in recent times are of supreme importance, namely the Canopus triglyph tablet and a bilingual inscription of Dali, 'Idalium,' in Cyprus. The Canopus stele has proved beyond a doubt, if doubt still lingered in dark corners, the truth of the decipherment of the hieroglyphs, whilst the Dali text has led to the recovery of the old Cyprian language, which turns out to be of Greek form. The Mesopotamian and Egyptian monumental discoveries make us acquainted with old submerged empires, and the Moabite stone is the most ancient document of alphabetic writing."

On Tuesday the second day's work commenced with the president's reception in the Egyptian and Oriental Department of the British Museum. The meeting of the Semitic Section, under the presidency of Sir Henry Rawlinson, took place in the theatre of the Royal Institution, where the learned Assyriologist delivered his opening address, in which he spoke on the great importance of the Semitic group of languages.

On the conclusion of this address Prof. Jules Oppert, in a lengthy speech delivered in French, brought before the meeting the result of his labours upon the second of the three inscriptions of King Darius at Behistun.

On Wednesday, after an entertainment by the Right Hon. Sir Bartle Frere, and a reception at Kew Gardens by Dr. Hooker, in his capacity as President of the Royal Society, the Turanian Section opened its session at King's College, under the presidency of Sir Walter Elliot. After his address a very interesting paper was read "On the Study of Turanian Languages," by Prof. Hunfalvy, of Hungary. In this paper the Professor showed

by numerous facts adduced from Hungarian, Wogul Ostiak, and Finnish, that the established notion of Turanianism seems not to be well founded, and that by the accepted maxims it leads the student into many errors. The author endeavoured to show, consequently, that the same method of studying, which has created the Aryan and Semitic linguistic science, must also be applied to the Turanian languages, and that before such a perfect scientific method is reached, every comparative study of them must be unavailing.

Perhaps the most interesting paper was entitled "The State of the Chinese Language at the time of the invention of Writing," by Rev. J. Edkins, in which the author treated of the state of opinion as to the time of the invention of Chinese writing, the changes in the language during the last 1,200 years, and from the time of Confucius till A.D. 600; and laid down the theory that the Chinese characters are an index to the sound of the words at the time of the invention, and that from them may be learned the phonetic changes that have since taken place; they are also an index to the nature and extent of the vocabulary then in use, and a measure of the civilisation that had then been attained.

On Tuesday, the 17th, the Aryan Section sat at the Royal Institution under the presidency of Prof. Müller, whose address was listened to with absorbing interest; we have only space for a few extracts.

What is the real use of an International Congress of Orientalists? asked the president. During the last hundred, and still more during the last fifty years, Oriental studies have contributed more than any other branch of scientific research to change, to purify, to clear, to intensify the intellectual atmosphere of Europe, and to widen our horizon in all that pertained to the science of man, in history, philology, theology, and philosophy. The East, formerly a land of dreams, of fables and fairies, has become a land of unmistakeable reality; the curtain between the West and the East has been lifted, and their old forgotten home stands before them again in bright colours and definite outline. Before all, a study of the East has taught the same lesson which the northern nations once learnt in Rome and Athens, that there are other worlds beside our own, that there are other religions, other mythologies, other laws, and that the history of philosophy from Thales to Schlegel is not the whole history of human thought. In all these subjects the East had supplied parallels, and all that was implied in parallels, viz., the possibility of comparing, measuring, and understanding. The comparative spirit was the truly scientific spirit of the age, nay, of all ages. An empirical acquaintance with single facts did not constitute knowledge in the true sense of the word. He advocated the founding of chairs in our Universities for the languages and antiquities of various extinct and existing peoples, and spoke of the great service which properly educated missionaries might render as pioneers of scientific research. What I should like to see is this, he said: I should like to see ten or twenty of our non-resident fellowships, which at present are doing more harm than good, assigned to missionary work, to be given to young men who have taken their degree, and who, whether laymen or clergymen, are willing to work as assistant missionaries on distant stations; with the distinct understanding that they should devote some of their time to scientific work, whether the study of languages, or flowers, or stars, and that they should send home every year some account of their labours. These men would be like scientific consuls, to whom students at home might apply for information and help. Thirdly, Prof. Müller continued, I think that Oriental studies have a claim on the colonies and the colonial governments. The English colonies are scattered all over the globe, and many of them in localities where an immense deal of useful scientific work might be done, and would be done with the slightest encouragement from the local authorities, and something like a systematic supervision on the part of the Colonial Office at home. Now, we should bear in mind that at the present moment some of the tribes living in or near the English colonies in Australia, Polynesia, Africa, and America, are actually dying out, their languages are disappearing, their customs, traditions, and religions will soon be completely swept away. To the student of language the dialect of a savage tribe is as valuable as Sanskrit or Hebrew, nay, for the solution of certain problems, more so; every one of these languages is the growth of thousands and thousands of years, the workmanship of millions and millions of human beings. If they were now preserved they might hereafter fill the most critical gaps in the history of the human race. And this is not all. The study of savage tribes has assumed a new interest of late, when the question of the exact relation of man to the rest of the animal kingdom has again roused the passions, not only of scientific inquirers, but also of the public at large. Now, what is wanted for the solution of this question is more facts and fewer theories, and these facts can only be gained by a patient study of the lowest races of mankind.

At Dr. Birch's, who gave a reception in the afternoon at his official residence, an agreeable surprise awaited the guests. A secretary of legation had just arrived from the French Embassy, bearing an official and holograph letter to Dr. Birch from the Comte de Jarnac, and a handsome jewel-box, containing the rare and exceedingly honourable decoration of the Golden Palm Branches, or, to speak more correctly, the order of "Officier de l'Instruction Publique," a decoration only conferred upon persons of the highest scientific and literary merit, and confined to ten personages only.

The Hamitic Section assembled in the evening at the rooms of the Society of Biblical Architecture, Conduit Street. The most interesting paper was "On the Place of the Lake or Sea passed by the Israelites at the Exodus," by his Excellency Prof. Brugsch, in French. The author was listened to with rapt attention as he endeavoured to demonstrate that the Hebrews did not really cross the Red Sea, but between the Bitter Lakes lying to the north of the sea. This paper will be printed.

On Friday, the 18th, the Aryan and Archæological Sections met, and in each valuable papers were read.

In the afternoon of Saturday, the Ethnological Section, under the presidency of Prof. Owen, C.B., F.R.S., Superintendent of the Natural History Collections in the British Museum, met at the rooms of the Royal Asiatic Society, where a very large attendance was gathered to hear the interesting addresses of the distinguished president.

In illustration of contributions to the physical elements of ethnology, Prof. Owen referred to the five quarto volumes of photographic illustrations, with descriptions of the various castes, outcasts, traders and artisans, soldiers, outlaws, and primitive hill tribes of Hindostan, issued by the India Office, under the editorial care of Sir John William Kaye and Dr. Forbes Watson. To Dr. Mouatt, when in the Indian service, Prof. Owen had first been indebted for the materials of a report on the natives of the Andaman Islands, published by the British Association in 1861. The language of that dwarf Nigrito race had been well studied by Mr. Homfray, and additional information had been recorded by other scientific Indian officers, as by Surgeon Francis Day and the lamented P. Stoliczka. In a brief summary of present knowledge of the Nigrito and Papuan tribes the president laid stress upon the geological and collateral evidences of their origin on land trusts related in time to recent geological changes, to a period vastly remote in relation to historical time. Their interest to the ethnologist was the retention by certain, now insulated, groups of Nigritos, of an early — he would not say primitive—condition of humanity, like those of some pre-historic races in Europe. The shell-mounds of the Andaman Islands, *e.g.*, were compared with the "kitchen-middens," on North European shores. The Nigritos of the Andamans, like those of New Guinea, waged an unmitigated, uncompromising hostility, by force and fraud, against invaders. Such disposition was comparable to that which the brute species in their wild state bear to man. These Nigritos seem to realise instinctively their fate through contact with a higher race. Since the establishment of a penal settlement in the smaller of the Andaman Islands, kindly disposed ladies have taken in hand Mincopie girls; some swam back to the larger islands, others, retained and taught to the age of puberty, were returned to their tribe. They forthwith resumed its condition and cast off their garments. The men girt the abdomen, against pangs of hunger, with a flexible tendril; but in other respects these dwarf Nigritos exhibit quite a prelapsarian, or quadrumanous, unconsciousness

of nakedness. After touching upon previous hypotheses that had been broached of the origin of Hill-men, Mincopies, and Papuans, the president summarised the observations on which he founded a recommendation to ethnologists to pause before concluding that the present disposition of land and sea was necessarily associated with the origin of such low forms of humanity, and to admit the possibility, if not probability, of its contemporaneity with the latest geological changes on the earth's surface. Prof. Owen then passed to the consideration of the origin, antiquity, and race-characters of the first scientifically known civilised people. This part of the discourse was illustrated by a diagram of the dynasties and reigns of Egyptian kings, and enlarged views from photographs of portrait-sculptures of individuals of the third and fourth dynasties, of a Hykshos Pharaoh of the sixteenth dynasty: of a monarch of the twentieth dynasty, belonging to the native race, after the expulsion of the "Shepherd Kings," and of Pharaohs of the Greek race, including one of Cleopatra, which, from the circumstances of its discovery, supported the belief of its being a true likeness of that queen. To ethnologists the greatest interest was attached to the evidences of the physiognomies of the race that founded the civilisation of ancient Egypt. They are supplied by statues of eminent individuals of well-to-do families, discovered in the temples connected with the tombs. Some are of wood, some of alabaster, some of granite; but the noblest of these is the statue of Chephren, the Phra, or Pharaoh of the fourth dynasty, who built the second of the great pyramids of Ghizeh. It was discovered by Mariette Bey in the temple contiguous to that mighty organised cairn or tomb. It is of life-size; the Pharaoh is seated on his throne, carved out of one block of the beautiful, intractable, and rare mineral called "diorite." Photographs of this statue were exhibited. The face, with features as refined and intellectual as those of a modern European, has a calm, dignified expression, free from the conventionality of the statues of later monarchs. The anatomy of the frame was as true as in works of art from the chisel of Michael Angelo. According to the "table" exhibited, this king lived B.C. 4200. The sculptor wrought thirty-seven centuries before Phidias. What was the period of incubation necessary to attain such perfection in both the creative and mechanical departments of the noblest of the arts? Prof. Owen then briefly discussed the evidence for this high antiquity. To the most philosophic and knowledge-loving of the kings of the Greek dynasty we owe the translation into Greek of the records written in the language, and entrusted to the care of the respective priesthoods of Egypt and of Judæa. Between these records there was great discrepancy. Egypt had risen from a long mythical period to become a state ruled by one mortal Phra, or king, at a period, according to Manetho, contemporaneous, according to Esdras, with the Creation! A later Pharaoh, Cheops, was, according to the Egyptian chronicle, building his pyramid at a time when, according to the Hebrew reckoning, the world was being submerged by the Flood. The attitude of the ethnologist, in the presence of the Manethonian and Septuagint documents, was plain; he has to put away any partiality towards one or other of the respective authors; any presumption of the superior claims of either to recognition; and to test them by facts open to discovery, and on which the truth-getting faculty can base scientific conclusions. This attitude in reference to the Hebrew record is taken by the "Palestine Exploration Fund." A like investigation of the remains of edifices, works of art, monumental records akin to the "Moabite Stone," geological and zoological phenomena, had been carried on in Egypt for a longer period and with richer results than elsewhere. Among the labourers in this monumental field the president more especially paid tribute to Lepsius and Mariette Bey. The testimonies bearing on Manetho's chronology were then briefly enumerated. From these the president inferred that if the Sebennyte priest had erred it was by omission rather than commission; and he expressed his conviction that the chronology set forth in the diagram best squared with the sum of scientific evidence on this important question. In the present palæontological evidence of the antiquity of the human race, 7,000 years seemed but a brief period to be allotted to the earliest civilised administratively-governed community; it seemed natural that such conditions should first have arisen in a land with such unique blessedness of soil and climate as Egypt; and with the high racial character of the people flourishing under its antediluvian Pharaohs. The question as to the origin of this race was then discussed; followed by remarks on the evidence of the periods required for the origin of the leading varieties of the human species. Some remarks on the evidences of the relative antiquity of Egyptian and Chaldæan civilisation followed; and the president concluded by appealing to his fellow Orientalists to cast aside prepossessions as to time, place, affinity, race, tor which there may not be any groundwork of rightly observed well-determined data, and to bring to bear on the dark vistas of the past the pure, dry light of science.

Dr. Forbes Watson, M.A., read a most important scientific paper "On the establishment, in connection with the India Museum and Library, of an Indian Institute for Lecture, Inquiry, and Teaching, and on its Influence on the Promotion of Oriental Studies in England, on the Progress of Higher Education among the Natives of India, and on the Training of Candidates for the Civil Service of India."

The India Museum and Library, Dr. Watson said, would afford a most suitable nucleus for the organisation of a centre for Indian research and information. Such a purpose would be best effected by establishing in connection with the museum and library an institute for lecture, inquiry, and teaching on all Indian subjects. Such an institute would prove highly advantageous from every point of view. The chief object of all scientific institutions is the promotion of research and the dissemination of information—the increase of knowledge, and the increase in the number of people possessed of it. In either direction these institutions would prove more effective if combined than if separate. It is clear that the public usefulness of the museum and library would be extended by the lectures and teaching of the institute; and that the action of the institute on the other hand would be supplemented by its connection with the museum and library.

The following is the plan of arrangement for an Indian Museum which would divide the whole of its contents into a series of groups and sub-groups affording a connected view of the country and its people. This plan takes account of the library as well; in fact, with regard to some of the divisions, reference must be made to the library for a large portion of the materials, and with regard to others for the whole of them.

A. THE COUNTRY AND ITS RESOURCES.

1. *Physical Geography.*
   - *a.* Boundaries and Administrative divisions.
   - *b.* Orography.
   - *c.* Hydrography.
   - *d.* Meteorology.

2. *Natural History.*
   - *a.* Geology and Mineralogy.
   - *b.* Soil.
   - *c.* Flora.
   - *d.* Fauna.

3. *Agriculture, Manufactures, and Commerce.*
   - *a.* Raw produce, mining agriculture, forestry, &c.
   - *b.* Trade and manufactures.
   - *c.* Tools, machinery, processes.
   - *d.* Locomotion by land and water.
   - *e.* Harbours, lighthouses, docks, warehouses, fairs and markets, telegraph and postal communications.
   - *f.* Currency, banks, &c.
   - *g.* Coins, weights, and measures.

B. THE PEOPLE AND THEIR MORAL AND MATERIAL CONDITION.

4. *Ethnography.*
   - *a.* Races.
   - *b.* Castes and religious sects.
   - *c.* Population and vital statistics.

5. *History and Administration.*
   - *a.* Philology.
   - *b.* Archæology.
   - *c.* Mythology.
   - *d.* Historical Geography.
   - *e.* Political and Administrative History.
   - *f.* Legislation.
   - *g.* Current Administration.

6. *Domestic and Social Economy.*
   - *a.* Food and cooking.
   - *b.* Houses and buildings.
   - *c.* Clothing and personal decoration.
   - *d.* Manners and customs.
   - *e.* Health and sanitation.
   - *f.* Education.
   - *g.* Religion.
   - *h.* Fine and decorative art.
   - *i.* Science and literature.

Several other papers were taken as read, and the session of the Congress ended with the choice of St. Petersburg for the meeting of the Congress of 1875. In the evening the Lord Mayor entertained the members at a magnificent banquet at the Mansion House.

COMMON WILD FLOWERS CONSIDERED IN RELATION TO INSECTS *

II.

THE Common Heaths (*Erica tetralix* and *E. cinerea*) offer us another very ingenious arrangement. In *E. tetralix* (the Cross-leaved Heath), for instance, the flower is in the form of a bell (Fig. 15), which hangs with its mouth downwards, and is almost closed by the pistil (*st*), which represents the clapper. The stamens are eight in number, and each terminates in two cells, which diverge slightly, and have at their lower end an oval opening. But though this opening is at the lower end of the anther cells the pollen cannot fall out, because each cell, just where the opening is situated, touches the next anther cell, and the series of anthers thus form a circle surrounding the pistil and not far from the centre of the bell. Each anther cell also sends out a long process, which thus forms a series of spokes, standing out from the circle of anthers. Under these circumstances, a bee endeavouring to suck the honey from the nectary cannot fail firstly to bring its head in contact with the viscid stigma, and thus to deposit upon it any pollen derived from a previous visit; and secondly, in thrusting its proboscis up the bell, it inevitably comes in contact with one of the anther processes, which acts like a lever and dislocates the whole chain of anther cells when a shower of pollen falls from the open anther cells on to the head of the bee. †

FIG. 15.

FIG. 16.

FIG. 17.

In the allied genus Vaccinium there is a similar arrangement, but the anther cells are closed, not by touching one another, but by resting against the style, so that the style itself closes the openings until the anthers are distributed by the proboscis of the bee. *V. uliginosum* is much larger than *V. myrtillus*, and consequently more conspicuous; *V. myrtillus*, on the other hand, has the compensating advantage of being richer in honey.

The genus Arbutus also is said to agree in essentials with Vaccinium.

In many cases the effect of the colouring and scent is greatly enhanced by the association of several flowers on one branch or raceme, as, for instance, in the Wild Hyacinth, the Lilac, and othe rfamiliar instances. In the great family of Umbelliferæ this arrangement is still further taken advantage of, as in the common Wild Chervil (*Cherophyllum sylvestre*).

In this group the honey is not, as in the flowers just described, situated at the bottom of a tube, but lies exposed, and is therefore accessible to a great variety of small insects. The union of the florets into a head is, moreover, not only of advantage in rendering them more conspicuous, but also effects a considerable saving of time, as it enables the insects to visit a given number of insects more rapidly, and consequently renders their fertilisation more certain than if they had stood singly.

The self-fertilisation which, in small flowers such as these, would otherwise naturally occur, is provided against by the fact that the flowers are generally proterandrous, that is to say, the stamens ripen before the pistil, and the latter is not mature until the former have shed their pollen. In some cases, as, for instance, in Myrrhis, the flowers of one head are all firstly in the male condition, and subsequently in that with mature stigmas, none of them arriving at the second stage until they have all passed through the first.

In *Cherophyllum* the petals are not symmetrical, the outer ones being considerably larger than the others, and in many umbellifers the florets themselves on the outer edge of the bunch or umbel are considerably larger than the inner ones.

This distinction is carried still further in the Compositæ, where

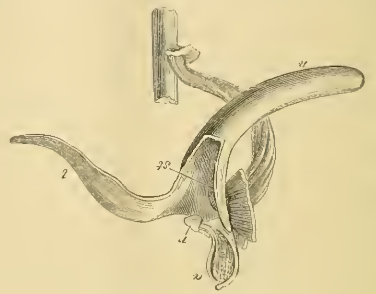


FIG. 18.

also the florets are so closely packed together that the whole umbel is commonly, though of course incorrectly, spoken of as a flower.

For instance, the heads of the common Daisy, as I need hardly mention, are not strictly speaking flowers, but bunches of flowers closely packed together on a common base or receptacle.

The advantages of this arrangement are :—

1. That the flowers become much more conspicuous than would be the case if they were arranged singly.

2. That the facility with which the honey is obtained renders them more attractive to insects.

3. That the visits of the insects are more likely to be effectual,

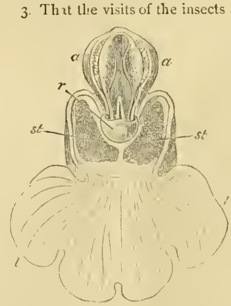


FIG. 19.

FIG. 20.

since the chances are that an insect which once alights, touches several, if not many, florets.

No wonder, therefore, that the Compositæ are the most extensive family among flowering plants, are represented in every quarter of the globe and in every description of station,* and contain nearly ten thousand species.

If we take, for example, the common Feverfew, or large white Daisy (*Chrysanthemum parthenium*), which has been well described by Dr. Ogle,† the flower-heads consist of an outer row of female florets, in which the tubular corolla terminates on the outer side in a white leaf or ray, which doubtless

* Continued from p. 406.
† *Popular Science Review*, April 1870.

* Bentham, "Handbook of the British Flora," vol i. p. 408; Jour. Linn. Soc. 1873, p. 335.
† *Popular Science Review*, April 1870.

is useful in making the flower conspicuous. The inner florets are also tubular, but are small, yellow, and without rays. Each of these florets is furnished with stamens as well as a pistil. The stamens are united on their inner sides so as to form a closed tube, within which the pistil lies. They ripen before the pistil, and dehisce on their inner sides, so that the pollen is discharged into the upper end of the tube above the head of the pistil. When the flower opens the pollen is already ripe, and fills the upper part of the stamen tube. A floret in this condition is represented in Fig. 15. The pistil, however, also continues to elongate, and at length pushes the pollen against the upper end of the tube, which gives way, and thus the pollen is forced out of the tube, as shown in Fig. 16. The pistil itself terminates in two branches, which at first are pressed closely to one another, and each of which terminates in a brush of hairs (Fig. 17). As the style elongates this brush of hairs sweeps the pollen cleanly out of the tube, and it is then removed by insects. When the pistil

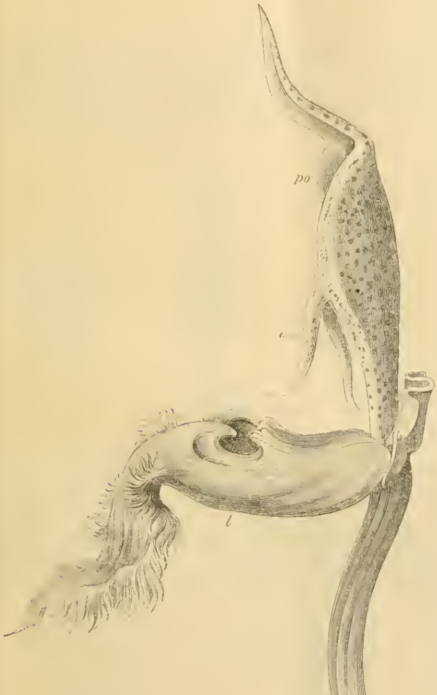


FIG. 21.

has attained its full length two branches open and curve downwards so as to expose the stigmatic surfaces (Fig. 17, *st*) which had previously been pressed closely to one another, and thus protected from the action of the pollen. From this arrangement it is obvious that any insect alighting on the flower-head of the Chrysanthemum would dust its under-side with the pollen of the younger flowers, which then could not fail to be brought into contact with the stigmatic surfaces of the older ones. As the expansion of the flowers begins at the outside and thence extends to the centre, it is plain that the pollen of any given floret cannot be used to fertilise one situated on its inner side. Consequently, if the outer row of florets produced pollen, it would, in the great majority of cases, be wasted. I have, however, already mentioned that these florets do not produce pollen, while the saving thus effected enables them to produce a larger corolla. It is also interesting to observe that in these outer flowers the branches of the pistil do not possess the terminal brush of hairs which, in the absence of pollen, would be useless.

In other Compositæ, as in the Marigold, while the ray flowers produce no pollen, the disc flowers develop stigmas only. In this case, as in the Feverfew, the pistil of the ray flowers does not require or possess the terminal brushes of hairs, as there is no pollen to be swept out. The central flowers, on the other hand, though they develope no stigmas, require a pistil in order to force the pollen out of the anther tube. Hence the pistil is present as usual, but the head is simple and not bifid. This complete alteration of the function of the pistil is extremely curious

Perhaps no group of flowers offers more remarkable adaptations than the orchids, which have been so admirably described by Mr. Darwin.* As an illustration of our English species, I shall take the common early purple orchis (*Orchis mascula*), as being one of the commonest, if not the commonest, species; and a fair example of some of the remainder, which however differs in many interesting and important points.

Fig. 18 represents the side view of a flower, from which all the petals and sepals have been removed, except the labellum (*l*), half of which has been cut away, as well as the upper portion of the near side of the nectary (*n*). The pollen forms two masses (Fig. 19, *a a*), each attached to a tapering stalk, which gives the whole an elongated pear-like form, and is attached to a round sticky disk (*d*), which lies loosely in a cap-shaped envelope or rostellum (*r*). This envelope is at first continuous, but the slightest touch causes it to rupture transversely, and thus to expose the two viscid balls (Fig. 20, *d*). Now suppose an insect visiting this flower; it alights on the labellum, and pushing its proboscis down the nectary to the honey, it can hardly fail to bring the base of the proboscis into contact with the two viscid discs, which at once adhere to it, so that when the insect draws back its proboscis, it carries away the two pollen masses. It is easy to imitate this with a piece of grass, and to carry away on it the two pollen masses and their stalks. If, however, the pollinium retained this erect position when the insect came to the next flower, it would simply be pushed into or against its old position. Instead however of remaining upright, the pollinia, by the contraction of the minute disc of membrane to which they are attached, gradually turn downwards and forwards, and thus when the insect sucks the next flower, the thick end of the club exactly strikes the stigmatic surface (*st*). The pollinium or pollen mass consists of packets of pollen grains, fastened together by elastic threads. The stigma, however, is so viscid, that it pulls off some of these packets, and ruptures the threads, without removing the whole pollinium; so that one pollinium can fertilise several flowers.

I cannot resist mentioning the case of Catasetum, one of the Vaudræ, which, as Mr. Darwin says, "are the most remarkable of all orchids." In Catasetum (Fig. 21) the pollinia and the stigmatic surfaces are in different flowers, hence it is certain that the former must be carried to the latter by the agency of insects. The pollinia, moreover, are furnished with a viscid disc, as in orchis, but from the large size of the flower, and the position of the honey, the insect has no inducement to approach, and in fact does not touch, the viscid disc. The flower, however, is endowed with a peculiar sensitiveness, and actually throws the pollinium at the insect. Mr. Darwin has been so good as to irritate one of these flowers in my presence: the pollinium was thrown nearly 3 ft., when it struck and adhered to the pane of a window. This irritability, however, is confined to certain parts of the flower of *Catasetum saccatum*, which is also shown in section in Fig. 22. In this figure it will be seen that the pollinium (*d p*) is curved, and in a state of considerable tension, but retained in that position by a delicate membrane. Now, insects alight as usual on the labellum of the flower (*l*), and it will be seen that in front of it are two long processes, or antennæ (*an*). In some species of Catasetum both these antennæ are highly irritable; in the present species the right-hand one is apparently functionless; but the moment the insect touches the left-hand one, the excitement is conveyed along it, the membrane retaining the pollinium is ruptured, and the latter is immediately jerked out of the flower by its own elasticity, with considerable force, with the viscid disc foremost, and in such a direction as to come in contact with the head of the insect which had touched the antenna.

I will only mention one other tropical flower, the very curious *Marcgravia nepenthoides*, described by Mr. Belt in his interesting work, "The Naturalist in Nicaragua." The flowers are disposed in a circle, and beneath them are suspended some

* Fertilisation of Orchids.

pitcher-like vessels, which secrete a sweetish liquid, and thus attract numerous insects. These again bring birds, which can hardly fail to brush against the flowers, and thus convey the pollen from one to the other.

In the flowers hitherto described, while the several species offer the most diverse arrangements, we have met with no differences within the limits of the same species, excepting those dependent upon sex. I must now call attention to some cases in which the same species possesses flowers of two or more kinds, which sometimes, as in the Violet, are adapted to different conditions; but more frequently are so constituted as to ensure cross-fertilisation.

In some of the violets (*V. odorata*, *canina*, &c.), besides the blue flowers with which we are all so familiar, but which produce very little seed, there are other autumnal flowers, almost without petals and stamens, and which indeed have none of the appearance of true flowers, but in which the seeds are produced. As these curious flowers, however, have no relation to our present subject, I shall not now dwell on them.

I pass on to the genus Primula, which offers a most interesting case of dimorphism. The Cowslip and Primrose resemble one another in many respects, though the honey they secrete must be

Fig. 22.

Fig. 23.

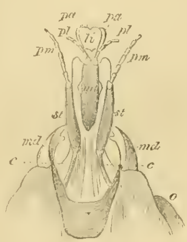


Fig. 24.

very different, for while the Cowslip is habitually visited during the day by humble bees, this is not the case with the Primrose, which, in Mr. Darwin's opinion, is fertilised almost exclusively by moths. (Jour. Linn. Soc., vol. x. p. 438.) This, however, is a digression.

Corresponding differences occur in the Polyanthus and Auricula, and had long been known to gardeners, and even to school children (by whom the two kinds of flowers are known as "pin-eyed" and "thumb-eyed"), but it was reserved for the genius and perseverance of Mr. Darwin, to explain * the significance of this curious phenomenon, and the important part it plays in the economy of the flower. Now that Mr. Darwin has pointed this out it is sufficiently obvious: an insect thrusting its proboscis down a primrose of the long-styled form would dust its proboscis apart, which, when it visited a short-styled flower would come just opposite the head of the pistil, and could not fail to deposit some of the pollen on the stigma. Conversely an insect visiting a short-styled plant would dust its proboscis at a part further from the tip, and which, when it subsequently visited a long-styled flower, would again come just opposite to the head of the pistil. Hence we see that by this beautiful arrangement insects will carry the pollen of the long-styled form to the short-styled, and *vice versâ*.

There are other points in which the two forms differ from one another: for instance, the stigma of the long-styled form is globular and rough, while that of the short-styled is smoother, and somewhat depressed. The pollen of the two forms is also dissimilar, that of the long-styled being considerably smaller than the other, 7-7000ths of an inch in diameter against $\frac{10\ 11}{7000}$ or nearly in the proportion of three to two; a difference the importance of which is obvious, for each has to give rise to a tube which penetrates the whole length of the style, from the stigma to the base of the flower, and the tube in the long-styled form must therefore be nearly twice as long as in the other. Mr. Darwin has shown that much more seed is set if pollen from the one form is placed on the pistil of the other, than if the flower is fertilised by pollen of the same form, even if taken from a different plant. Nay, what is most remarkable, such unions in Primula are more sterile than crosses between distinct, though nearly allied species of plants, have in some cases been found to be.

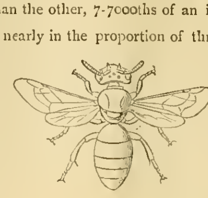


Fig. 25.

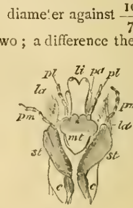


Fig. 26.

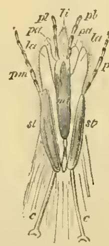


Fig 27.

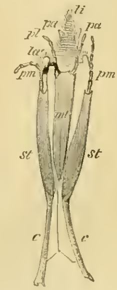


Fig. 28.

Fig. 29.

The majority of species of the genus Primula appear to be dimorphic, but not all.*

Mr. Darwin has pointed out † that several species of Linium are dimorphic in the same manner as the Cowslip and Primrose. *Lythrum salicaria*, however, ‡ is even more remarkable, since as was remarked by Vaucher, but first explained by Mr. Darwin, it presents us with three distinct forms (each contain-

Fig. 30.

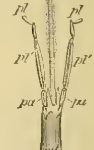


Fig. 31.

* *Linnean Journal*, 1862, p. 77.

* Scott, Proc. Linn. Soc., vol. viii., 1864, p. 80.
† Jour. Linn. Soc., 1863, p. 69.
‡ Linn. Jour. 1864, p. 169.

ing a pistil and two groups of stamens), which he calls, from the relative lengths of their pistils, the long-styled, mid-styled, and short-styled. In this species, also, it is remarkable that the seeds of the three forms differ from one another, 100 of the long-styled seeds being equal to 121 mid-styled or 142 short-styled. The pollen grains also not only differ in size (the long stamens having the largest-sized pollen grains, the middle-sized stamens middle-sized pollen grains, and the short stamens small pollen grains), but also in colour, being green in the longer stamens, and yellow in the shorter ones; while the filaments are pink in the long stamens, uncoloured in the shorter ones. Mr. Darwin has also proved by experiment that this species does not set its seeds, if the visits of insects ares prevented; in a state of nature, however, the plant is much frequented by bees, humble-bees, and flies, which always alight on the upper side of the flowers in the stamens and pistil.

He has also shown that in this species, as in Primula, perfect fertility can only be obtained by fertilising each form with pollen from stamens of corresponding length. This case is indeed most complex, as the pollen of each set of stamens, when applied to the same stigma, acts most differently, and it would appear that the greater the inequality in length between the pistil and stamens, the greater the sterility.

The genus Lythrum is also remarkable for the great differences existing between different species. *L. græfferi*, like *L. salicaria*, is trimorphic; while *L. thymifolia* is dimorphic; and *L. hyssopifolia* is homomorphic.

Let us consider the manner in which the bees are adapted to the flowers. Although we may in one respect say that the general organisation of the insect is modified with reference to these

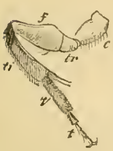


FIG. 32.

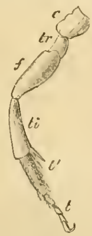


FIG. 33.

FIG. 34.

relations, still, as Müller, from whom the following facts are mainly taken, has well shown, the parts which have been the most profoundly modified are the mouth and the legs. If we are asked why we assume that in this case the mouth-parts and legs have been modified, the answer is that they depart greatly from the type found in allied insects, and that between this type and these modified examples various gradations are to be found.

The mouth of an insect, say of a wasp (Fig. 23), is composed of (1) an upper lip, *a*, (2) an underlip, *d*, (3) a pair of anterior jaws or mandibles, *b*, and (4) a pair of posterior jaws or maxillæ, *c*. These two pairs of jaws work laterally, that is to say, from side to side, and not as in man and other mammalia, from above to below. The lower lip and maxillæ are each provided with a pair of feelers or palpi (*c* and *d*, *x*). The above figures represent the mouth-parts of a wasp, in which, as is very usually the case, the mandibles are hard and horny, while the maxillæ are more delicate and membranous. In the different groups of insects these organs present, however, almost infinite variations.

Fig. 24 represents the mouth-parts of a bee, Prosopis (Fig. 25). The bees belonging to this genus construct their cells in sand, or in dry bramble sticks, lining them with a transparent mucus, which they smooth down with their trowel-like lower lip and which hardens into a thin membrane. That the mouth of Prosopis probably represents the condition of that of the ancestors of the hive-bees before their mouthparts underwent special modifications, may be inferred from the fact that the same type occurs in other allied groups, as is shown in Fig. 26, which represents the mouth of a wasp (Polistes), also seen from below.

We may therefore consider that Prosopis shows us special adaptation for the acquirement of honey, and in fact though the bees belonging to this genus feed their young on honey and pollen, they can only get the former from those flowers in which it is on the surface. In Andrena (Fig. 27), Halictus (Fig. 28), Panurgus (Fig. 29), Halictoides (Fig. 30), and Chelostoma (Fig. 31), we see various stages in the elongation of the lower lip until at length it reaches the remarkable and extreme form which it now presents in the hive- and humble-bees, and which enable them to extract the honey from most of our wild flowers, though no bees have the proboscis so much elongated as is the case with some butterflies and moths; perhaps as Hermann Müller has

FIG. 35.

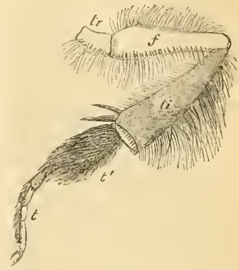


FIG. 36.

suggested, because the necessity of using their mouths for certain domestic purposes has limited its specialisation in this particular direction.

There are several flowers which are inaccessible to hive-bees, and to *Bombus terrestris*, which has a shorter proboscis than some of the other species belonging to that genus. Hermann Müller mentions, for instance, that he has often seen *Bombus terrestris* endeavouring, in vain, to suck the flowers of the Oxlip (*Primula elatior*). Having satisfied themselves that they were unable to do so, but not till then, they proceeded to cut a hole in the base of the tube, and thus arrived at the honey. This seems to show, he observes, that they act upon the results of experience, and not by what is called mere instinct. Indeed any one who has watched bees in greenhouses will see that they are neither confined by original instinct to special flowers, nor do they visit all flowers indifferently. Müller mentions several cases in which he has seen honeyless flowers visited by insects; *Genista tinctoria*, for instance, is frequently visited by insects in search of honey although it does not contain any.

Certain insects, on the other hand, confine themselves to particular flowers. Thus, according to H. Müller,

Andrena florea	visits exclusively		*Bryonia dioica*,
Halictoides	,,	,,	species of *Campanula*,
Andrena hattorfiana	,,	,,	*Scabiosa arvensis*,
Cilissa melanura	,,	,,	*Lytterum salicaria*,
Macropis labiata	,,	,,	*Lysimachia vulgaris*,
Osmia adunca	,,	,,	*Echium*.

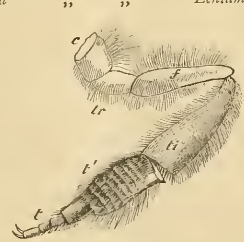


FIG. 37.

It would also appear that individual bees differ somewhat in their mode of treating flowers. Some humble bees suck the honey of the French Bean and the Scarlet Runner in the legitimate manner, while others cut a hole in the tube and thus reach it surreptitiously; and Dr. Ogle has observed that when he followed any particular bee she always proceeded in the same manner; some always entering by the mouth, others always cutting a hole. He particularly mentions that this was the case with bees of one and the same species, and infers, therefore, that

they differ from one another in their degrees of intelligence; and his observations, though of course not conclusive, are interesting and suggestive.

If again we examine the hind legs of bees, we shall find similar gradations. In Prosopis (Fig. 32) they do not differ materially from those of genera which supply their young with animal food. Portions of the leg, indeed, bear stiff hairs, the original use of which probably was to clean this burrowing insect from particles of sand and earth, but which in Prosopis assist also in the collection of pollen.

Fig. 33 represents the hind leg of Sphecodes (Fig. 34), a genus in which the tongue resembles in form that of Halictus. Here we see the hairs decidedly more developed, a modification which has advanced still further in Halictus (Fig. 35), in which we see that the development of the hairs is most marked on those segments of the hind legs which are most conveniently situated for the collection and transport of pollen.

In Panurgus the same change is still more marked, and the pollen-bearing apparatus is confined to the tibia and first segment of the tarsus, a differentiation which is even more apparent in Anthophora. In these bees the pollen is simply entangled in the hairs of the leg as in a brush, but there are other genera, as for instance the humble bees and the hive bee, which moisten the pollen with honey, and thus form it into a sticky mass, which is much more easy to carry, and is borne, not round the leg, but on one side of it. In the humble bee (Bombus, Fig. 36), for instance, the honey is borne on the outer side of the hinder tibiæ, which are flattened, smoothed, and bordered by a row of stiff curved hairs, which thus constitute it a sort of little basket. Lastly, in the hive bee (Fig. 37), the adaptation is still more complete, the hairs on the first tarsal segment are no longer scattered, but are arranged in regular rows; and the tibial spurs inherited by Bombus from far-distant ancestors have entirely disappeared.

In some bees the pollen is collected on the body, and here also we find a remarkable gradation from Prosopis, which has only minute and simple hairs, like a wasp; through Sphecodes, a Nomada, in which the longer hairs are still few, and generally simple, though some few are feathered; to Andrena and Halictus, where the hairs are much more developed; a change which is more marked in Sarapoda, Colletes, and Megachile; still more so in Osmia and Anthophora; until we come to the humble bees, in which the whole body is covered with long feathered hairs.

Although flowers present us with all these beautiful and complex contrivances, whereby the transfer of pollen from flower to flower is provided for and waste is prevented, yet they are imperfect, or at least not yet perfect, in their adaptations. Many small insects obtain access to flowers and rob them of their contents. *Malva rotundifolia* can be, and often is, sucked by bees from the outside, in which case the flower derives no advantage from the visit of the insect. In *Medicago sativa*, also, insects can suck the honey without effecting fertilisation, and the same flower continues to secrete honey after fertilisation has taken place, and when apparently it can no longer be of any use. Fritz Müller has observed that, though *Posoqueria fragrans* is exclusively fertilised by night-flying insects, many of the flowers open in the day, and consequently remain sterile.

It is of course possible that these cases may be explained away; nevertheless, as both insects and flowers are continually altering in their structure and in their geographical distribution, we should necessarily expect to find such instances. Animals and plants constantly tend to adapt themselves to their conditions, just as water tends to find its own level.

I have been good-humouredly accused of attacking the little busy bee, because I have attempted to show that it does not possess all the high qualities which have been popularly and poetically ascribed to it. But if scientific observations do not altogether support this intellectual eminence, which has been ascribed to bees, they have made known to us in the economy of the hive many curious peculiarities which no poet had ever dreamt of, and have shown that bees and other insects have an importance as regards flowers which had been previously unsuspected. To them we owe the beauties of our gardens, the sweetness of our fields. To them flowers are indebted for their scent and colour, nay, their very existence in its present form. Not only have the brilliant colours, the sweet scent, and the honey of flowers been gradually developed by the unconscious selection of insects, but the very arrangement of the colours; the circular bands and radiating lines, the form, size, and position of the petals, the arrangement of the stamens and pistil, are all arranged with reference to the visits of insects, and in such a manner as to ensure the grand object which renders these visits necessary.

Thus, then, I have attempted to point out some of the relations which exist between insects and our common wild flowers; the whole subject is one, however, which will repay most careful attention, for, as Müller has truly said, there is no single species the whole history of which is yet by any means thoroughly known to us, and while, with reference to the regions of thought brought before us by the president on Wednesday evening, few can hope themselves to assist in the progress of truth, the case is very different with reference to my subject of this evening, in which every one of us by care and perseverance may fairly hope to add something to the sum of human knowledge.

NOTES

WE hear that it is most probable that Dr. T. Lauder Brunton, F.R.S., whose investigations in the science of therapeutics have made him so well known to physiologists and pathologists generally, will undertake the editorship of the *Practitioner*, rendered vacant by the death of Dr. Anstie.

THE forty-seventh congress of German naturalists and physicists opened at Breslau on Sept. 18. The proceedings were opened by the eminent chemist, Prof. Loewig, who expressed his satisfaction at seeing so many foreigners, whose presence in that assembly, he added, was a living testimony to the truth that science was of no country. Capt. von Dechen read a paper upon the present state and the future prospects of geology. After him, Prof. Virchow, of Berlin, spoke upon miracles regarded from the scientific standpoint. The several sections were then constituted, and the members of the congress afterwards adjourned to a banquet. In the evening an open-air entertainment was given by the city, and a telegraphic greeting was sent to the Emperor.

THE fortieth congress of the French Institute of the Provinces, *Les Mondes* informs us, opened at Rodez on Monday last, under the presidency of M. de Toulouse-Lautrec, and will last ten days. There are five sections, in which questions are discussed connected with the mathematical, physical, and natural sciences, agriculture, industry and commerce, anthropology and the medical sciences, history and archæology, philosophy, literature, the fine arts, and social economy. This is certainly comprehensive enough.

THE last expedition for observing the transit of Venus is now on the point of leaving England for Egypt. It has developed into one of considerably greater magnitude than was at first intended. The Government expedition organised by Sir George Airy, instead of being located at Alexandria, will have its headquarters at Cairo, the longitude of which city is to be found by exchange of telegraph signals with Greenwich, for which purpose a branch station will be established for a time at Alexandria. For the actual observation of the transit, Cairo, Thebes, and Suez are selected, the longitude of the last two being obtained by exchanging telegraph signals with Cairo. The photographic branch of the enterprise will probably be at Thebes. Private expeditions have been organised, all of them in concert with the English Government one. The whole may be enumerated as follows:—English Government Expedition.—Chief captain, C. Orde Browne; photographic branch, Capt. Abney; astronomers, Mr. S. Hunter and Mr. Newton. Prof. Döllen, the Russian astronomer, and Col. Campbell have organised private expeditions to Thebes. Dr. Anvers proposes to be either at Cairo or Thebes, and Admiral Ommanney may also join the English party as an associate astronomer. The whole of the telescopes and huts from Greenwich are now on board the Peninsular and Oriental vessel *Hindostan*, which is to leave Southampton on the 1st proximo.

MR. LOUIS SEEBOHM, one of the chief photographers who embarked on the *Swatara* in June last as a member of the American Transit of Venus expedition, died at Bahia on July 22. He had been extremely ill during the voyage, and was ordered home by the medical officer of the vessel, but died of fever before he could be removed.

THE October number of Petermann's *Mittheilungen* will contain a valuable paper by Prof. H. Fritz on the geographical extension of the Aurora Borealis; the accompanying map, which contains the magnetic meridians, shows by a system of curves the places on the earth's surface from which the light is seen with equal frequency. Also a fine map of Haiti on the scale of $\frac{1}{1100000}$, with accompanying description; and the continuation of Dr. Nachtigal's contribution on the tributaries of the kingdom of Baghirmi, in which he gives some account of the fauna and flora of the region and of the manners, customs, and condition of the people. There is also a paper translated from the Russian of L. Kostenko, giving a personal account of the country between Khiva and Fort Kasala on the Sir-Daria.

A MOVEMENT is on foot among the students of the University of St. Andrews with the object of electing Mr. Darwin to the Rectorial chair in the room of Lord Neaves, who retires in November. On the last occasion a large number of the students were favourable to the election of a scientific man in the person of Prof. Huxley, and as he lost his election by only three votes, the Darwinians are encouraged to prosecute the candidature of their nominee. The election will take place on the fourth Thursday of November.

THE *Daily News* of Saturday last has a letter, dated Kandavan, Aug. 8, from its correspondent with the *Challenger*, giving an account of a short cruise from Wellington, New Zealand, which was left on July 6, to the Fiji Islands. The trawling and dredging was very successful, and many zoological and botanical specimens have been obtained. Among the treasures obtained by the trawl was a live nautilus, the only one caught alive since the ship left England. The *Challenger* was to proceed to the New Hebrides and Torres Straits, where it was expected to arrive about the beginning of this month.

M. CORENWINDER has contributed to a recent meeting of the Société des Sciences of Lille an exhaustive series of observations on the processes of respiration and nutrition in plants. He supports M. Claude Bernard's view, that the process ordinarily known as the respiration of plants—the decomposition of the carbonic acid of the atmosphere—is really a process of digestion, and that simultaneously with this, plants carry on, by day as well as by night, a true process of respiration, similar in all respects to that performed by animals, consisting in an oxidation of the carbonaceous matters of their tissues. By a very careful series of analyses, performed mainly on the lilac and maple, M. Corenwinder determined that the proportion of nitrogenous matter in the leaves gradually and progressively diminishes from the time that they emerge from the bud till their fall; the proportion of carbonaceous matter increases very rapidly during April and May, and then remains nearly stationary till October; while that of incombustible substance increases during the whole period of vegetation. He distinguishes, therefore, two periods in the vegetative season of the plant—the first period, when nitrogenous constituents predominate, is that during which respiration is the most active; the second, when the proportion of carbonaceous substance is relatively larger, is the period when respiration is comparatively feeble, the carbonic acid evolved being again almost entirely taken up by the chlorophyll, decomposed, and the carbon fixed in the true process of digestion.

PROF. H. HOFFMANN of Giessen has made some interesting experiments on the permanence of varietal and specific characters in the case of the French Bean and Scarlet Runner (*Phaseolus vulgaris* and *multiflorus*). A very large number of attempts to fix special varieties which were casually produced invariably failed, the tendency towards reversion to the ancestral form being apparently irresistible. On the other hand, no one of the characters which are ordinarily relied on to distinguish the two species from one another is constant, but is liable, under certain circumstances, to disappear. Dr. Hoffmann has also made a similar series of experiments on the Common Red Poppy (*Papaver Rhœas*). Constant cultivation for six years produced no perceptible variation; but in the seventh year several varieties in the colour, and in the next year in the form of the petals, made their appearance, tending towards an assimilation to *P. dubium*.

THE *Gardener's Chronicle* announces a new material for paper in a well-known American grass, *Zizania aquatica*. It is stated that the Zizania yields fully as much of the raw material as esparto, and has the great and peculiar merit of being comparatively free from silicates. Paper made from it is quite as strong and quite as flexible as that made from rags; it is easily bleached, economical in respect of chemicals, pure in colour, and remarkably free from specks and blemishes. It is especially recommended for the manufacture of printing paper. The grass grows in enormous quantities in our Canadian Dominion, on the shores of Lakes Erie, St. Clair, Ontario, &c., and it is affirmed that a supply of 100,000 tons annually may be looked on as certain. Its habitat is swamps, ponds, and shallow streams, where it grows to a height of from 7 to 8, or even to 12 and 14 ft. The structure is similar to that of rice, except that the flowers are unisexual. The grains are largely used as an article of food by the native Indians, some tribes depending on them to a large extent for their subsistence. The flavour is said to be superior to that of most other cereals, and it has long been known from these properties as "Canada Rice."

THE will of the late Girolamo Ponti, of Milan, which has just been published in the *London Gazette* by order of Lord Derby, is likely to give rise to some trouble before it can be carried into effect. The testator has bequeathed a considerable portion of his property to the "Academies of Science of London, Paris, and Vienna," to be divided among them in equal proportions, for the purpose in each case of founding, with the proceeds resulting from investment, two competitions yearly on the subjects of Mechanics, Agriculture, Physics and Chemistry, Travels by Sea and Land, and Literature. The committees to be appointed by the societies are instructed to give preference to those competitors who will have advanced any of the subjects mentioned by original discovery. The relatives of Signor Ponti are to dispute the will, and those London societies that think they have claims upon the legacy are urged to bring them forward at once. There can be no doubt which societies are meant in the case of Paris and Vienna; and at first sight there appears to be little doubt as to what body the title of "Academy of Science of London" would most appropriately apply.

AT the meeting of the Paris Academy of Sciences held Sept. 14, Dr. A. W. Hofmann announced that his two students, MM. Tiemann and Haarmann, who had obtained vanilline (the aromatic principle of the vanilla bean) from pine sap, propose to manufacture this substance on a large scale. The sap of a tree of medium height gives vanilline to the value of 100 fr., and the wood is not injured by the extraction of the sap. This will be the second vegetable product manufactured by purely chemical methods.

THE first fungus exhibition held in Scotland was opened in Aberdeen on Friday. The idea of the exhibition was first suggested by the Rev. Mr. Ferguson, of New Pitsligo, in the *Scottish Naturalist* for April. The suggestion was readily taken up by fungologists and men of science, and the result was an exhibition

which those entitled to speak with authority say was never equalled in this country. The specimens numbered about 7,000. Almost every county in Scotland made large contributions, while England and Wales sent a number of exhibits. In fact, almost every fungologist in Britain contributed specimens.

IN an address on Education at Rochdale on Saturday, Mr. Jacob Bright urged the claims of Owens College, Manchester, to assistance from the national exchequer, and hinted that a time was approaching when the enormous revenues of Oxford and Cambridge would be made more productive to the country.

THE members of the *Tegethof* Austrian Polar Expedition have arrived at Hamburg. They everywhere in Norway met with a very cordial welcome. The new country, as far as explored, comprises five islands, and contains hares and foxes. When rescued, the members of the expedition were in rags, and for a fortnight had been short of provisions and of firing. They were compelled to shoot all the sledge dogs, as the animals showed signs of madness. The members of the expedition will, it is expected, reach Vienna to-morrow.

A NOTICE has been issued from the Science and Art Department that the Classes in Chemistry (Prof. Frankland), Biology (Prof. Huxley), Physics (Prof. F. Guthrie), and Applied Mechanics (Prof. Goodeve), have been tranferred to the new buildings, South Kensington, where they will open in the beginning of October.

MR. ANDREW MURRAY writes to the *Gardener's Chronicle* that he has, within the last few weeks, made some observations at the Ochil Hills, Kinross-shire, on *Pinguicula* and *Drosera*, with reference to the fly-digesting powers they are asserted to possess. He states that he found the leaves of *Pinguicula* close, quite independently of the fact of a fly being in them or not. "The leaves are found with their margins in all stages of curling over, some with no insect on them much more curled over than others with several." The secretion which Dr. Hooker states kills a captured insect he finds is glutinous, and he believes it does not fall on to the insect, but that death results from the secretion adhering to and closing up the spiracles by which the insect breathes. With regard to Dionæa, he suggests that it should be carefully noted (1) whether the secretion is never present until after an insect has been captured; (2) whether it is always present after one has.

AMONG the recent additions to the Manchester Aquarium is fine specimen of the Monk or Angel Fish, between five or six feet in length, and weighing at least one hundred pounds. With the exception of an example of very similar dimensions brought to the Brighton tanks about a year ago, but since dead, it is one of the largest yet recorded as taken on the British coasts. This specimen was captured at Colwyn Bay, near Conway, and is still in the most healthy and perfect condition. A number of young herring, of which fish the Manchester Aquarium now possesses many hundreds, were consigned last week by the curator, Mr. W. Saville-Kent, to the aquarium at the Crystal Palace; most of these arrived in safety, and are of especial interest as being the first of the species successfully introduced at that institution.

THE additions to the Zoological Society's Gardens during the past week include a Chimpanzee (*Troglodytes niger*); a Bay Antelope (*Cephalophus dorsalis*), and three Royal Pythons (*Python regius*), from West Africa, presented by Mr. C. B. Mosse; a King Vulture (*Gyparchus papa*) from South America, presented by Mr. G. I. Brumschweiler; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Capt. Hallett; two Little Bitterns (*Ardetta minuta*), European, presented by Mr. A. A. van Bemmelen; an Alligator (*Alligator mississippiensis*) from Demerara, presented by Capt. Turner; a Yellow-fronted Amazon (*Chrysotis ochrocephala*) from Guiana, deposited.

MARITIME CONFERENCE

THE conclusions come to by the recent Conference on Maritime Meteorology have been forwarded to us with the following letter:—

"Sir,—I have the honour to inform you that the Permanent Committee of the International Meteorological Congress at Vienna (1873), at whose suggestion the recent Conference for Maritime Meteorology was held in London, has resolved to forward the Resolutions adopted at that Conference for publication at once, thus anticipating the publication of the full Official Report of the Conference. The Permanent Committee will feel deeply obliged if you can find space for them.

"ROBERT H. SCOTT,

"Secretary to the Permanent Committee."

Resolved—"That there should be but one form of Meteorological Register for the Navies and Merchant Services, and that those who cannot fill the log should keep part of it."

Questions.	*Resolutions.*
I.—OBSERVATIONS—	
Columns 1 to 6.*—*Date and Position of the Observations.*	
Is it your opinion that a fresh column should be added headed "Course and distance by the log in every watch of four hours?"	That an additional column should be given in the log for "Course and distance." That the course should be expressed in degrees, and not in points. That the question of hours, 4-hourly periods, as proposed by Captain Toynbee, should be, adopted.
Columns 7 and 8.—*Currents.*	
	That observations on the "direction and rate" of currents be transferred to the column for Remarks.
Column 9 —*Magnetic Variation.*	
Is it desirable to give an additional column for the "Direction of ship's head"?	That an additional column be given in the log for the direction of the ship's head, and the amount of heel to port or starboard. That the total compass-error and not variation only be given. That the Conference expresses its opinion that the lettering on the English compass should be adopted by all nations for meteorological purposes.
Columns 10 and 11.—*Wind Direction and Force.*	
Is it possible to employ an anemometer at sea, so as to give trustworthy results?	That a decided answer to this question cannot at present be given, but it is desirable that various anemometers should be tested by special ships, and that a special form of four extra columns should be prepared for the purpose of recording such observations.
Can the use of the Beaufort scale be made universal?	That the use of the Beaufort scale should be continued, with the addition of the amount of sail which Beaufort's ship would have carried had she been rigged with double topsails. Also that the direction and force of the wind should be recorded at the *time* of observation, and not estimated for a certain number of previous hours. Also, that they should be recorded every two hours.
Columns 12 and 13.—*Barometer.*	
To what degree of minuteness is it necessary to observe this instrument?	To one-hundredth of an inch at sea, or its equivalent in the metric scale.

* The numbers of the columns refer to the Brussels Abstract log.

Columns 14 and 15.—*Thermometers, Dry Bulb and Wet Bulb.*

Should these observations be required from all ships?	That wet and dry bulb observations are desirable, and should be obtained whenever possible.

Column 16.—*Forms and Direction of Clouds.*

Is this column sufficient, or should any notice be taken of more than one stratum of clouds?	That the upper and lower clouds should be recorded in separate columns, and that the direction from which *upper* clouds come should be recorded when possible.

Column 17.—*Proportion of Sky Clear.*

Is it not advisable to substitute for this heading "Proportion of sky clouded"?	That it is preferable to give the proportion of sky clouded instead of the entry "proportion of sky clear," as recommended by the Brussels Conference.

Column 18.—*Hours of Rain, Fog, Snow, &c.*

Is it desirable to retain this heading, or to substitute for it and No. 23, a column headed "Weather by Beaufort Notation"?	That it is desirable to retain this heading, but that the use of Beaufort's Notation may be continued by those accustomed to it.

Column 19.—*State of the Sea.*

Should this be given according to a numerical scale?	That a numerical scale (0 – 9) be adopted, and that an extra column should be given to the observation. The direction of the sea swell, or the different swells, to be given in the original column.

Columns 20 to 22.—*Temperature of Sea Surface, Specific Gravity, Temperature at Depths.*

Is it desirable to retain these columns, or can the observations when taken be inserted in the column for "Remarks"?	That the first two columns should be retained. That sea temperatures at depths should not be required from all ships, and should be recorded in the "Remarks."

Column 23.—*Weather.*

Vide the resolution on Col. 18.

Column 24.—*Remarks.*

That the "Remarks" as asked for by the Brussels Conference should be adopted, with the exception of the observations of temperature with coloured bulbs at sea.

II.—Instruments.

What patterns of instruments should be employed for any observations which may require them?	That the question of the precise pattern of instruments is not of very great importance, so long as they satisfy the tests applied at the several central Institutions and are compared with standard instruments; but it is recommended that they shall be of a pattern as easy as possible for reading.
Is there any reasonable possibility of introducing the metric and centigrade systems for general use at sea?	The recommendation respecting the use of the metric and centigrade systems as expressed at the Vienna Congress was approved, and it was recommended that a table of conversion should be entered in each log to enable Captains to compare barometers which have different scales.

III.—Instructions.

Is it possible to devise a general form of Instructions to ensure uniformity in regard of methods of observation and registration?	That the Instructions should be suited to the log now proposed by the Conference, but modified to meet the various requirements of different nations.

The Conference requested that Capt. Toynbee's proposed form of log should be lithographed and the English "Instructions" printed for circulation amongst its members.

IV.—Observers.

What control should be exercised over the Observers as to their instruments and registers?	That it is necessary that all instruments used should be compared with standard instruments, either at the central or the filial institutions (if such exist), before and after the voyage; and that the corrections and date, &c., of the comparison should be entered in the log.
Is it desirable that all instruments employed should be the property of the central establishment, and *lent* to the observers?	That it is desirable that the instruments should be the property of the central office. That it is necessary that a careful examination should be made into the quality of the observations recorded, and that the attention of the observers should be specially directed to any errors which may have been detected.

V.—Co-operation of the Royal Navy.

To what extent can ships of war assist in forwarding the ends of meteorological inquiry?	The Royal Navy can furnish more complete observations than are possible on board merchant ships, as, *e.g.*, Deep-sea soundings and temperatures. Observations in unfrequented parts of the sea. Special experiments. It is most desirable that the duty of observing should be intrusted to some responsible Officer. It is therefore resolved that the Authorities of the Navies shall be requested to continue to give such assistance to the prosecution of meteorological science as circumstances shall permit.

A Report was handed in which had been drawn up by a number of the members who were in the Naval Services of some of the countries represented, and it was decided that the following resolutions which it contained should be adopted in lieu of those given above:—

1. "It is very important that the organisation of meteorological inquiry as regards the Navies of all countries should be arranged in accordance with the principles and stipulations laid down by the Conference for Marine Meteorology generally; and it is further important that the results of all observations made on board ships of war in any country should be rendered accessible for discussion by the central station for maritime meteorology in that country without prejudice to any subsequent publication by the respective Naval Authorities."

2. "The Conference, while admitting that the introduction of measures calculated to improve the condition of meteorological inquiries in the Navy must be left to the Authorities of the respective Navies, is nevertheless of opinion that all care should be taken to secure uniformity as to mode of observation, and especially to provide for the comparison of all instruments used with the respective standard instruments of the Central Institutes."

3. "The Conference considers it to be its duty to request that those entrusted with the management of scientific affairs on board men of war will lend their strenuous support in securing from the Naval Authorities in each country such regulations as will place meteorological inquiry on board such ships in as favourable a position as may be deemed consistent with the execution of the ordinary duties of the Service, and will also induce the commanders to render to such inquiries all the assistance and furtherance in their power. The Conference, knowing that such regulations must be framed according to the requirements of each country, expresses, nevertheless, its opinion that, inasmuch as meteorological observations require considerable experience, they should be entrusted to experienced Officers on board suitable vessels."

4. "Although the Conference is of opinion that, as far as the general scope of meteorological inquiry goes, the same form of register should be supplied to merchant ships as to men of war, it declares it will be most desirable that, besides the regular observations, a more extended scale for scientific inquiry should be adopted on board ships of war, as in such cases there is a large number of suitable officers, as well as more means for carrying on the service. As examples of observations which are of importance for the development of Maritime Meteorology, over and above the regulations embodied in the scientific instructions given to Naval expeditions for the special purpose of the advancement of science, the following suggestions may be enumerated :—

(*a*) "Possibility of carrying out accurate observations on the velocity of the wind by anemometers at sea.

(*b*) "Possibility of employing rain-gauges satisfactorily at sea.

(*c*) "Observations with Regnault's and other hygrometers, and experiments on the best mode of observing wet and dry thermometers, and the best position to place them in on board ship.

(*d*) "Currents at the surface and at depths to be observed with great minuteness, with the special object of defining their limits.

(*e*) "The comparison of various instruments, among which are expressly mentioned that of aneroids with mercurial barometers. It is further deemed very desirable that frequent comparisons should be instituted between the instruments used at sea and meteorological stations on shore in various countries.

(*f*) "Deep-sea soundings and temperatures, with specimens of water.

(*g*) "The collecting of information on Ocean Meteorology at outlying stations.

(*h*) The furnishing of synchronous observations at 0h. 43m. G. M. T., in accordance with the suggestion and request of the United States Signal Office."

VI.—DISCUSSION.

Can general suggestions be thrown out as to the most profitable mode of discussing the observations?	That it is desirable that every Institution should publish the observations and results in such a manner that every foreign institute can incorporate them with its own observations and results in the easiest way possible; that is, by preserving the number of observations, together with any means derived from them, for single square degrees. That it is further desirable that, whatever charts be published, the results for single square degrees should be published in a tabular form. That it seems desirable for the use of the sailor that each chart should have reference to only one element, or, at least, only to elements closely related to each other.

VII.—SUBJECTS OF INQUIRY.

To what extent can a division of labour, as regards subjects of inquiry, be carried out in a spirit of fairness to the collecting and discussing establishments respectively?	That the division of labour, as regards investigations, can only be carried out by mutual agreement between the several institutions; and each institution should announce to other institutions what investigations it proposes to undertake. It is very desirable that such divisions of labour should be effected.

VIII.—SAILING DIRECTIONS.

In how far are purely practical investigations, such as the preparation of sailing directions, admissible for a scientific institution?	That the sailor wants the result of experience alone, and he must receive assurance that his observations have been turned to use. When these results of experience have been given, the theorist may point out the reason why certain routes are the best.

It was resolved, that Capt. Toynbee's remarks on the programme should be printed in full, with extracts from the remarks of other gentlemen, should they contain important suggestions.

THE BRITISH ASSOCIATION

REPORTS

Report of the Committee on Luminous Meteors, by Mr. Glaisher.—The appearance of meteors noticed in published journals, and otherwise ascertained by the committee during the past year, include some striking examples of such remarkable exhibitions, discussed and investigated very ably by astronomers, as well as of others passing almost unobserved excepting by accidental gazers. A few such large meteors were doubly observed in England. Some have been visible in the day-time, while many other large and small fire-balls have been described to the committee, of which it is to be regretted that notices have hitherto only reached them from single observers. The months in which these phenomena have been most abundant were September, December, and January last, April, June, and again quite recently, the last few days of July and beginning of August of this year. The report contains descriptions of the brightest of these meteors, and an account of Prof. Galle's calculations and inquiries regarding the real cause of two large meteors which passed over Austria on the 12th and 19th of June last, with the probable path that he assigned to them. If a mass of burning sulphur found on the ground immediately after the disappearance of the latter meteor is not considered presumably meteoric, no occurrence of a fall of aërolites, as far as the committee is aware, has taken place during the past year.

The annual star-showers have been watched for with the usual attention of observers in correspondence with the committee; and the results of their combined observations are described, with accounts of some other occasional star-showers, at some length in the descriptive part of the report. Although little important information was thus added this year to our present well-known star-showers of January, April, and October, and the cometary meteor showers of November 14 and 27, connected with Tempel's and with Biela's comet, all of which, in spite of very favourable weather for their observations, were this year most remarkable by their non-appearance; yet the fluctuating intensities of these showers at their successive periodic dates are an important element to record; and in the case of the star-showers of August 10 and December 12 of the past year, the watch was at least attended with more positive success. Duplicate observations of meteors were obtained in them, and the general centre of divergence of each of these two meteor-currents was pretty exactly ascertained. Bright meteors were more frequent on each of these two nights than is at all usual in ordinary exhibitions of those showers. It will be found among these observations that the return of Biela's meteor-shower on the 27th of November last disappointed expectation, and the small extent and rapid departure of that meteor-cloud from the earth's neighbourhood is clearly shown by its visibility as a star-shower only for a single year.

The duplicate observations described in former reports have been reduced at the request of the committee by Mr. T. H. Waller, whose report of these calculations is added, and whose conclusions of their real heights and velocities are without doubt very accurate and complete.

The publication of Capt. Tupman's observations of shooting stars in the Mediterranean during the years 1869-71, with the list of radiant points obtained from them and shown on a pair of charts accompanying them by Capt. Tupman, is now brought to a close, and the catalogue and charts have been sent to astronomers and correspondents of the committee in England and abroad, and in America, and discussions of these in foreign scientific journals have appeared, showing the important light in which the appearance of this valuable new meteor catalogue has been regarded. Its principal part, the comparative catalogue of his meteor-showers with those of other observers, and the charts on which they are projected, are presented in this report, with Dr. Schmidt's similar catalogue (the remaining two principal meteor-shower lists, of which no account has yet appeared in these reports), thus placing before readers of recent volumes of these reports all the material contributions to this branch of meteoric astronomy that have yet been made.

They are summed up in a very concise catalogue at the end of this report by Mr. Greg, who has selected, to corroborate such observations already published in his former lists, the greater

part of Dr. Schmidt's and Capt. Tupman's observations, and has included them with his own former collection, thus forming a very extended catalogue founded on all the similar work of his contemporaries and predecessors, and omitting but few genuine meteoric showers, chiefly in the southern hemisphere, which have only been observed by Dr. Neumayer in Australia.

Following the method of Dr. Weiss, viz. to calculate the radiant points of those comets of early and recent times whose orbits are believed to pass near the earth, a list of such comets for both the northern and southern hemispheres is annexed to Mr. Greg's catalogue, and the cases where they corroborate each other are pointed out. Many important and well-known comets are found to have meteor-showers as their present representatives, as would, perhaps, be still more apparent if more reliable orbits of comets could be used; but the coincidences are, however, numerous enough and sufficiently exact to render desirable the further cultivation of cometary astronomy by the help of star-shower observations.

Report on Isomeric Cresols, by Dr. Armstrong.—Little has been done by the committee during the past year. *Para* and *ortho* cresols have been obtained from ordinary cresylic acid, but it has not been with certainty determined whether the *meta* cresol is likewise present, or whether these are the sole constituents of this substance.

Report of the Committee for the Utilisation of Sewage, by Prof. Corfield.—The committee has been unable, from want of funds, to carry on the quantitative experiments as they would have wished. Of the total nitrogen supplied to the farms during the year March 25, 1873, to March 24, 1874, 37·7 per cent. was recovered in the crops, during the preceding year 41·7 per cent. was recovered, while during the first year of the experiments the nitrogen recovered amounted to 26 per cent. The committee will be enabled, through the liberality of a gentleman, to carry on their investigations during another year.

SECTIONAL PROCEEDINGS

SECTION A—MATHEMATICS

On the Construction of a perfectly Achromatic Telescope, by Prof. G. G. Stokes.

At the meeting of the Association in Edinburgh, in 1871, it was stated that it was in contemplation actually to construct a telescope by means of discs of glass prepared by the late Mr. Vernon Harcourt, which should be achromatic as to secondary as well as to primary dispersion. This intention was subsequently carried out; and the telescope, which was constructed by Mr. Howard Grubb, was now exhibited to the Section. The original intention was to construct the objective of a phosphatic glass containing a suitable percentage of titanic acid, achromatised by a glass of terborate of lead. The percentage of titanic acid was so chosen that there should be no irrationality of dispersion between the titanic glass and the terborate. As the curvature of the convex lens would be rather severe if the whole convex power were thrown into a single lens, it was intended to use two lenses of this glass, one in front and one behind, with the concave terborate of lead placed between them. It was found that provided not more than about one-third of the convex power were thrown behind, the adjacent surfaces might be made to fit, consistently with the condition of destroying the spherical as well as the chromatic aberration. This would render it possible to cement the glasses, and thereby protect the terborate, which was rather liable to tarnish. At the time of Mr. Harcourt's death two discs of the titanic glass had been prepared, which it was hoped would be good enough for employment, as also two discs of terborate. These were placed in Mr. Grubb's hands. On polishing, one of the titanic discs was found to be too badly striated to be employed; the other was pretty fair. As it would have required a rather severe curvature of the first surface and an unusual convexity of the last to throw the whole convex power into the first lens, using a mere shell of crown glass behind to protect the terborate, Prof. Stokes thought it more prudent to throw about one-sixth of the whole convex power into the third or crown-glass lens, though at the sacrifice of an *absolute* destruction of secondary dispersion, which by this change from the original design might be expected to be just barely perceptible. Of the terborate discs, the least striated happened to be *slightly* muddy from some accident in the preparation; but as this signified less than the striæ, Mr. Grubb deemed it better to employ this disc. The telescope exhibited to the meeting was of about $2\frac{1}{2}$ in. aperture, and 28 in. focal length, and was provided with an objective of the ordinary kind, by which the other could be replaced, for contrasting the performance. When the telescope was turned on to a chimney seen against the sky and half the object-glass covered, in the case of the ordinary objective, vivid green and purple were seen about the two edges, whereas with the Harcourt objective there was barely any perceptible colour. It was not, of course, to be expected that the performance of the telescope should be good, on account of the difficulty of preparing glass free from striæ, but it proved to be quite sufficient to show the possibility of destroying the secondary colour, which was the object of the construction.

On Cyclone and Rainfall Periodicity in connection with the Sunspot Periodicity, by Charles Meldrum.

The catalogue of cyclones experienced in the Indian Ocean, from 1847 to 1873, submitted last year, indicated that during this period the number of cyclones in the space between the equator and 34° S. lat. and the meridians of 40° E. and 110° E. are much greater in the years of maximum than in the years of minimum sunspot frequency.

It will now, and in subsequent reports, be shown that not only the number of cyclones, but their duration, extent, and energy, were also much greater in the former than in the latter years, and that there is a strong probability that this cyclonic fluctuation has been coincident with a similar fluctuation of the rainfall over the globe generally.

The present communication is confined to the twelve years 1856-67, comprising a complete sunspot cycle.

With regard to the cyclones of the Indian Ocean, the investigation is based upon the extensive collection of observations made by the Meteorological Society of Mauritius on the assumption that the observations are so numerous that no cyclone of any considerable extent or violence can have escaped detection.

A chart has been prepared for noon on each day of the period during which a cyclone lasted. The chart shows the positions of the vessels, the directions and force of the wind, the state of the weather and sea, &c. In this way the position of the centre of the cyclone is ascertained for each day; then, by examining the several charts, the duration, extent, &c. of the cyclone are determined.

The number of cyclones thus examined for the twelve years is 113, and their tracks have been laid down on six charts.

The total cyclonic area in 1860 and 1861 was about twelve times greater than in 1856 and 1857, and nearly eight times greater than in 1867; in short, all the factors were greater in the years of maximum sunspot frequency. It is evident from the table that the cyclonic area increased rapidly from 1858 to 1860, and diminished slowly from 1861 to 1866. The registers for the years 1856, 1857, 1866, and 1867 have been examined with special care in order that nothing might be omitted; and, to give the utmost possible weight to those years, every instance of even an ordinary gale has been taken into account. In 1856 there was no great hurricane at all, and the same may be said of 1857, 1866, and 1867. From the chart for 1866 it will be seen that in April of that year there was a number of small cyclones. The south-east trade-winds and north-west monsoon were in collision for a considerable time, and several cyclonic eddies of short duration were formed.

If we could obtain good values of the mass of air in motion and the velocity of the wind, it would probably be found that the ratios of cyclonic energy were greater than those of cyclonic area, for in the maxima years the cyclones were much more violent than in the minima years. Assuming the mass to be nearly proportional to the area, and the velocity of the wind in a strong gale to be 55 miles, in a whole gale 70 miles, and in a hurricane 85 miles an hour, the amount of cyclonic energy in 1860 was about eighteen times greater than in 1856, the squares of the velocities being as three to five.

Although the results are necessarily rough approximations, yet the fact that the number and violence of the cyclones of years of maximum sunspot were far greater than in the years of minimum sunspot is beyond all doubt.

When a great hurricane takes place in the Indian Ocean, the disabled ships are obliged to put into the nearest port, and the newspapers in their shipping intelligence announce the arrival of the vessels, the dates and localities of the bad weather, and the amount of damage sustained. For upwards of twenty years the *Commercial Gazette* of Port Louis has published all arrivals of vessels and all maritime events which have been reported by them. Considering, then, the geographical position of Mauritius,

a cyclone periodicity, if one exists, should be traceable in the shipping intelligence. Now, from Table II., which gives the published reports for 1856, 1860, and 1867, it will be seen that the number of storms and the damage sustained in 1856 and 1867 were insignificant compared with the long list of hurricanes and disasters in 1860.

Table III. gives as complete a list of hurricanes and storms experienced in Mauritius as I have hitherto been enabled to prepare. The list comprises only such storms as from the violence of the wind committed considerable damage.

Table IV., which contains a list of Bourbon (Réunion) hurricanes and gales from 1733 to 1754, shows also the number of hurricanes that occurred in the maximum and minimum sunspot years.

For the two islands the number of cyclones in the maxima years was thirty-six, and for the minima years nineteen. This result is favourable.

It would appear also from M. Poey's researches, and from investigations made at Mauritius in 1872, that the cyclones of the West Indies are upon the whole subject to the same periodicity. The rainfall for the twelve years under discussion is given in Tables V. to IX. It thence appears from the rainfall at sixty-seven stations that the maximum fall was in the years 1859 to 1862, and the minimum in the years 1857, 1858, and 1864. We thus find a certain degree of correspondence between the cyclone and rainfall fluctuations; and it is possible that if we had returns from America the correspondence would be much greater; for it would appear from researches by Mr. G. M. Dawson, that the level of the American great lakes was considerably less in 1867–68 than in 1859–61. (The year 1867 has been almost the only exception to the rule in Europe since the commencement of the century, and as most of the stations are in that part of the world the results for 1856 and 1857 are not so favourable as for previous cycles).

A large number of additional rainfall returns has been received from Europe and other parts of the world, and the results, which will be communicated in another report, afford fresh evidence of a rainfall periodicity.

(The paper was accompanied by several elaborate tables).

SECTION B—Chemical Science

On some Opium Derivatives, by Dr. C. R. A. Wright.—The action of free chlorine on codeine is to produce higher polymerides, especially tricodeine, from which again, by the action of hydrochloric acid, apocodeine is formed. This apocodeine may be looked on as three molecules of codeine *minus* six molecules of water. Narceine is feebly basic, but it has a strong attraction for hydrochloric acid, giving rise to the crystallisable hydrochloride $C_{23}H_{29}NO_9 + HCl$. If the salt is dissolved in boiling water, crystals are obtained containing six molecules of $C_{23}H_{29}NO_9$ plus one molecule of HCl. Basic chlorides, probably not definite compounds, have also been obtained. With excess of hydrochloric acid at 100° the elements of water are removed from narceine, and we get $C_{23}H_{27}NO_8$. The hydrochloride of this base is non-crystallisable. By the action of glacial acetic acid on codeine there is produced diacetyl codeine, $C_{36}H_{40}2(C_2H_3O)N_2O_6$. Acetic acid acts in a similar way on morphine, a considerable quantity of triacetyl morphine being also produced. Acetic anhydride gives rise to the formation of an isomeric diacetyl morphine. We have, therefore,—

α diacetyl morphine . . . crystallisable
and β ,, ,, ... non-crystallisable.

Butyric and benzoic acids give analogous compounds; so also do acetic acid and strychnine. The following general formulæ for the morphine and codeine salts are given:—

$$M + n HX - n H_2O,$$
$$C + n HX - n H_2O,$$

when HX = a monobasic acid.

On a Phenomenon noticed on boring a Well, by Dr. Andrews.—The author described a remarkable jet of almost pure marsh-gas, obtained on boring a well near Belfast. The borings first descended through about 33 ft. of silt, and then reached a gravelly deposit 7 ft. in thickness, interspersed with organic *débris*. It was from this deposit that the marsh-gas was evolved.

Reaction of Hydrogen, Peroxide, &c., by Mr. Fairley.—The author believes that he has succeeded in preparing hypochlorous acid according to the equation $H_2O_2 + Cl_2 = 2HClO$. By the action of hydrogen peroxide on bleaching powder, and on other hypochlorites, oxygen is evolved; thus, with potassium hypochlorite, $KClO + H_2O_2 = KCl + H_2O + O_2$. Chloric acid has no action on hydrogen peroxide; neither has sulphuretted hydrogen in the absence of air. By the action of ozone on hypochlorous acid there seems to be produced perchloric acid.

On the General Equations of Chemical Decomposition, by Prof. Clifford, F.R.S.—This paper was also read before Section A. The author thinks that chemical equations may be brought under a general formula. Thus, $H_2 + Cl_2 = 2HCl$. If we assume that there is a structure common to the hydrogen and the chlorine atoms, also a structure confined to the hydrogen and likewise a structure confined to the chlorine atoms, we may represent this equation thus: $XYY + XZZ = 2XYZ$, when X represents the common structure and Y and Z the structures which are confined to hydrogen and chlorine respectively. So $2H_2 + O_2 = 2H_2O$ may be represented thus: $2XY + XXZZ = 2XXYZ$. These equations involve no hypotheses, because the fundamental facts of the molecular theory are now firmly established. Reasoning from these and similar equations, the author deduces the result that the ordinary equations of chemistry, such as those just stated, are expressive of facts, and that the hydrogen molecule really consists of two equal atoms.

On the presence of Cyanogen in Commercial Bromine, and a means of detecting it, by Dr. T. L. Phipson.—The author states that commercial bromine often contains cyanogen; by adding an equal weight of iron filings and four to five times its weight of water to the bromine, stirring, filtering, and allowing the filtrate to remain for twenty-four hours in a closed bottle, a precipitate of *Prussian blue* is thrown down if cyanogen is present.

On a Sesqui-sulphide of Iron, by Dr. Phipson.—The author describes a greenish black salt having the composition Fe_2S_3. This salt is produced by precipitating a ferric salt by means of ammonium sulphide in the presence of a free chlorite or hypochlorite. The salt is soluble in hot water, also in ammonia, giving an emerald green liquid.

On the Chlor-Bromides and Brom-Iodides of the Olefines, by Prof. Maxwell Simpson, F.R.S.—The author described various substances obtained by acting on ethylene, &c., with iodine chloride, with bromine chloride, with bromine iodide, &c. In the case of ethylene the substance C_2H_4BrI, C_2H_4ClI, and C_2H_4ClBr, were described. These bodies may also be obtained by agitating the chloride bromide or iodide of ethylene with a solution of iodine or bromine chloride: thus, $C_2H_4Br_2 + BrI = C_2H_4BrI + Br_2$. The reaction $C_2H_4Cy_2 + BrCy = C_2H_4CyBr + Cy_2$ would not take place; indeed, the author was totally unable to prepare the brom- or iodide cyanide corresponding to the salts just mentioned.

On an Aspirator, by Dr. Andrews, F.R.S., and *On another form of Aspirator*, by Prof. Delffs, could not well be understood without drawings.

SECTION C—Geology

The Geological Structure of the Tyrone Coal-field.—Mr. Hardman, after describing the position of these beds, remarked that the carboniferous rocks of this district appear to resemble somewhat those of the northern counties of England. The coal-bearing beds are true coal measures. The underlying limestone is split up by numerous sedimentary beds, and, on the whole, agrees with the Ballycastle coal-field, which beds Prof. Hull assigns to the same horizon with those of the Scotch coal measures. The author referred in detail to the thickness and position of the beds. With reference to the Dungannon coal-field, which extends from near Dungannon to beyond Coalisland, he remarked that though small in area it was rich in coal seams, possessing twenty-four coal-beds, of which at least thirteen were workable. They are highly bituminous, and two of the beds contain valuable seams of cannel coal. The chemical analyses show that these coals are valuable, possessing from 37·5 to 47 per cent. of volatile matter for gas manufacture. In the upper measures we have valuable deposits of fire-clay, which are extensively used for the manufacture of bricks and tiles. The ironstones are not sufficiently abundant to be worked, yet they yield as much as 21·7 to 35·5 per cent. of metallic iron. There must be from 30,000,000 to 40,000,000 tons of coal yet untouched. If we count the smaller beds we shall have at least 9,000,000 more. The coal-field is bounded on the north-west by a large fault, which brings down the coal measures on the south against the calp and lower limestone. It must have a downward throw of 2,000 feet. Northwards, the limestone is covered by trias,

without any intervening coal measures, for three-and-a-half miles, when a small trough of the middle coal measures, with four of the upper Coalisland beds, rise up. This field is but two-and-a-half miles long, and a quarter wide, and yet it must contain the whole series of the middle and lower coal measures, the millstone grit and Yoredale beds. Here, the author calculates, there are 800,000 tons of coal. The author proceeded to explain when and how the two coal-fields became isolated from each other; and why, in the immediate vicinity of these coal measures, the Permian rocks are found reposing directly on the limestone. At the close of the carboniferous period the rocks were forced into flexures, ranging east and west, owing to forces acting from the northwards, as Prof. Hull shows acted in England. Denudation following, we had a set of plains, or edges of limestone, and troughs of coal measures, all of which were overlapped by the Permian and Trias. On subsequent denudation and post-triassic faults occurring, some portions of the coal measures would be laid bare or saved beneath the newer formations. As the whole district is cut up by faults, and the rock exposures few, the evidences of these flexures are obscure.

———

SECTION D—BIOLOGY

DEPARTMENT OF ZOOLOGY AND BOTANY

Dr. Williams read a paper *On Specimens of Algæ from Jersey.* The paper referred to the large number of species of marine algæ to be found at Jersey, and to the favourable position of the island for their development. Dr. Williams produced a splendid collection of algæ preserved by a lady residing in Dublin.

Prof. Lawson read a paper *On certain peculiarities in the Indian Ampelidæ.* He remarked that many of the species were climbers, with their branches interlacing in the tops of the highest trees. In the stems of all were to be found numerous very large ducts, and these ducts were filled with intra-cellular vesicles, in which, at a certain time of year, abundance of starch was developed. He also remarked that in the fruit most important differences might be found, but that these afforded no means by which to divide the genus into natural sections. With respect to the inflorescence, he said there was great variety of form. Two species only reached the eastern coast of Africa, most being confined to India, though some few were common throughout the Malayan Archipelago.

On the Growth of Tree-ferns, by D. Moore.—The general conclusions arrived at in this paper were (1) Some of the kinds of tree-ferns grow with greater rapidity and form their stems in a much shorter period than is generally supposed to be the case; (2) After they attain a certain height the acrogenous buds are formed much closer together, one above the other, than they are lower down on the stem; hence their elongation is much slower; (3) Some of the sorts which at first form short rhizomatous stems before they take an upright position require a considerable number of years to perfect the early parts, but after the stem has been formed and an upright position taken, the growth is much quicker and the elongation advances rather rapidly compared with it, while the stem remains in a rhizomatous state.

Mosses of the North of Ireland, by S. A. Stewart.—Turner, in 1804, enumerated as Irish 230 species of mosses; Dr. Taylor, in 1836, mentions about the same number; and Dr. D. Moore, in 1872, gives a list of 385 Irish species, to which the author of the present paper adds four others, viz., 389, or more than two-thirds of the British mosses. Thus, relatively to the British Flora, Ireland has quite as large a proportion of mosses as she has of flowering plants, proving that Irish muscology has not been neglected. No separate lists of the mosses occurring in the northern counties have been published; but after consulting the records of Dr. Taylor in the "Flora Hibernica," and the valuable list of Irish mosses by Dr. Moore, also some detached papers on the subject, the author ascertains that the number of species occurring in the district amounts to 195, or more than one-half of the Irish mosses. The district is defined to consist of the counties of Down and Antrim, with a small portion of Co. Derry, bordering on Antrim. The list includes a large number of rare mosses. The following have not been previously recorded as Irish, viz.:—*Fissidens incurvis* Schw. var. *Lylei*, found only on a greensand rock on the Black Mountain, near Belfast; *Tayloria serrata*, in small quantity, near the summit of Benbradagh Mountain, Co. Derry: *Mnium subglobosum*, in wet peat bog on Cave Hill, near Belfast, and in a similar habitat on Carrickfergus Common; *Seligeria calcarea*, on Black Mountain, near Belfast, appearing like black specks on small lumps of chalk in the grass. Mr. C. P. Hobkirk, of Huddersfield, has been kind enough to identify the specimens of the above-named mosses.

Prof. Dickson exhibited specimens of an abnormal form of the ox-eye daisy (*Chrysanthemum leucanthemum*), in which the outer florets of the ray (normally ligulate and female) exhibit an irregularly tubular corolla, not very unlike that in the neuter florets in certain Centaureas. Structurally these abnormal florets are hermaphrodite, but appear always to be functionally neuter or sterile.

Mr. Bentham remarked that similarly abnormal tubular florets, structurally hermaphrodite, and functionally neuter, occur in certain varieties of *Chrysanthemum indicum* and *Dahlia*.

Mr. G. Bentham, F.R.S. read a report *On the recent progress and present state of Systematic Botany*, commencing with a summary sketch of the state of science in 1830, when the natural method of Jussieu was beginning to supersede the sexual system of Linnæus; of its progress from that year to 1859, when the study of the general affinities of plants had entirely superseded the classing them according to single organs; and of the great advance effected since 1859, owing to the explanation of affinities given by the adoption of the doctrine of evolution. After some notes on the language to be preferred, systematic works were then considered under the six several heads of *Ordines plantarum*, *Genera plantarum*, *Species plantarum*, Monographs, Floras, and miscellaneous descriptions. Under each head the particulars required were specified, the principal recent works glanced over, with a short mention of the chief desiderata now recommended to the attention of systematic botanists.

Prot. Thiselton Dyer referred to the paper as evidencing the labour necessary to acquire a proficiency in the knowledge of botany. Some people thought botanical study was a kind of pastime, but the paper just read proved the contrary.

Sir John Lubbock believed that *mutatis mutandis* a great deal of what Mr. Bentham said with regard to systematic botany would apply equally to zoology.

Prof. Dickson gave the results of his investigations on the embryogeny of *Tropæolum peregrinum* and *Tropæolum speciosum.* In these species the principal peculiarity consists in the constant penetration of the carpellary tissue by the extra-seminal root-process. In *Tropæolum majus* the extra-seminal root-process developed from the outer side of the base of the suspensor. After perforating the seed-coat it becomes elongated, and finishes its course in the cavity of the seed-vessel. In rare cases, however, this process has been found to penetrate by its very extremity the carpellary tissue. In *Tropæolum peregrinum* the extra-seminal process penetrates the carpel after having run in the cavity of the seed-vessel half-way. In *Tropæolum speciosum* this process dips into the carpel immediately after emerging from the seed. Dr. Dickson remarked that some would be disposed to look upon the abnormality in *Tropæolum majus* and the normal form in *Tropæolum peregrinum* as forms representing what might be viewed as stages in the evolution of such a species as *Tropæolum speciosum* from some form analogous to *Tropæolum majus*. In regard to this, Dr. Dickson adversely criticised the Darwinian hypothesis, as, in his opinion, inapplicable to the case under consideration.

Mr. A. W. Bennett read a paper *On the form of pollen-grains in reference to the fertilisation of flowers.* He stated that although not unfrequently a common form of pollen-grain runs through a whole group of plants, yet more often the form is found to be adapted to the requirements of the species, and varies even within a small circle of affinity. In those plants which are fertilised by the agency of insects, there are three general modes in which the form of the grain is adapted for the purpose. We have, firstly—and this is by far the most common form—an elliptical grain, with three or more longitudinal furrows, as in *Ranunculus ficaria*, *Aucuba japonica*, and *Bryonia dioica*; secondly, spherical or elliptical, and covered with spines, as in many Compositæ, Malvaceæ, and Cucurbitaceæ; and, thirdly, where they are attached together by threads or a viscid excretion, as in *Richardia Æthiopica.* In those plants, on the contrary, which are fertilised by the agency of the wind, as most grasses, the hazel, and *Populus balsamifera*, the pollen is almost perfectly spherical and unfurnished with any furrows, and is generally, moreover, very light and dry. The genus Viola supplies two very markedly different forms, in one of which, the section to which *V. canina* and *V. odorata* belong, the grains have the ordinary elliptical

three-furrowed form, and where every point of the structure of the style and stigma is favourable to fertilisation by bees; the other, the section to which *V. tricolor* belongs, where they are very much larger and either pentagonal or hexagonal, and the style and stigma are adapted for fertilisation by Thrips. In all Crucifers hitherto known the pollen has the most common form. *Pringlea antiscorbutica*, the "Kerguelen's Land cabbage," has been shown by Dr. Hooker to be wind-fertilised, from the following considerations: the absence of petals, the absence of honey-glands, the exserted style, and the stigma being covered with long papillæ. The form of the pollen supports the same view, being very small and perfectly spherical, extremely different therefore from every other plant of the order. In the cowslip and primrose there is a uniform difference in size between the pollen belonging to the two dimorphic forms, that of the short-styled being always considerably larger than that of the long-styled form. An interesting discussion followed, in which Dr. Hooker, Prof. Dickson, Sir J. Lubbock, Prof. Balfour, and Mr. W. E. Hart took part.

SCIENTIFIC SERIALS

Memorie della Società degli Spettroscopisti Italiani, June.—This number contains a very interesting account of the theories of the cause of formation of comets' tails, by Schiaparelli. The author seems to have no doubt that a repulsive force is in action, and that the only two acceptable theories are that the force is due to electricity or the repulsive power of the sun's heat.—Tacchini contributes a note on the polarisation of the zodiacal light, in which he corroborates Wright's observations of polarisation, and the presence of reflected sunlight. He also adds position observations of Coggia's comet in June.—Prof. Lorenzoni contributes a paper On some theoretical researches for a manner of rendering the whole of the solar chromosphere visible at once.

Bulletin de l'Académie Royale de Belgique, tome 37, No. 6.—This number contains an article by M. P. I. Van Beneden, On the whales of New Zealand. He refers to the fact that Dr. Gray of the British Museum has recognised three species in the New Zealand district, *Neobalæna marginata*, *Caperea antipodium*, and *Macleayius australiensis*, and urges that among the right whales there should be but one genus, *Balæna*. Those genera were established on imperfect data, and now that we have more material, several supposed diagnostics are found not to exist, and those that are established are of no great importance. As regards the skeleton at the Museum at Paris, studied by Prof. Lilljeborg, being without the ear-bone, that had been removed to be figured, and had not at the time been replaced. It is reported, however, as safe. Dr. Gray, believing that Van Beneden's drawing of the ear-bone was from some other source, erected it into a new genus.—MM. Cornet and Briart draw attention to some little known beds of phosphate of lime in the cretaceous beds of Hainault, and urge their being worked commercially.—M. Gluge gives a short note on tonic muscular contraction being converted into rhythmic contraction. His observations were on the sphincter ani muscles of rabbits, and he refers to similar experiments by M. Goltz on a dog. He believes that such experiments may lead to the explanation of the rhythmic contraction of the heart.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, Sept. 14.—M. Bertrand in the chair.—The following papers were read:—Science before grammar, by M. E. Chevreul. A considerable portion of the paper (which is but an abstract of a more lengthy memoir) is devoted to a discussion of the word "*fact*." The author also draws a parallel between psychic and chemical analysis, the former separating simple ideas perceptible by the mind, and the latter ponderable simple substances perceptible by the senses. The difference between the moral and political sciences and the sciences of the domain of natural philosophy is pointed out, and in an appendix the author states his reasons for dissenting from scepticism and materialism.—On a particular toxic action exercised at a distance by *Colchicum autumnale* at the time of flowering; extract from a letter from M. Is. Pierre to M. Dumas. The hand, when held near the anthers of the flowers without coming into actual contact with them, changes in a few seconds to a livid greenish-yellow colour. The natural colour returns about ten seconds after the removal of the hand. The author believes that this remarkable action is chiefly exerted during or near the period of fertilisation, and proposes to examine further the nature of the substance emitted.—New conditions for the production of the silent electrical discharge; its influence on chemical reactions; by M. A. Boillot. The author concludes, from his experiments, that the space traversed by the silent discharge can be considerably augmented without a diminution in the chemical effects produced.—On some tungsten minerals from Meymac (Corrèze), fourth note, by M. Ad. Carnot. The minerals now described are wolfram (containing $FeWO_4$ and $MnWO_4$) calcareous scheelite (containing $CaWO_4$), and hydrated tunstic acid, to which the author assigns the formula $2WO_3, 5HO$, or $WO_3, 2HO$ (old notation).—On the supposed migration of winged *Phylloxera* to *Quercus coccifera*, by M. Balbiani. The author states his belief that the species seen by M. Lichtenstein on this tree is not identical with *Phylloxera vastatrix*. The following species of *Phylloxera* are recognised in addition to *vastatrix*:—*P. quercus*, especially inhabiting *Quercus pedunculata*, and *P. coccina*, inhabiting *Q. robur*. The species found by M. Lichtenstein on *Q. coccifera* it is proposed to name *P. lichtensteinii*.—Experiments on the employment of alkaline sulpho-carbonates for the destruction of *Phylloxera*; a letter from M. Mouillefer to M. Dumas.—On new points attacked by *Phylloxera* in Beaujolais; a letter from M. Rommier.—On the actual state of the invasion of *Phylloxera* in the Charente provinces; extract from a letter from M. Maurice Girard.—Employment of the water used in purifying gas for the destruction of *Phylloxera*; a letter from M. G. Beaume.—Note on the action exercised by the soil of vine fields on sulphuretted gases, and memoir On the propagation of *Phylloxera*, by M. Cauvy.—Other communications were received on the same subject from various authors, and M. Dumas gave a *résumé* of M. Balbiani's observations, and stated that in future the sending of living specimens of the insect to Paris would be interdicted.—The Minister of Foreign Affairs forwarded to the Academy a communication from the French Consul at Messina, relating to the opening of new vents of eruption in Etna, and on some earthquakes felt at Messina.—On a transformation of the equations of celestial mechanics, by M. Allégret.—On the causes which modify the setting of plaster, new cements with plaster and lime bases, by M. Ed. Landriu.—Action of heat on phenylxylene, by M. P. Barbier. The products are anthracene, benzene, and xylene, produced thus—

$$2C_{14}H_{14} = C_{14}H_{10} + C_6H_6 + C_8H_{10} + H_2.$$

—On a case of decomposition of chloral hydrate, by M. Tauret. By the slow oxidation of this substance, carbonic oxide is liberated. The author thinks this furnishes a new explanation of the action of chloral upon the system, and accounts for the accidents occasionally resulting from its use.—On the development of red vapours during the boiling of saccharine juices in manufacture, by M. E. J. Maumené. The author attributes these to the action of nitrates. On the *rôle* played by gas in the coagulation of the blood, by MM. E. Matthieu and V. Urbain.—Synthesis of purpurine, by M. F. de Lalande. This was effected by the action of oxidising agents on pure alizarine.—During the meeting, a communication was read from his Majesty the Emperor of Brazil, offering his thanks to the Academy for adding a young Brazilian astronomer to one of the Transit of Venus expeditions.

CONTENTS

THURSDAY, OCTOBER 1, 1874

HINTS ON MEDICAL STUDIES

FEW of those who to-day commence their medical education will be able fully to realise what would have been their position if they had done the same some fifty years or more ago, instead of now. After an apprenticeship of from three to five years to a country practitioner, during which time, at the expense of their general education, they would have been employed in dispensing medicines, and other less honourable duties, they would have entered on their medical studies, properly so called, possessing a certain empirical acquaintance with a few of the details of professional life, which might however, have been obtained in an infinitely shorter time after the principles of the subject had been mastered.

This state of things is fortunately past. The pupil now leaves school, having had a more liberal general training, conducted mostly during the time which used to be wasted in apprenticeship, and after being tested by a commencing examination in Latin, arithmetic, &c., he immediately begins his special studies at a recognised college and hospital. At the outset several questions respecting the direction that his work has to take, suggest themselves, which are only partially answered in the calendars of the different examining bodies, and on which there is considerable diversity of opinion amongst teachers and the profession generally. One of the most important of these refers to the question whether or not it is advisable to commence clinical work at once, or to wait until some knowledge of anatomy and physiology has been obtained. As the medical education consists of two parts, a theoretical and a practical, one conducted in the lecture-theatre and the dissecting-room, the other in the wards, out-patient department, and post-mortem theatre of the hospital: is it wise to pursue these two independent courses simultaneously, and if not, which should have the preference? This question is not difficult to answer, for it is evident that attendance in the wards of the hospital during the first medical session must very much resemble the justly disparaged period of apprenticeship. Like it, the knowledge acquired will be almost entirely empirical, and therefore so much the less useful; for the numerous facts which the student is learning from the classes he is attending at this early period, must for some time be so crudely associated in his mind that he will experience difficulty enough in retaining them there at all, let alone having to apply them to previously unexpected instances. We therefore would advise that the first winter session at least should be entirely devoted to lecture-work and the dissecting-room, and that the wards should not be systematically visited until the following summer. Then, even, as Materia Medica is not a winter subject, but little can be learnt with reference to treatment, except in surgery; experience in diagnosis must consequently be the only object kept in view. Afterwards, as much time as can be spared may be devoted to clinical work.

Another question which requires an answer refers to the number of subjects which ought to be embraced in the necessary course of study. Without wishing at present to enter into a discussion as to whether the vital force which is at work in the living body is anything *sui generis*, or only an elaboration of other well-known forces which are manifested by inorganic matter, there is no doubt that those physiological phenomena which are within the reach of complete human comprehension are all capable of being represented as problems of pure physics. Such being the case, the great importance to all thinking students of medicine, of a knowledge of the fundamental properties of matter, must be self-evident. Some may have had the opportunity of learning a little about mechanics, heat, light, and electricity at school, but most will be sadly ignorant on these subjects; and being so, when they have advanced sufficiently far in physiological and pathological investigation to appreciate the enormous fields for work which they open up, they will find no greater stumbling-block to their further progress than their imperfect training in the science of physics; it will act as a barrier against sound original work in all directions, and prevent many an able man from doing full justice to his mental capacities.

It is this unsoundness of the physical basis of physiology which maintains the considerable interval between physiologists and physicists; which makes it necessary to have physiological and physical laboratories as separate institutions instead of as different departments of the same establishment, and which allows flagrant physical inaccuracies in physiological investigations to be stated and restated under the approving sanction of those who ought to know better. What can horrify a pure physicist so much at the present state of physiological knowledge as, when he reads in a recently published work by one who is considered to be the British representative of the subject on which he treats, to learn that in the flight of birds the wings strike downwards and forwards; and in another work, by another prominent author, that the aortic valves, which correspond to the secondary valve of an ordinary pump, close *during* the contraction of the ventricles of the heart? Similarly, the phenomena of electrotonus, in the eyes of a physicist, have as little to do with the true nerve-current as the spark obtained from a Leyden jar has with that circulating in an ordinary electric telegraph cable. These instances, and many others which might be adduced, all point to the importance of a thorough knowledge of physics to the student of medicine.

Second only to physics, as a collateral part of medical education, is zoology. Many, however, would place botany next. No doubt a knowledge of botany is essential to a thorough comprehension of the details of Materia Medica; nevertheless, for the prosecution of work bearing on medicine proper, an acquaintance with the structure of animals is more important than that of plants. The latter may, most of it, be left to the pharmaceutical chemist, and be neglected by the physician. Very little is gained by the medical student when he learns that podophyllin is obtained from the rhizome of a ranunculaceous plant, or even that the natural order Solanaceæ has been divided up in a manner which physiological action justifies: but that the cæcum of the intestine is absent in many mammalia, and that it is of very much larger proportionate size in some than in man, must have an important bearing on our conception of the function of that organ. Many other similar instances might be given,

all proving the importance of comparative anatomy in a medical point of view; and it is almost certain that before long that science will have a more prominent position in medical education than it at the present time possesses.

Those who have no other aspirations than to follow the routine practice of their profession immediately their few years of education are completed, will no doubt ignore the value of the extended curriculum we advocate: they imagine that it does not conduce to more accurate diagnosis or more correct treatment. This view is a short-sighted one, to say the least; for though the most able theorist may, by chance, be a bad practical physician or surgeon, yet the good he does by his higher work is insuperably greater in the long run than the immediate relief of individual cases. It is by the progress that is made by the profession in obtaining the mastery of disease that its position is maintained in society generally, and this progress is due much more to the theoretical chemist and physiologist than to the successful practitioner who simply follows the ordinary routine of his calling.

NOMENCLATURE OF DISEASES

Nomenclature of Diseases, prepared for the use of the Medical Officers of the United States Marine Hospital Service, by the Supervising Surgeon. (Washington: 1874).

THE preparation of this volume by Dr. Woodworth, supervising surgeon, has consisted in adopting, with some important omissions and unimportant transpositions, a literal transcript of the original "Nomenclature of Diseases" drawn up by a joint committee appointed by the Royal College of Physicians of London, of which Dr. Sibson was the editing secretary.

The original work received a modified sanction from the British Government, inasmuch as by the remarkable liberality of Mr. Lowe, then Chancellor of the Exchequer, money enough was provided to print off a large edition, and transmit a copy gratis to every member of the medical profession in Great Britain and Ireland. The further diffusion of the work in the United States by Dr. Woodworth is a thing for which the profession owes that gentleman hearty thanks. The work, indeed, seems to be more authoritative on that side of the Atlantic than on this; for the statistics of mortality for the ninth census of the United States were made up in accordance with its arrangement. This extension of a uniform nomenclature is itself, apart from the merits of the work, an evident great gain to science.

It is proposed to give the book a decennial revision; but while revision of some kind is periodically necessary, we do not anticipate that, after the work is thoroughly matured, it will be required above once in a generation,—three or four times in a century.

In the meantime, the book is in a somewhat imperfect state, many inaccuracies having been pointed out in a report upon it by the Edinburgh College of Physicians. The correction of such errors and the bringing of the work to the level of the present state of medical science will make it mature for the time being. But we hope that a new generation of medical men will find it necessary to revise it; not to correct common errors, but to adapt it to the then advanced state of medical science. We are doubtful as to the propriety of attempting work of this kind by a mixed committee. The committee should be of the only kind Dr. Chalmers could tolerate—a committee of one! only the one should have power to call in aid. The work of Linnæus or of Jussieu could not have been done by a committee.

A good nomenclature of diseases will inevitably represent the science of the day. According as science advances, so will the nomenclature and arrangement be more and more natural. The profession of medicine is to be congratulated on the felt want of a nomenclature temporarily fixed, and on the evidence this work affords of its generous ambition to rise above a mere nosology, to something like a natural pathological arrangement.

The wide diffusion of a book like this in the medical profession, besides its own immediate utility, is sure to exercise a very beneficial and much wanted scientific influence. The looseness of much professional writing will be diminished and precision encouraged. If medical terms are well defined, writers will naturally become more careful in their use of them. At present, medical writing is infested not only with ill-defined terms but indefinite description. How often do we see such phrases as "once or twice," when we should have "once" or "twice." We might give many examples of this looseness for which we tolerate no excuse; but there is a looseness arising from the imperfection of medical science which we must meantime tolerate. Good and precise definition of terms only becomes possible when we know the properties or peculiarities of what is to be defined, and medicine is as yet in too empirical a state for satisfactory definitions. That subdivision of it which is most advanced—pathological anatomy—illustrates well the growth of precision of terminology as advancing knowledge permits and demands it, definition and discovery going hand in hand.

The same branch of medicine affords the best illustration of an admirable struggle after a good nomenclature, but even for this branch there has not as yet arisen a Tournefort to produce, if not temporary unanimity, at least temporary union in regard to nomenclature—a deficiency which, however much to be deplored as a cause of confusion and error, implies blame to no one. If in morbid anatomy we have no established nomenclature, how can we expect it in the nosology? This department of medical nomenclature we regard as being meantime best left in what may be called its popular state, such names as scarlatina, erysipelas, cholera, thrush, being better than any that could be based on our present imperfect knowledge of these diseases. But although this may be so now, there is good reason to expect the day when good descriptive names will be found for all these diseases—names which will suggest to the instructed an epitome of what is known regarding them.

Such suggestive names cannot be, however, without a well-matured classification. At present there are several very natural but isolated classes of diseases which form good samples of what is wanted—zymotic diseases, parasitic diseases, mechanical injuries—but for the most part we have a disjointed catalogue rather than a classification. The attainment of a complete classification will be a great step, an index of progress and an aid to it; but it

will be a structure, as we have already said, that advancing science will periodically overthrow. The ruin, however, will not be deplorable, because not only not irreparable, but certain to be succeeded by a new edifice which will in all probability be better and more useful than its predecessor. J. M. D.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.]

The Education of Women

In your excellent article (vol. x. p. 395) on this subject, you forcibly point out that custom and prejudice have established for boys and girls a curriculum of studies which seems to have but little reason to justify it. You particularly mention that whereas music is, in England, but rarely taught to boys, it is "almost compulsory on girls, whether they have the talent for it or not."

This monopoly of music for girls, supposing our system of education to be founded on reason, should imply, amongst other considerations, that females possess peculiar aptitudes for this branch of art, and that instructing them in it is more likely to produce favourable results in their case than in that of males. I do not say that this is the only probable justification for our practice, but it should certainly be one strong ground for it.

But how does the matter really stand? It is a most remarkable fact that in the highest walk of musical achievement, composition, women are positively nowhere. I believe I am safe in saying that not a single opera, or oratorio, for instance, the work of a woman, has ever maintained even brief popularity; nor has the sex furnished us with one representative worthy of being placed by the side of Bach, Handel, Mozart, Beethoven, Rossini, Mendelssohn, and a host of other great male composers who could be named.

In almost every other department of art and knowledge eminent women have been found—in literature, both prose and poetic, in mathematics, science, painting, sculpture, medicine: but not a solitary great female musical composer can be named.

I do not point out this fact for the purpose of disparaging the female intellect, of which I have the highest admiration, but for the purpose of reinforcing with it the arguments put forward by yourself and other friends of female education in favour of a revision of the subjects appropriated by unreasoning custom to the two sexes.

Considering, however, that the doctrine of chances might have been expected to give us at least one female musician of the highest order out of the myriads who devote a large portion of their existence to the cultivation of the art, the striking fact that it is not so is one well calculated to excite speculation. Is the power of producing new and acceptable music distinguishable in any way from other art power—that for instance of producing a fine painting, statue, or poem? There does seem to me to be this peculiarity belonging to music. The subjects of a painting, statue, or poem, may, and generally are, suggested by some event, person, tradition, or thing already existing. The suggestions of colour, form, light, and shade, furnished by nature, are endless, and capable of infinite diversification—they often, no doubt, act on the mind of the artist unconsciously—but, whether he is conscious of it or not, their influence is always at work—and though he produces something which we feel to be truly original, yet he is probably indebted for the first germ of the idea and for the greater part of the machinery by means of which it has been realised, to sources and materials previously existing, some of which have indeed generally left their traces on the work.

Can anything like this be said of music? What can have suggested some of the simple melodies to which we are never tired of listening, and which are so complete, so consistent, so satisfying, that we accept them almost like works of nature which we do not dream of altering? That there are associations of ideas between musical sounds and visible things, and even moral sentiments, may be true, but such relations must be vagueness and mistiness itself, compared with the relations on which other arts are dependent. So slight, so remote, so intangible are the sources of original music, that it has always seemed to me that the faculty of musical composition of the highest order approaches more nearly to inspiration than any other faculty with which mankind is endowed.

How can the apparent absence of this faculty in women be explained? ALEX. STRANGE

London, Sept. 22

Double Rainbow

On the 11th, at 5.40 P.M., this comparatively rare phenomenon was well seen here by the crowd assembled at the Ladies' Golf Match. The accompanying sketch, by T. Hodge, Esq., gives a thoroughly artistic view of the scene.

Unfortunately the estuary of the Eden, whose quiet water furnished the reflected sunlight, is considerably north of the observer's station. Hence the necessary incompleteness of the second bow. I cannot learn whether any spectator was fortunate enough to observe the phenomenon from a point a mile or two north, whence it would probably have been seen entire.

As seen from stations to the eastward of St. Andrews, the second bow, there due to light reflected from the rougher water of the bay, was considerably broader than the first; so much so

at the upper end of the visible portion as to give, even to intelligent spectators, the impression that it was convex instead of concave to the point opposite the reflected sun.

It was not possible to ascertain whether the light of the portions of the two bows visible below the horizon was that coming from the rain-drops directly, or that subsequently reflected from the sea; though (*pace* Dr. Tyndall) probably the latter was at least a considerable agent. P. G. TAIT

St. Andrews, N.B., Sept. 15

P.S. In my note on "Bright Meteors" (NATURE, vol. x. 305) I find I have inadvertently written Saturday in place of Sunday. Perhaps, with this correction, Mr. Waller may be able to identify both meteors in a satisfactory manner.

This is the phenomenon observed by Dr. Halley, Aug. 6, 1698, at Chester. The second bow was formed by the sun's light reflected from the river Dee. See "Brewster's Optics," p. 380.

Of the parts of the two bows below the horizon, the outer is a continuation of the primary bow, and is formed principally by direct sunlight striking the drops between the observer and the sea and reflected in the ordinary manner.

It may derive a slight increase of brightness from light first reflected at the sea, then by rain-drops, and lastly by the sea again. The inner part is produced by one reflection from the sea and one reflection from rain-drops. The brightness will be the same whichever reflection comes first, provided the smooth sea, the rain-drops, and the sunlight are present.

J. CLERK-MAXWELL

Curious Rainbow

I do not see that the rainbow described by Mr. Swettenham (NATURE, vol. x. p. 398) was different from an ordinary rainbow of moderate brightness, except in there being a slight interval between the two series of colours, which generally blend into

one another. The fainter series are attributed to interference. In bright rainbows there are three, if not four, series of colours, at least in the upper part of the arch, where the colours are always the most distinct, probably owing to the rain-drops being smaller high up, and therefore more perfectly globular. It may not be generally known that a rainbow may be seen much more perfectly in a single drop of dew, by placing the eye close to it, than in rain, and then no less than ten or twelve series of colours may be seen; and in the irregular dew-drops (as also in hoar-frost) a great and very beautiful variety of bows and spectra can be seen. T. W. BACKHOUSE

Sunderland, Sept 23

I SHOULD like to say a few words regarding Mr. Swettenham's letter (NATURE, vol. x. p. 398). The mathematical theory of the rainbow has been worked out pretty completely. We must not look for it, however, in text-books, which generally give a very unsatisfactory account of the rainbow, but in the original memoirs, which sometimes are very difficult to find.

The appearance of coloured bands inside the primary rainbow is not at all of very rare occurrence; since my attention has been drawn to them by a casual observation, I have seen them repeatedly. Only a few weeks ago I saw distinctly three concentric bows, with all the colours inside the primary bow. These bows have been called supernumerary rainbows. The complete mathematical theory has been given by the Astronomer Royal in the *Philosophical Magazine*, and the theory has been verified by Mr. Miller. The cause of these coloured rings is the interference of two rays of light entering the rain-drop at different angles of incidence, but having the same deviation, and therefore leaving the rain-drop parallel to each other. It is clear that two such rays must exist for all deviations from the maximum to the deviation of ray of light having an angle of incidence of 90°.

In text-books no mention is ever made of these supernumerary rainbows, and this is the more to be regretted as the interference mentioned above is, I think, one of the principal causes of its formation.

Were the explanation given in text-books complete, we should not have in the rainbow such pure colours as we actually see, but the yellow would contain a great deal of red, and the green would be contaminated by a great quantity of red and yellow. As it is, however, the red, which would have the same deviation as the green and yellow rays, is destroyed, or nearly so, by interference, which, therefore, is the cause that the colours of the rainbow are nearly pure. What is called the violet of the rainbow is generally the violet mixed with the red of the next supernumerary rainbow. This is not the only instance that text-books contain incomplete accounts of phenomena which have been satisfactorily explained. ARTHUR SCHUSTER

Sunnyside, Upper Avenue Road

Mist Bows

ON Sept. 14 I was driving from the Lizard just after sunrise with Mr. Lugg of Manaccan. A thick mist covered the fields and moorland. The tops of the farm buildings and corn stacks and the church towers were visible above the sea of mist which, matted on the ground, gave the entire country the appearance of being covered with snow. About 6.30 A.M. the sun was bright on our right hand, and on the left we saw a halo of prismatic colours forming a distinct circle of rainbow at a little distance from and encircling the shadows of our heads, and only broken where the shadows of our bodies interposed. This appearance lasted for ten minutes, and our shadows with their attendant bow showed brightly against the mist background as we passed hedges and fields, and kept pace with us like "the mist raised from the plashy earth" by the hare in Wordsworth's poem,

> "That, glittering in the sun,
> Runs with her all the way wherever she doth run."

We afterwards opened a valley terminating in an extensive moor, when the mist appeared as a sea of prismatic colour extending to the horizon. About 7 A.M. we saw a perfect bow free from any prismatic colour, both ends of which terminated in the field immediately to our left.

My companion, who is constantly driving about this district in early morning, says he never before saw similar phenomena.

Lizard Signal Station, Sept. 16 HOWARD FOX

Carnivorous Plants—how to be obtained

IT is not unlikely that there may be a great demand for plants of the genus Drosera, and as I am in a neighbourhood where the supply of the *D. rotundifolia* and *D. intermedia* is inexhaustible, I shall be glad to send, through the post, plants of the same to any who are desirous of investigating their carnivorous habits; but to meet the necessary expenses of collecting and postage, six penny stamps must be enclosed in the application for each dozen plants. The applications of dealers in plants will not be attended to.

The *D. intermedia* is far more abundant than the *D. rotundifolia*, and will answer the purpose of investigators quite as well. A few words about the method of growth of these may not be out of place. Pure peat well soaked with water suits either kind, but while the *D. intermedia* flourishes with its roots beneath the surface of the water, *D. rotundifolia* grows best when it is from 3 in. to 4 in. above the surface; now and then it happens that it is found with its roots in the water, and then the hairs on the stalks of the leaves, which constitute one of the distinguishing features between these species, are much diminished, both in number and length.

The Liverpool naturalists will find a large supply of the *D. rotundifolia* on Oxton Common, and there they are most abundant in the corner nearest to Noctorum Farm. Thurstaston Hill is another locality in the same neighbourhood where this plant grows.

The *Pinguicula lusitanica* is not uncommon in the bogs of the New Forest, but I cannot promise specimens of this plant with the same certainty as I can those of the Droseræ. Applications for plants had better have the word *Drosera* written on the envelope, to prevent the delay which would arise from such letters being forwarded to me when away from the New Forest.

Bisterne Close, Burley, Hants G. H. HOPKINS

[Both species are moderately abundant, though small, in a peat-bog near Burnham Beeches, Bucks, about four miles from Slough.—ED.]

Automatism of Animals

PROF. HUXLEY'S most interesting address published in NATURE, vol. x. p. 362, seems to me to involve some difficulty, which I take the liberty to state, though well aware that I am stepping on slippery ground. I allude to this passage:—"Suppose I had a frog placed in my hand, and that I could make it, by turning my hand, perform this balancing movement. If the frog were a philosopher he might reason thus: 'I feel myself uncomfortable and slipping, and feeling myself uncomfortable I put my legs out to save myself. Knowing that I shall tumble if I do not put them further, I put them further still, and my volition brings about all these beautiful adjustments which result in my sitting safely.' But if the frog so reasoned he would be entirely mistaken, for the frog does the thing just as well when he has no reason, no sensation, no possibility of thought of any kind."

Now, does it unavoidably follow from the latter fact that this philosophising frog would be *entirely* mistaken? What I should venture to object is simply this:—Experiment shows, indeed, that very delicate combinations of muscular actions (as in swimming) are brought about by impressions upon the sensory nerves, even when, after ablation of the brain, there can be no longer any consciousness. But have not those combinations originally arisen during undisturbed consciousness, and therefore, perhaps, under the influence of consciousness, inscrutable as the relation of consciousness to corporeal phenomena is acknowledged to be? And even if the experiments alluded to should succeed with animal individuals which, before vivisection, never had executed the movements in question (and I was once assured by a distinguished physiologist that similar experiments do really succeed with rabbits deprived of part of brain soon after birth), yet those adjustments may be rather considered with regard to the great principle of inheritance, as it has been applied to instincts by Mr. Darwin and Mr. Spencer, and alluded to in Prof. Tyndall's address. Though now performed by animals without possibility of sensation and thought, those movements were adjusted to each other, and to impressions on sensory nerves in these animals' ancestors while in possession of consciousness.

Surely such questions will ever remain doubtful; yet I think it not unbecoming to state a view of them which seems to me to be in accordance with the present direction of biological theories. I. D. WETTERHAN

Frankfort-on-the-Maine, Sept. 20

Photographic Irradiation

I HOPE you will allow me space to correct a slight misunderstanding which has got into the present discussion on photographic irradiation. Mr. Crofts (NATURE, vol. x. p. 245) places my views in opposition to those of Lord Lindsay and Mr. Ranyard. Mr. Stillman (NATURE, vol. x. p. 381), who has given us such valuable information on the molecular condition of different preparations of collodion, also takes the same view. Now in reality Lord Lindsay's and Mr. Ranyard's views are not opposed to mine. I have simply attempted to prove that molecular reflection was *a cause* of photographic irradiation, not that it was *the only cause*, as I quite agree with Lord Lindsay and Mr. Ranyard, that the imperfections of the lens are also causes of photographic irradiation, and in NATURE, vol. x. p. 185, I pointed out one form of irradiation due to the lens. But the imperfection of the lens which is most fatal is that pointed out by Lord Lindsay and Mr. Ranyard, namely, the inability of the lens to bring all the rays to a focus, whether this results from the imperfections of the outside portion of the lens, or from imperfect achromatic* correction. No maker of lenses will tell you that any lens, far less that every lens which he puts out, is perfectly corrected for dispersion. Working with such an instrument, it is very clear that if we only allow an exposure sufficient to give an image on the part of the collodion where the great proportion of the rays are focused, then the photographic impression will give very nearly the true boundary line. But suppose we allow more light to pass through the lens, either by turning the camera to a brighter light or by giving a longer exposure, then it is clear that the unfocused rays which gave no impression when the exposure was short, will now impress themselves on the collodion, and thus the photographic impression will be extended beyond the true boundary line.

That there should be difference of results in experiments on photographic irradiation is quite to be expected, as there are so many variables in the experiments. The light, temperature, and condition of the collodion are all constantly changing, and the conditions under which the experimenters work, and the apparatus and chemicals used, are different for each experimenter; different results may therefore be expected. If the experimenter use a good lens, and employ only the central portion of it, the imperfection due to the lens may be small in quantity. But if his lens is imperfectly shaped and badly corrected for dispersion, and he uses the full aperture, the result will be very different. Again, if the experimenter work with different collodions, Mr. Stillman has shown that, altogether independent of the lens, a very slight change in the preparation of the collodion greatly alters the amount of irradiation. So far as I can at present judge, the imperfections of the lens and molecular reflection are not opponents, but allied enemies, which we must meet on the same field.

JOHN AITKEN

Darroch, Falkirk, N.B.

Can Land-crabs Live under Water?

WHEN in Atchin, in Sumatra, during the second Dutch expedition, it occurred to me to put to experimental test a statement which I thought I had seen in some book or other—this book turns out to be Prof. Marshall's work on "Physiology"—to the effect that land-crabs are drowned when kept immersed in water.

On one occasion I kept one of these crabs under water for two hours, after which time it was as lively as ever; and on another day a larger specimen was kept submerged for exactly four hours, after the lapse of which time it was somewhat subdued, but by no means moribund.

Unfortunately the duration of my experiments was always limited by the necessities of ablution, as our largest receptacle for fluids was a small-sized Huntley and Palmer's biscuit-tin, which served as our only washing apparatus, as well as the laboratory—eventually a very leaky one—for my experiments, for a period of four months spent under an equatorial sun.

New University Club, Sept. 22 J. C. GALTON

* We here require some new word, or we must greatly extend our conception of achromatism, as we have here to deal with rays far beyond the limits of the sensitiveness of the eye; and the word achromatic, as applied to lenses for chemical purposes, is somewhat misleading. I may here offer two suggestions as to how the imperfect power of the lens to bring all the different rays to a focus may be partially corrected:—(1) By using a collodion which is as nearly as possible only sensitive to those rays which the lens can bring to a focus; or (2) by providing each lens used for making accurate observations with a screen, which shall stop back all the rays beyond the limits which the lens can focus.

Salivary Glands of Cockroach

I SEE in NATURE, vol. x. p. 381, a letter on the salivary glands of the cockroach, by Dr. W. Ainslie Hollis, in which he remarks:—

"As far as my experience carried me, the sacculi, the supposed reservoirs of the saliva, never contained naturally any liquid whatever, but on opening the thorax were invariably found to be collapsed and empty."

A few days ago I was observing some of these creatures. I examined several shortly after they were caught; in these the sacculi were empty, but others which I had kept alive in a cup with only a few drops of water for a day or two, had invariably the sacculi distended with liquid.

I will not attempt to explain these facts, but leave that to others more capable than myself. CHAS. WORKMAN

Belfast, Sept. 21

THE AUSTRIAN POLAR EXPEDITION

THE Vienna correspondent of the *Times* supplies some interesting details concerning this important expedition. Events have proved that there has not been an expedition better fitted out, as to ship, stores, or crew, than that in which this North Pole Expedition left Bremerhaven on June 13, 1872.

As to the crew of twenty-four men, it was composed of three naval officers, Lieutenants Weyprecht and Brosch and Ensign Orel; two engineers, and fifteen picked Dalmatian sailors; Lieut. Payer, of the Jägers, an Alpine Club man, with two Tyrolese mountaineers; Haller and Kletz, and the Hungarian Képesy as surgeon. It was thus calculated for land work not less than sea work, and events proved that the company had been well sorted.

The object of the expedition being to find a north-easterly passage towards the coast of Siberia, the expedition having arrived at Tromsoe, and having taken on board Capt. Carlsen as harpooner and ice-master, started on the 14th of July for the sea and the coast of Novaya Zemlya. At Novaya Zemlya they met the Norwegian yacht *Jsbjörn*, in which Count Wilczek and Baron Sternberg, two of the chief promoters of the expedition, had come over from Spitzbergen to establish a store for them near Cape Nassau. They were for two years the last human beings they saw. The stores being laid in a cleft of the rocks inaccessible to the Polar bears, and the state of the ice looking more promising, the ships parted company on the 21st of August, the *Tegethoff* going north, the *Jsbjörn* south. The hope proved to be fallacious long before evening. The *Tegethoff* was icebound, and never was got out again. The temperature sank, copious snowfalls cemented the loose ice-fields, and the *Tegethoff* was surrounded by a solid mass of ice.

In this precarious state the ship lay for five months, the ice freezing together and bursting in turn, and so exposing it perpetually to fresh pressure. All was prepared for leaving the ship. The stores were brought on deck and a portion placed on the ice. This was the most trying time of the whole. Every moment the alarm was sounded and the signal given for leaving the ship. It was sufficient to wear out the strongest. In spite of this, meteorological and other observations were carried on. The strain on the mind told on the state of health in spite of all precautions, and scurvy and pulmonary affections set in.

All this time the ship was being driven in a north-easterly direction until, towards the end of January, 1873, 73 W. long. and 79 lat. were reached on February 25. The sun appeared again after five months on the horizon, and on the 25th the pressure of ice ceased. A massive wall had been formed round the ship, protecting it from further injury. The drifting was now to the north-west. Milder weather having set in, the hope revived of setting the ship free, and for five months the work went on. By dint of boring and blasting the fore part of

the ship was made free, but to free the aft proved impossible, ice of 30 ft. thickness lying underneath.

Disheartened, the expedition had almost resigned itself to have to pass another winter in the same position, when, on the 31st of August, high land was seen in the north, some fourteen nautical miles off. The feeling at first of great joy at the unexpected discovery became soon a torture. To be so close and not to be able to get to that unknown land. At last, towards the end of October, the ship drifted to about three miles off one of the islands which lay before the main land, and there the ship froze in at the beginning of November, and lies still in 79° 51′ N. lat. and 58° 36′ W. long. Here the winter of 1873-74 was passed in comparative quiet.

During the time a series of highly interesting astronomical, meteorological, and magnetical observations were made. The Northern Lights were very numerous and magnificent—white, red, and green, with crowns, bands, and rays of great size and brilliancy. The needle was so disturbed that oscillation became the rule and steadiness the exception. The cold was more intense than the year before, there being 37° Réaumur below zero on the ship. But the supply of fresh bear's meat and the absence of that strain on the mind produced by constant danger kept the crew in better health. The reappearance of the sun on the 24th of February did the rest for all except Krisch, the engineer, who died of consumption on the 17th of March, and was buried in the newly discovered land, between two basalt columns; for the explorations had already begun.

A first expedition of Payer, the two Tyrolese, four sailors, and the only three dogs remaining started for the mainland, went up the promontories named Tegethoff and M'Clintock, 2,500 ft. high, and up the Nordenskjold Fjord, bordered by the large Souklar glacier. It was still very cold, 40° Réaumur. All was still white with snow and hoar-frost, making the symmetrical rock columns look like candied sugar.

The second expedition of thirty days started on the 24th of March. The temperature had risen, but snow-drifts, wet, and the breaking up of ice made the journey still more dangerous. Of course, before getting the map it will be impossible to form a clear image of the configuration of the country. The atmosphere over the ice being hazy, the only way for making observations was by going to the heights, and by these means a succession of points was established—Cape Koldewey, 80° 15′; Cape Frankfurt, 80° 25′; Cape Ritter, 80° 45′; Cape Kane, 81° 10′; and Cape Fligely, 82° 5′, all on the Austria Sound. The diminished stores and the short available time necessitated forced marches, so one-half of the party was left under a rocky eminence in 81° 38′, and Payer, Lieut. Orel, the sailor Zaninovich, and the three dogs started to cross Crown Prince Rudolf's Land. Undeterred by a dangerous accident, the expedition went on by a roundabout way to the coast, and along it again northward. The progress became more and more difficult and dangerous; it was all fresh ice, often not more than a few inches thick. From Cape Fligely, the most northerly point touched, another elevated point, named Cape Wien, was sighted in 83°, the most northerly point of the known earth. Then the journey back again was more dangerous than the advance, but on the 25th of April the ship was seen on the spot where it had been left.

After a few days' rest, very much wanted, a third expedition was made, again to the west—like the first—when a high mountain, Cape Brünn, 40 miles from the ship, opened out a view over the mountainous country, with the Humboldt Peak, about 5,000 ft. high, as its culminating point.

Already, in March, a council had been held, and the decision had been come to to abandon the ship and to try to make their way back on sledges and boats. On the 20th of May the colours were nailed to the masts of the ship, and the expedition started with three boats and as many large sledges. The exertions proved almost too much. The journey had to be made five times over, three times tugging at boats and sledges, then twice back again. The continual south wind driving the ice northward seemed to make all efforts to get south useless, and after eight months' toil it seemed as if nothing remained but to return to the ship and pass there another winter. In the second half of July, however, north winds set in with rain, loosening the ice, and breaking it up, until on the 13th of August the expedition got into free water. It was in the unusually high latitude of 77° 40′. Had it not been for this exceptionally favourable state of the ice, the impression is that the expedition would not have been able to return. Now there was the pulling for the land. The crew and officers, divided into two watches, took it in turn day and night, so that forty miles' progress was made daily. On the second day the mountain of Nowaja Saulja was sighted. There were still provisions for a fortnight. A portion was left on shore, and then the southern bays were searched for Russian fishermen. None were found at the Barents Islands; bad weather set in, the sea ran high, all were wet through and unable to pull. It was already settled that the White Sea was to be made if no ship was found up to the 28th. However, on the 29th, two fishermen were sighted in a boat belonging to the schooner *Nicolay*, which brought the expedition to Vardöe on the 2nd of September.

The new land, as far as discovered, is about the size of Spitzbergen, and consists of several large masses intersected by fjords and surrounded by islands. A large passage called the Austria Sound separates these masses and forks under 82° north latitude into a north-easterly arm, which could be followed up to Cape Pest in the furthest north. The mountains are dolomitic. Their middle elevation is from 2,000 to 3,000 feet, only towards the south they may rise up to 5,000. All the depressions between the summits are occupied by glaciers of gigantic size, as they only occur in arctic regions. The vegetation is much poorer than that of Greenland, Spitzbergen, or Novaya Zemlya, and in the south, except for Polar bears, it is devoid of animal life too. Several attempts were made to pass through the country, but they were found impossible, mountains barred the road, so progress was tried along the coast line, and the more the explorers penetrated north by west the more the temperature rose, and the coasts of Crown Prince Rudolf Land were found to be tenanted by myriads of birds, elks, &c., traces of bears, foxes, and hares appeared, and seals lay on the ice. In spite of the treacherous nature of the road, it was continued to 82° 5′, where, at Cape Fligely, a wide expanse of water only covered with ice of recent formation was seen. In spite of this the explorers think the open Polar sea a delusion. Without raising a theory about the possible connection of this new land with Gillis Land in the south-west, the opinion is that it bears out up to a certain point Peterman's assumption of an inner arctic archipelago.

The fact of the expedition having found *hares* in the newly discovered land seems significant of a channel, not invariably frozen in winter, between Franz-Joseph Land and Spitzbergen, since hares do not occur in the latter.

In Norway the members of the expedition were received with the greatest enthusiasm, at Hamburg they were welcomed like bringers of good tidings, and on their entry into Vienna they could not have received a greater ovation had they been the remnant of a conquering army. All this they have richly merited, and there can be no doubt that Lieutenants Payer and Weyprecht have won for themselves a place in the first rank of arctic explorers.

A second Austrian Arctic Exploring Expedition is

being prepared at Vienna to start next summer. One half of the expedition will seek to advance to the north, under Lieut. Payer, by way of East Greenland, and the other half, under Count Wilczek, will proceed *viâ* Siberia. The object of the expedition is to ascertain if the newly-discovered Franz-Joseph Land is a continent or an island.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE twenty-third meeting of this Association, which commenced at Hartford, under the presidency of Dr. J. L. Le Conte, on Aug. 12, seems to have been a successful one. Apart from the regular growth in prosperity which is exhibited every year, there was the unusual accession of the chemists, who have resolved to make their science strongly represented, and there was the excitement and interest which attended an important change in the constitution of the Association. The nature of the change we have already indicated (vol. x. p. 382). There was an unusually large attendance of the most eminent American representatives of science. The Association meets at Detroit next year on the second Wednesday of August.

The president's address consisted chiefly of allusions to some of the principal scientific events of the year, and of a summary of the matters to come before the Association. At a later period of the meeting the retiring president gave his address, in which he reviewed the progress of scientific instruments and methods. We can only refer very briefly to some of the more important papers read.

In a paper *On the Periodicity of the Rainfall in the United States in Relation to the Periodicity of the Solar Spots*, by Prof. John Brocklesby, the author concludes from his investigations that in the United States there is a connection existing between rainfalls and variations in the sun-spot area; the rainfall rising above the mean when the sun-spot area is in excess and falling below it when it is deficient.

Differential Measurements of Solar Temperature, by Prof. S. P. Langley of Pittsburgh, Pa. After stating the aims of the Alleghany Observatory at Pittsburgh, and giving details of the work now carried on there, consisting largely of observations and photographs of the sun, Prof. Langley said that there is a very wide variation in both the heat and light, and probably also in the actinic force of different parts of the sun. The difference is due principally, but not wholly, to differences in atmospheric absorption. Prof. Henry observed that the image of a sun-spot is colder than the photosphere surrounding it. Secchi has shown that the heat of the sun diminishes as we approach its edge, and he thinks that there is a different temperature at the sun's equator and the poles. Prof. Langley gave details of his own experiments with a thermopile upon these points. He finds that the observation of Prof. Henry is correct. But comparing the image of the spot with the photosphere immediately surrounding it, he finds that the image of a spot not far from the centre is uniformly warmer than that of the edge. To get the full significance of this observation we must consider that the image of the same spot is at the same time darker and colder than the photosphere near the centre, and darker and warmer than the photosphere near the edge. A series of measurements of the heat from the centre to the edge were made.

It does not appear as the result of these experiments that there is so great a selective absorption of heat in the lower regions of the sun's atmosphere, that when rays come from the edge of the disc and pass through a greater proportional thickness of his atmosphere, the heat is filtered from them and the light allowed to go through. We find that the heat falls away so very rapidly towards the edge as to indicate a much greater thinness of the solar chromosphere than has been hitherto admitted. We appear to have been led to the conclusion that there is a local obscuration over the spot very remarkable both in degree and kind. Prof. Langley exhibited a photograph of a sun-spot that looked, he said, like a sketch of a crystallising substance; when, however, we consider the enormous areas involved, we find the analogies of crystallisation wholly fail us, and we may more probably account for the facts by a hypothesis of cyclonic action. He concluded by pointing out the great value of these studies in connection with investigations in terrestrial meteorology.

Distribution of the Poles of Nebulæ, by Prof. Cleveland Abbe, of Washington. The general problem attacked in the present paper is the question whether there are planes that have a definite relation to nebulæ.

It may in general be stated that the positions of planes ot rotation among the nebulæ do not show any such uniformity as is the case with the solar system: on the contrary, they are at all possible angles with each other. But there is this remarkable feature: that their nodes cluster about a point in R.A. 12h. 45m. and declination 60° N., that point being the North Pole of the plane near which lie the majority of the so-called axes of rotation.

Cave Fauna of the Middle States, by Prof. A. S. Packard, jun., of Salem, Mass.—For about a month during the last part of April and early in May last, Prof. Packard was engaged with Mr. T. G. Sanborn in exploring the caves of Kentucky under the auspices of the Geological Survey of that State, Prof. Shaler accompanying Prof. Packard. They first examined the Mammoth Cave, and doubled the number of animals known to exist therein and in others adjoining. An exploration, with Prof. Shaler, of the Carter Caves in Grayson County, Ky., also revealed a rich fauna composed of twenty species. Prof. Packard also examined Wyandotte Cave alone, and found a wingless Procus and two species of Thysanura new to the cave. Several caves within sixteen miles of New Albany, Ind., at Bradford, were examined. Finally, a careful examination of Weyer's Cave, in Virginia, and the adjoining Cave of the Fountains revealed a fauna containing some twenty species, no life having been previously reported from those caves.

These results show a great uniformity in the distribution of life—more than would at first be expected, though these caves lie in a faunal region nearly identical as regards the external world, and the temperature of the caves is very constant. Still some notable differences occurred.

Change by Gradual Modification not the Universal Law, by Thomas Meehan, of Germantown, Penn.—After adducing many instances in support of the theory that new forms are often generated by "leaps," Mr. Meehan concludes with the following propositions:—1. Morphological changes in Individual plants are not always by gradual modifications. 2. Variations from specific forms follow the same law. 3. Variations are often sudden and also of such decided character as to seem generic. 4. These sudden formations perpetuate themselves similarly in all respects to forms springing from gradual modifications. 5. Variations of similar character occur in widely separated localities. 6. Variations occur in communities of plants simultaneously by causes affecting nutrition, and perhaps by other causes. Mr. Meehan argues from these premises that new and widely distinct species may be suddenly evolved from pre-existing forms without the intervention of connecting links.

This paper provoked considerable discussion. Prof. Morse said that the impression seemed to prevail among a great many that Prof. Meehan's paper was an argument against Darwinism, while in reality, in whatever sense you look at it, it was a corroboration of the theory of evolution. Prof. C. V. Riley insisted that most of the circumstances cited by Prof. Meehan found their parallels in what were generally known to zoologists as well as botanists as "sports" or even "monstrosities," and that Mr. Darwin himself had instanced some of the most interesting cases.

Prof. Asa Gray remarked that he only wished to state in respect to variations occurring abruptly as they did, that those certainly were not the kind of things which Mr. Darwin would have regarded as in any way interfering with his view, and he did not think Mr. Meehan had rightly comprehended the statement to which he had called attention. "I think (pursued Prof. Gray) that the statement, whatever it is, taken in connection with the remark which Mr. Riley made, and which Mr. Darwin a good deal insists upon, viz., that he does not look to monstrosities for the introduction of new forms, because the monstrosities may be expected to be taken out of relation to the surrounding circumstances, and that it is only those modifications which are in relation to surroundiug and changing circumstances that can be utilised and turned to account—is not to be found fault with. Mr. Darwin distinctly notes that monstrosities may be hereditary, and so may be supposed even to be continued if they were sufficient in relation to surrounding circumstances. So, if Mr. Darwin readily takes into his view changes like that which everyone calls monstrosities, he may readily be expected not to regard it as any infringement upon the maxim that varieties should come into existence quite abruptly with considerable differences. I think it is true that varieties are apt to arise in

that way with very considerable differences, and so true that those surely are not the kind of things to which Mr. Darwin looks as difficulties to overcome, but as stepping-stones in his way."

Glacial Phenomena in the Sierra Nevada, by Prof. John Muir, of Oakland, Cal.—The studies of Prof. Muir referred particularly to that portion of the Sierra which is embraced between lat. 36° 30′ and 39°, which measures about 200 miles in length by about 60 in width, and attains an elevation along the axis from 8,600 ft. to nearly 15,000 ft. above the sea. All the individual mountains distributed over this vast area, of whatever kind, have been brought into relief during the glacial epoch by the direct mechanical action of the ice-sheet and the glaciers into which it afterwards separated. The chief phenomena presented are :—(1) scratched and polished surfaces, (2) moraines, (3) moutonned rock-forms, and sculpture in general, as seen in valleys, ridges, lake basins, and separate mountains.

The paper goes on to describe the lofty mountains distributed along the summit of the portion of the Sierra under consideration, which are almost wholly unexplored—Mounts Dana, Lyell, Whitney, and Tyndall. The Pinnacles, which are the smallest of the summit mountainets, are described in an interesting way, the author concluding that instead of each being formed by special upheaval, or supposing that the chasms which separate them were made by subsidence, they were formed by the removal of the materials which once filled the intervening chasms. The same truth applies to the larger peaks, and the author concludes this branch of his subject by saying that they are all residual masses of the once solid wave of the entire range, and all that would be required to obliterate their distinctive character would be the restoration of the materials which have been carried away.

The next inquiry is, what has become of this material, not the millionth part of which can now be seen? and the author answers himself with the statement that glaciers were the transporting agents, and that in forming the basins and valleys in which they flowed, they carved out the summit peaks. This is so important a proposition as to demand careful attention to its proof. This proof is brought forward in detail. Subsequently, granting this proposition to be true from the proof, the author is obliged to go on to show what force or forces have sharpened the crests, which bear no trace of glacial action, and which were probably always above its reach. Next is considered the formation of special groups of mountains, and the geological effects of shadows—in prolonging and intensifying the actions of portions of glaciers, as shown in moraines, lake basins, and in the difference in form and sculpture between the north and south sides of valleys and mountains; especially as to their effects in the segregation of mountain masses. Also as to the effect of physical structure upon surface features, and the cause of the absence of well-marked individuality in summit mountains.

Prof. F. W. Clarke, of the University of Cincinnati, read a paper *On the Molecular Volume of Water of Crystallisation*. He stated that, to the chemist, it is important to get at some distinguishing character between water of crystallisation and true water of hydration. This character may be found by a study of the molecular volumes of various hydrated compounds. If we determine the molecular volume of frozen water, that is ice, we shall find it to be 19·6. If that water unites to form a hydrate or a crystalline salt, contraction ensues, and by studying that contraction we get at curious results. In the case of water of crystallisation, Prof. Clarke has studied over thirty salts, and in every case the molecular volume of the water is about 14. With water of hydration no such regularity is found. Evidently, then, when water unites with an anhydrous salt from water of crystallisation, all the condensation which occurs is on the part of the water, the volume of the molecule of the salt itself remaining unchanged.

Prof. Clarke also read a paper *On the Molecular Heat of Similar Compounds*. Prof. Clarke said that it is commonly thought that similar compounds have equal molecular heat. This is only approximately true. In comparing about twenty series of similar compounds, Prof. Clarke finds that the molecular heat increases slightly with the molecular weight, though in a very different ratio. In comparing all the extant determinations of specific heat, he has found only two or three exceptions to this rule, and even they were doubtful.

Prof. R. E. Rogers, of the University of Pennsylvania, read a *Notice of Prof. A. K. Eaton's new Compound One-prism Spectroscope*. The instrument is the invention of a Brooklyn chemist, and is by himself named "a direct-vision spectroscope." It consists of a thick plate of glass with parallel sides, united to one of the faces of an ordinary bisulphide of carbon prism, or a prism of dense flint-glass. According to the amount of dispersion desired, the light is made to enter either on the end of the glass plate or on the opposite face of the bisulphide prism. The results obtained from this instrument are as follows :—The dispersion of this compound prism is nearly four times greater than that of the ordinary 60° prism. The mean emergent ray is practically parallel to the incident ray. It does not deflect the ray from its original path. Many Frauenhofer lines are visible by this prism with the naked eye, while with the observing telescope all the prominent lines are clearly reversed, without the use of the slit or collimator, by merely throwing a strong beam of light by means of a mirror.

Dr. J. H. Mellichamp, of Bluffton, S.C., gave an account of some recent observations at Bluffton upon the *Sarracenia variolaris*, which abounds in that locality. This species of the pitcher plant has an elongated, conical, erect leaf, with a broad lamina curved over the opening, and a wide longitudinal wing upon one side the whole length of the tube. The upper portion is veined with purple, the intervening spaces being white and diaphanous. Dr. Mellichamp establishes the following points :—The base of the tube secretes a watery fluid, which is not sweet nor odorous, but which proves quickly fatal to all insects that fall into it. The whole inner surface is covered with very minute prickles, perfectly smooth and pointed downward, which render it impossible for an insect to ascend by walking, even when the leaf is laid nearly horizontal. Within the somewhat dilated rim of the tube there is a band half an inch in width, dotted with a sweet secretion, attractive to insects, but not intoxicating. This also extends downward along the edge of the outer wing to the very ground, thus alluring many creeping insects, and especially ants, to the more dangerous feeding-ground above, where, once losing foothold, it is impossible to regain it. Even flies escape but rarely, the form of the tube and lid seeming to effectually obstruct their flight. As the result, the tube becomes filled to the depth of some inches with a mass of decaying ants, flies, hornets, and other insects. Within this there is always found a white grub feeding upon the material thus gathered, perhaps the larva of a large fly which has been observed to stand upon the edge of the tube and drop an egg within it. Soon after the full development of the leaf the upper portion becomes brown and shrivelled, which is due to still another larva, the young of a small moth, which feeds upon the substance of the leaf, leaving only the outer epidermis, and works its way from above downward till in due time it spins its cocoon, suspending it by silken threads just above the surface of the insect *débris* at the bottom. The whole forms a series of relationships and an instance of contrivance and design, the full purport of which is still by no means fully understood. Other species of the genus, as also the allied Darlingtonia of California, manifest the same purpose of insect-capture, whatever the final object may be.

As complementary to Dr. Mellichamp's paper, Prof. C. V. Riley gave an account of his investigations on the insects more particularly associated with *Sarracenia variolaris*, which we shall reprint separately in an early number.

Number and Distribution of Fixed Stars is the title of a paper read by Prof. B. A. Gould, of Cambridge, Mass. The great work of Argelander undertook no less than a complete census of all stars in the northern hemisphere to the ninth magnitude inclusive, with as many as possible of the magnitude 9½. This was successfully executed, and an association comprising the great majority of northern observatories is now employing the working list thus obtained for the construction of a catalogue to fix star-places with the utmost attainable accuracy. The magnitudes are given to the tenth of a unit, from a number of observations on each, in the published catalogue, after having been first estimated by half units.

Prof. Littrow of Vienna made a careful enumeration of stars for each magnitude, to ascertain whether an approximate uniformity in the distribution of stars was indicated. If the magnitudes depend upon distances from us, and the stars are distributed with uniformity in space, the number of stars of any given magnitude should be proportioned to the spherical area within which they are observed. The truth of the hypothesis may be inferred from the degree of accordance between the numbers of stars of given magnitudes in the catalogue, and numbers computed from the contents of imaginary spherical shells whose radii would correspond with the respective magnitudes. An approximate indication might be obtained of the relative distances of

each magnitude. Notwithstanding the difficulties which are incident to this method, due to inevitable errors of observation and comparison, Littrow believed that a sufficient degree of uniformity was demonstrated to justify faith in the general theory that there is a considerable degree of uniformity in the distances of the fixed stars within his investigation, and that there is warrant for applying his formulas—the results of his research—to regions outside of his limits. Discussing the numbers in Argelander's catalogue assorted by units as far as the eighth magnitude, he obtains the fraction 0·423 for the ratio of brilliancy between stars of two successive magnitudes; assorted by half units, the fraction is (including $8\frac{1}{2}$) 0·431. Each computation gives the distance of a star of the eighth magnitude as 18, that of a star of average first magnitude being taken as a unit. The discordances between the results given by the empirical values of the formula and those from the enumeration of the catalogue are large, amounting to 39 per cent. for stars of the fourth, and 44 per cent. for stars of the ninth magnitude.

The recent completion of our Argentine Uranometry determines the actual magnitudes for all stars easily visible to the naked eye throughout the heavens. Prof. Gould thinks it improbable that the error of individual magnitudes exceeds the tenth of a unit. Prof. Heis has revised and extended Argelander's work to the nearest third of a unit for all stars visible in Central Europe with the naked eye, his lowest limit being $6\frac{2}{3}$. The Argentine work furnishes similar data with respect to the stars in the southern hemisphere. Prof. Gould has carefully studied the results of Littrow's enumeration, is convinced of the accuracy of his computations, and accepts his formula as the best obtainable. Prof. Gould has extended a similar comparison to all the stars in the heavens of the sixth magnitude, using the numbers and magnitudes furnished by the uranometries, and obtains the value of the constant as 0·482. The accordance of this with observations may be judged from the following table:—

NUMBER OF FIXED STARS.

Magnitude.	Argelander. Count.	Argelander. Formula.	Uranometries. North'n.	Uranometries. South'n.	Whole Sky. Observ.	Whole Sky. Formula.
1	6	4	8	6	14	23
$1\frac{1}{2}$	4	4	7	4	11	16
2	22	8	25	20	45	29
$2\frac{1}{2}$	12	15	35	33	68	50
3	51	28	55	41	96	85
$3\frac{1}{2}$	60	53	103	87	190	149
4	128	99	132	108	240	257
$4\frac{1}{2}$	140	186	254	154	408	444
5	379	350	392	240	632	768
$5\frac{1}{2}$	403	658	696	563	1,259	1,329
6	1,242	1,236	1,374	1,075	2,449	2,300
$6\frac{1}{2}$	2,231	2,322	—	2,022	—	3,976
7	4,608	4,362	—	3,317	—	6,879
$7\frac{1}{2}$	6,878	8,197	—	—	—	11,900
8	14,525	15,402	—	—	—	20,582
$8\frac{1}{2}$	28,486	28,937	—	—	—	35,601
9	78,185	54,370	—	—	—	61,582

The columns under "Argelander" give the numbers obtained respectively by enumeration and by the formula thence deduced, from the *Durchmusterung*, and, of course, apply only to the northern hemisphere. The columns under "Uranometries" are deduced from Heis's *Atlas Cœlestis* for the northern sky and from the Argentine Uranometry for the southern. Under the "Whole Sky" the first contains the sum of northern and southern stars from the columns immediately preceding; the second the numbers computed on the hypothesis of uniform distribution in space and equal brilliancy. Comparing these numbers with those obtained from the *Durchmusterung*, the latter must of course be doubled.

The carefully determined numbers of bright stars from the Uranometry afford no greater support to the hypothesis than those obtained from the *Durchmusterung*. While a general similarity between the numbers of count and of theory is apparent, the accordance is sufficient to warrant deductions which are not essentially vague. Still the approximate accordance, as far as it goes, may furnish us with a constant magnitude ratio for crude estimates in cosmical inquiries.

If we assume, according to hypothesis, an equal number of stars in each hemisphere, there are altogether not less than 15,300 stars as bright as the seventh magnitude. But since the count indicates an excess of bright stars in the northern sky, there may be a thousand more, as given by the formula. The numbers of the *Durchmusterung* imply the existence of over 200,000 stars as bright as the ninth magnitude, though the magnitudes of faint stars in that work seem given on the average a little too bright. The average distance of ninth magnitude stars seems to exceed 25. The manifest agglomeration of faint stars in the Milky Way shows the inapplicability of the hypothesis to stars fainter than a certain magnitude. The limit of applicability is probably considerably beyond stars of the seventh magnitude or distances twelve times the average of first magnitude stars. There is no contradiction in all this to the well-known fact of accumulation of brighter stars in certain regions.

With regard to the belief that the number of stars of any given magnitude diminishes with their distance from the Milky Way, Prof. Gould says that in the clear atmosphere of Cordoba the existence of a bright stream of stars was very noticeable, including Canopus, Sirius, and Aldebaran, with the most brilliant ones in Carina, Columba, Canis Major, the Pleiades, &c., and skirting the Milky Way on its preceding side. On the opposite side of the galaxy the same was true, the bright stars fringing it in a stream that leaves it at Alpha and Beta Centauri, comprises the constellation Lupus and a great part of Scorpio, and extends onward through Ophiucus toward Lyra. Thus a great circle or zone of bright stars seems to gird the sky, intersecting with the Milky Way at the Southern Cross, but far more conspicuous on the other. The northern intersection of this zone Prof. Gould finds in Cassiopeia, which is diametrically opposite to the Southern Cross. The right ascension of the northern node is 0 h. 50 m.; the southern 12 h. 50 m.; the declination about 60°, and very near the points where the great circle of the Milky Way has its maximum declination. The inclination of this stream of stars to the Milky Way is about 25°; the Pleiades occupying a point just midway between the nodes. Prof. Gould after making this discovery found that it had been partially anticipated by Sir John Herschel, so far as the recognition of a portion of the zone was concerned. The two classes of considerations—the approximate method furnished by the hypothesis of an equable distribution of stars, and the existence of a well-marked zone of very bright stars as much inclined to the Milky Way as the equator is to the ecliptic, may assist in determining the position of our sun with reference to its own cluster, that of the cluster itself, and the scale of distances between its constituent stars.

Prof. Wright read two papers on cognate subjects, one *On the use of Natural Twin Crystals of Quartz in the construction of Polariscopes*, and *On the nature of the Zodiacal Light and the distribution of matter which occasions it.*—Prof. Wright gave reasons for doubting whether the hypothesis of bodies rotating around the sun in all directions, and within the orbit of the earth, will account for the zodiacal light. The observed form of the zodiacal light is consistent with the supposition that the reflecting bodies move in long orbits—*i.e.*, orbits of great eccentricity.

Small Brains in Tertiary Mammals.—Prof. Marsh compares the mammals of the Eocene, Miocene, and Pliocene, with the result that in the case of the animals observed, Dinoceras and Brontotherium, a very distinct and remarkable development of brain from the lower to the higher formations.

Summer Dormancy of Butterfly Larvæ, by Prof. C. V. Riley, of St. Louis.—In this paper the author, referring to Mr. S. H. Scudder's paper in the *American Naturalist* for Sept. 1873, gave the results of his observations on the larvæ of *Phyciodes nycteis*, some of which appear to remain in a dormant state through the summer and succeeding winter.

The Disintegration of Rocks, by Prof. T. Sterry Hunt, of Boston.—This subject the speaker had noticed briefly in a communication to the Association last year on the geology of the Blue Ridge. The change of the rocks in question is a chemical one, which is the most obvious in the case of crystalline rocks; the feldspar loses its alkalies and part of its silver, being changed into clay, and the hornblende its lime and magnesia, retaining its iron and peroxide. From this results a softening and decay, to greater or less depths, of the strata, so that while they still retain their arrangement, and are seen to be traversed by veins of quartz and metallic ores, the strata are often so much changed to depths of one hundred feet or more from the surface as to be readily removed by the action of the water.

Fog Signals and Transmission of Sound, by Prof. Joseph Henry, of Washington.—Prof. Henry does not exactly accept the deductions recently made by Prof. Tyndall, having himself observed a large number of similar phenomena, and attributing them to refraction, not absorption, of sound by wind and other causes. Prof. Henry found Tyndall's explanation, that a mixed atmosphere absorbed sound, inadequate to explain the facts. The practical interference, and therefore the practical absorption, must be very inconsiderable compared with the volume of sound. In the case of the syren, such is the intensity of the sound that it would cause sand to dance on a stretched membrane at a dis-

tance of one-and-a-half miles, while a 2500-pound bell would not set the same sand in motion at a distance of thirty yards.

It has been frequently observed that a distinct echo is sometimes obtained from the ocean. Prof. Tyndall thinks the reflection is from surfaces of wind. Prof. Henry thinks it is from the surface of the waves of the ocean, and that the sound is afterwards refracted by the wind.

In a paper *On the Tails of Comets*, Mr. Henry M. Parkhurst endeavours to give data for predicting the form and appearance of these appendages.

Thermo-electric Properties of Minerals, by Professors A. Schrauf and E. S. Dana.—The interesting investigations of the late Gustave Rose, an eminent mineralogist at Berlin, have, during two or three years past, excited considerable interest in this subject. He began with the fact first announced by Hankel that some crystals of pyrite and cobaltite are electrically positive and others negative, and the endeavour to explain this opposite character on the assumption that it was connected with a condition of the right and left hemihedrism characteristic of both species. This touches a fundamental point in molecular physics, and if it could be sustained, Rose's hypothesis would be very valuable.

Schrauf and Dana, however, after the examination of a large number of minerals, comprising nearly all the metallic sulphids, have come to the conclusion that the cause of the variation of electrical character in this species must be sought elsewhere. They attribute it not to an opposite molecular condition shown in the hemihedral crystals, but to a change in chemical composition. They call their attention, in the first place, to the series of Seebach, where, for example, platinum occupies a varying position according to its degree of purity; moreover, they urge that the single case observed by Stefan, where some specimens of granular galena are positive and others of crystallised galena negative, is strong evidence against the influence of hemihedrism, as nothing of the kind can be assumed here. The force of their argument lies in the fact that they have found several other well-defined cases of minerals having peculiar varieties, and that among minerals crystallising holohedrally. Chemical analyses were here desirable to show how far the material under investigation varied in composition. In the absence of these, however, the specific gravity was resorted to as an indicator of the chemical character.

This afforded decisive results of plus and minus varieties of species, showing a decided difference in density and implying a corresponding change in composition. This was true also, in a marked manner, of cobaltite, and in a somewat less degree of pyrite, showing in each case where the explanation for the electrical character was to be looked for.

Several other conclusions were deduced from the long list of observations contained in the paper, but the foregoing will be sufficient to indicate its principal points.

Distribution of American Woodlands, by Prof. Wm. H. Brewer, of New Haven.—The flora of the United States, the author said, is believed to contain over 800 woody species, and over 300 trees. Of these trees, about 250 species are somewhere tolerably abundant, about 120 species grow to a tolerably large size, 20 attain the height of 100 ft., 12 a height sometimes of over 200 ft., and a few—perhaps 5 or 6—a height of 300 ft.

Notes on Tree Growth, by Prof. Asa Gray, of Cambridge, Mass.—Whether the trunk of a tree increases in length, in the parts once formed, is still an open question in the popular mind. From careful observations made by Prof. Gray and many others, the conclusion is that the trunks of trees do not grow in length.

Natural History at Penikese, by Prof. F. W. Putnam.—In speaking of the method of teaching at Penikese School, Prof. Putnam said :—"Text-books are not allowed. Our way was to give e ch student a specimen of fish and ask him or her to study that fish and tell the instructor what had been observed. Thus we developed their powers of observation upon the external character of the fish. After they had studied the fishes for about two days, they were called upon to state what they had seen. Then the anatomy of the specimens was gone into, and the students were led on step by step until they had secured a very firmly founded idea of the structure of a vertebrate animal. Then we asked questions as to the character of vertebrates, and finally they began to be original investigators. We really demonstrated in a practical way the subject, which is exciting so much attention now, of co-education of the sexes. We found that the ladies of the school were as capable in every way of making careful dissections and rendering careful accounts of the work they had done as the gentlemen, and, in fact, four or five of the ladies became original investigators before any of the gentlemen. This showed conclusively that the ladies had the power of becoming original investigators in science if they only would give the application."

Organic Change produced in the Bee, by Sophie B. Herrick, of Baltimore.—This was a very interesting paper, containing the authoress's own observations and experiments on bees.

The Reversion of Thoroughbred Animals, by Prof. Wm. H. Brewer.—It is often claimed that if the care of man be withdrawn an improved breed will retrace the steps of its ancestry and revert to its original characteristics. For some years Prof. Brewer has been investigating this subject and seeking for proof of the alleged tendency to reversion. To carefully-worded inquiries in writing, following upon every report of such "reversion," Prof. Brewer has received very numerous replies, and they are unanimously in the negative. This is certainly remarkable, following upon the confident assertions that animals so frequently exhibited the alleged tendency. The inquiries were pushed in the specific localities where the reversion was said to have occurred ; the questions have been put to a large number of stock-breeders, and finally have been made by means of a printed circular. But the result was always the same, except that a smile of incredulity extended over the faces of some stock-breeders when such inquiries were put to them, and they feared they were to be made the victims of a "sell." No instances of the alleged "reversion" having been authenticated in Prof. Brewer's experience, he asked the Association to aid in exposing and refuting the pernicious notion.

REPORT OF PROF. PARKER'S HUNTERIAN LECTURES "ON THE STRUCTURE AND DEVELOPMENT OF THE VERTEBRATE SKULL" *

VII.—*Skull of the Snake* (Coluber natrix).

AMONG the most noticeable features of the Ophidian skull may be mentioned the ivory-like texture of the bones, the immense strength and compactness of the brain-case, and the equally remarkable mobility of the facial bones, the maxillary and palatine apparatuses and the lower jaw being arranged in such a way as to allow of the greatest possible extension of the mouth during deglutition. Another important characteristic is the bony completeness of the brain-case, which is as thoroughly closed in as that of a mammal, scarcely any part of its walls being formed in the adult either by cartilage or fibrous tissue ; the inter-orbital septum, also, or laterally compressed anterior moiety of the basis cranii, so characteristic of the Sauropsida, is absent, the base of the skull being flat throughout, and abruptly terminated in front. But the most interesting and at the same time most anomalous feature is the persistence of the fœtal trabeculæ, in the form of two slender cartilaginous rods (Fig. 23, Tr), lying in grooves on either side of the parasphenoid.

The hinder part of the skull is formed by a well-ossified occipital segment, the four elements of which are firmly united with one another by suture ; the single convex occipital condyle is borne chiefly by the basi-occipital, the exoccipital, however, taking a considerable share in its formation. The basi-occipital is continued forward by a broad, expanded, basi-sphenoid, produced anteriorly into a slender prolongation or rostrum (Fig. 22, Pa.S), which underlies the front half of the brain-case, and answers to the parasphenoid bone.

The parietals are completely fused together in the mid-line, where they are produced in the Pythons and Boas into a strong sagittal crest for the attachment of the temporal muscles. In their hinder half they are simply roofing bones, as in Lizards and Amphibia ; but in front of the auditory capsule they extend downwards (Fig. 23, Pa^1) and meet the parasphenoid, forming with it a complete cylindrical cavity. The frontals, unlike the parietals, have only a sutural union with one another ; but they, too, are produced downwards (Fr′), and, moreover, come into contact with one another below, above the parasphenoid, so as to form

* Continued from p. 250.

unaided the whole of the anterior third of the brain-case—roof, walls, and floor. There is yet another important feature in these curious bones—the cylindrical cavity which they enclose is divided in front by a double pillar of bone, to which each frontal contributes its own half, and on either side of which the olfactory nerves pass to the nasal sacs: in this way a remarkable resemblance, both in form and position, to the frog's "girdle-bone" is produced; an analogy, indeed, which only the study of

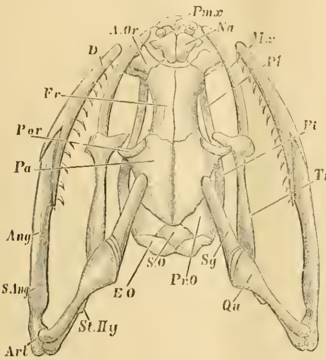


FIG. 21.—Skull of Snake (upper view). Tr. Os transversum

development can show to be as far as possible from a true homology.

Interposed between the anterior border of the ex-occipital and the posterior border of the descending portion of the parietal, is a stout irregular bone, which anyone studying the adult skull only would certainly look upon as the periotic or ossified otic capsule. As a

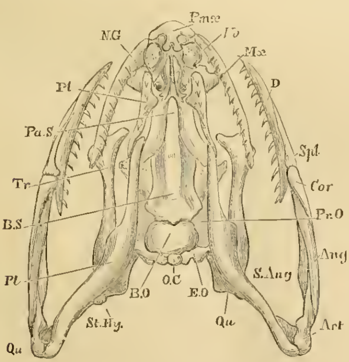


FIG. 22.—Skull of Snake (under view). Spl, splenial; Cor, coronary; Ang, angular; S.Ang, supra-angular.

matter of fact, however, it is both more and less than this. In the young state it consists of two perfectly distinct ossifications, between which the fifth nerve makes its exit. Now, this nerve (see NATURE, vol. x., p. 10) marks the line of demarcation between the posterior boundary of the parietal segment and the auditory capsule; the bone in front of it is, therefore, the alisphenoid, and that behind it the prootic, the latter being further determined by the fact that it lodges the main part of the vestibule, of the anterior and horizontal canals, and of the rudimentary cochlea. The remaining elements of the ear-capsule are, in the adult, quite undistinguishable; it is seen, however, that the arch of the posterior canal, as far forward as its junction with the anterior, extends into what appears to be the supra-occipital, and that the ampulla of the posterior and the hinder portion of the horizontal canals invade, in like manner, the ex-occipital. The explanation of this seeming anomaly—so common in the Sauropsida—is to be found in the snake at the time of hatching, when the pro-, epi-, and opisthotic elements are perfectly distinct from the neighbouring bones as well as from one another: as

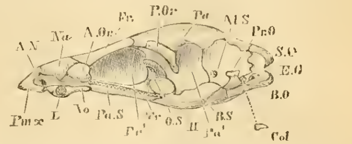


FIG. 23.—Skull of Snake (side view, with jaws removed). Col, columella, displaced from the fenestra ovalis, with which it is connected by a dotted line.

growth proceeds the epiotic becomes firmly anchylosed with the supra-occipital, and the opisthotic with the ex-occipital: the prootic, at the same time, remaining separate from the bones with which it is naturally related, acquires an intimate connection with the alisphenoid, forming with it the seeming "periotic" of the adult snake.

At the sides of the frontal region, and forming the anterior and posterior boundaries of the orbit, are two representatives of the "lateral line series" so prominent in osseous fish: these are the antorbital and the post-orbital. The antorbitals are large triangular bones, and between them lie the nasals, which together have a rhomboid form, and the inner edges of which are turned downwards, forming vertical plates similar to the inter-olfactory pillars of the frontals. In front of the nasals, and forming the termination of the snout, is the small toothless premaxilla, an azygos bone, with short nasal, maxillary, and palatine processes. The vomers are two hollow,

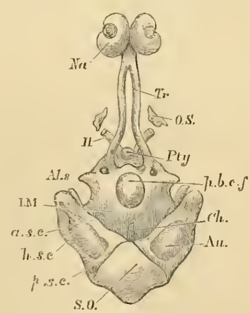


FIG. 24.—Chondro-cranium of Embryo Snake (upper view). p.b.c f, posterior basi-cranial fontanelle.

scroll-shaped bones, bearing on their excavated upper surfaces the nasal glands; the ducts of these pass through a notch in the outer border of the vomers, which is converted into a foramen by means of a triangular ossification, the septo-maxillary, here attaining its greatest development. The duct of the nasal gland is also supported on the outer side by two labial cartilages (l).

The foregoing bones are all compactly united with one another; the remaining ones, forming the powerful manducatory apparatus of the upper and lower jaws, are articulated only by loose fibrous tissues, and are thus

rendered capable of the greatest possible amount of extension.

On the upper surface of the skull, clamping the lateral occipital region and projecting backwards for fully half its length beyond the latter, is the flat sabre-like squamosal (Fig. 21, Sq), articulated to the hinder end of which, and thus carried completely away from the auditory region, is the quadrate, a stout bone passing obliquely downwards and outwards, and giving attachment by a rounded pulley-like surface to the mandible. On the inner edge of the quadrate, and partly coalesced with it, is a small nodular ossification representing the stylo-hyal (Figs. 21 and 22, St.Hy). The palatines and pterygoids are well developed and bear large recurved teeth; the latter extend backwards to the quadrate, to which they are united by ligaments just above its articular surface. The maxillæ are large strong bones lying parallel with the palatines and the front half of the pterygoids, and forming an outer dentigerous arch. Between the hinder end of the maxilla and the centre of the pterygoid runs a stout bone, the os transversum, found in this distinct form in all Ophidia, as well as in Lacertilia and Crocodilia, and occurring as a rudiment in some birds.

The two rami of the mandible are united at the symphysis by elastic fibrous tissue only, and each consists of six separate ossifications more or less fused together in the adult. These are the articular (Art) coming into relation with the quadrate, the angular (Ang) and supra-angular (S. Ang) applied, one above and one below, to the outer surface of the articular, the dentary (D) bearing the teeth, and the splenial (Spl) and coronary (Cor) appearing only on the inner surface.

The columella or auditory ossicle is extremely small in the common snake (Fig. 23, Col), and consists of a plug of bone fitting into the fenestra ovalis by a rounded disc-like end, the stapes, and of an extremely short rod anchylosed with and projecting backwards from the disc, which is all that represents the stapedial bones of the frog. In many of the larger serpents, both venomous and harmless, the columella is a rod of very considerable length, tipped at its end, in some cases, by an expanded cartilaginous flap, the homologue of the extra-stapedial.

The earlier stages in the development of the snake's skull have been well worked out by Rathke ("Entwickelungsgeschichte der Natter"). Abstracts of his views will be found in Prof. Huxley's Croonian Lecture (Proc. Roy. Soc., 1858), and in the "Elements of Comparative Anatomy" of the same author (p. 237). The earliest stage described by the lecturer corresponds with Rathke's third period, when chondrification is already thoroughly established, and the slender trabeculæ have united behind with the investing mass, and in front with each other (see Fig. 24). The notochord (Ch) reaches only to the middle of the broad investing mass (I.M), a large membranous space, the "posterior basi-cranial fontanelle" of Rathke (p.b.c.f) being between its anterior pointed end and the "anterior basi-cranial fontanelle," or pituitary space. A large occipital ring is already formed by the growing up of the investing mass around and above the neural canal, and articulating with its edges are the sub-triangular auditory capsules, on which the elevations caused by the semicircular canals (a.s.c, p.s.c, h.s.c) are particularly well marked. The trabeculæ diverge strongly in the pituitary region, in front of it run almost parallel, having between them the tissue from which the para-sphenoid is afterwards formed, and eventually unite and expand into the large reniform roofs of the nasal sacs (Na). The alisphenoids (Al.s) are already chondrified, but the orbito-sphenoids (O.s) are backward in development, being mere patches of indifferent tissue in front of the exit of the optic nerve (II). The mandibular arch is completely divided into a short quadrate and a long Meckel's cartilage. The hyoid arch is cartilaginous only in its upper part, and its apex is already fused with the stapes.

In the second stage all the bones of the adult have appeared with the exception of the alisphenoid, orbito-sphenoid, columella, stylo-hyal, and otic bones. The basi-occipital arises in the same manner as the urostyle of a frog or osseous fish,* as a bony deposit in the sheath of the notochord, affecting subsequently the surrounding cartilage; the basi-sphenoid makes its appearance as a pair of ossific centres, one on each side of the apices of the trabeculæ, where they join the investing mass. The parietals and frontals are quite normal in their development, arising as symmetrical ossifications in the supero-lateral region of the membranous cranium, and only acquiring their anomalous adult character by downward extension towards the base of the skull at a later period. In this stage a segment has separated from the hyoid arch and attached itself to the inner border of the quadrate: this is the stylo-hyal, the remainder of the arch now constituting the columella.

In the third stage, consisting of snakes at the point of hatching, all the ossifications have appeared, with the exception of the orbito-sphenoid, which is unusually late and uncertain in its development. Besides the three chief otic centres, which are perfectly distinct from the occipital regions, a plate of bone is to be seen in this stage within the lower edge of the squamosal: this answers to the ectosteal plate of the pterotic, so largely developed in osseous fishes. Lastly, the jaws have acquired their adult character by the loosening of the quadrate from the auditory capsule and its retrogression to its adult position, articulating with the hinder end of the backward-turned squamosal.

NOTES

A movement which has been for some time on foot for establishing in London a School of Medicine for Women is now so far matured that the school will be opened for the winter term on Oct. 12, in commodious premises, 30, Henrietta Street, Brunswick Square. The full staff of lecturers has not yet been appointed, but among those who have already consented to take part in the instruction are Dr. King Chambers in the practice of Medicine, Mr. Berkeley Hill in Surgery, Mr. A. T. Norton in Anatomy, Dr. Sturges in Materia Medica, Mrs. Garrett Anderson in Midwifery, Mr. Critchett in Ophthalmic Surgery, Dr. Cheadle in Pathology, Mr. Heaton in Chemistry, and Mr. A. W. Bennett in Botany. The following gentlemen have, in addition, consented to serve on the Council:—Dr. Billing, Dr. Buchanan, Mr. Ernest Hart, Prof. Huxley, Dr. Hughlings Jackson, Dr. Murie, Dr. F. Payne, Dr. W. S. Playfair, and Dr. Burdon-Sanderson, as well as Dr. Elizabeth Blackwell. A fair number of students are already enrolled. It is intended to build a detached dissecting-room in the garden attached to the house.

Dr. William Rutherford has been appointed to the Professorship of Physiology at the University of Edinburgh, vacated by the resignation of Dr. J. Hughes Bennett. Dr. Rutherford, in accepting his new appointment, vacates the Professorship of Physiology at King's College, London, the Assistant-Physicianship at King's College Hospital, and the Fullerian Professorship at the Royal Institution. The duties of the first of these will most probably be undertaken, during the coming session at least, by Dr. David Ferrier.

Dr. Adolf Bernhard Meyer, the recent explorer of New Guinea, has been appointed director of the Zoological Museum at Dresden, in succession to Dr. Reichenbach, who has retired.

* In these types a variable number of vertebræ at the termination of the column undergo a process of absorption, and a single ossification appearing in the sheath of the notochord constitutes the urostyle or coccyx. In the head a similar process takes place at the anterior end of the notochord, where a number of vertebræ may be considered to have been suppressed, forming what may be termed a "cephalostyle": the bony deposit spreading from this into the investing mass, gives rise to the basi-occipital.

Dr. Meyer entered upon his new duties on the first of last month.

A CORRESPONDENT with the Transit of Venus Expedition to Honolulu, writing from Valparaiso, informs us of the safe arrival there of the party after a particularly fine passage south; the weather was not so favourable up the Chili coast.

A LARGE and influential meeting of the professional and private friends of the late Dr. Anstie was held on the 23rd ultimo, at the house of Dr. George Johnson, in Savile Row, for the purpose of taking steps to raise a fund to be applied in perpetuation of Dr. Anstie's memory, and in recognition of his public and professional services. Dr. Burdon-Sanderson moved, and Dr. Glover seconded, a resolution—"That, considering the labours of the late Dr. Anstie for the promotion of science, and the circumstances of his untimely death, it is desirable that some permanent memorial of his career should be established." In speaking to this resolution, it was pointed out that Dr. Anstie's widow and three young children were but slenderly provided for, and hence that his only son would probably be unable to obtain the complete education which his father, if his life had been spared, had intended to secure for him. It was felt that the proposed memorial might fittingly take the form of a fund to be devoted to this object, and it was hoped that such an application of money might not be unacceptable to his family, and might be received by them as a fitting tribute to the estimation in which Dr. Anstie was held. By subsequent resolutions, a large committee was appointed to carry out the objects of the meeting, and Mr. J. S. Storr, of 26 King Street, Covent Garden, was appointed treasurer, and Mr. Brudenell Carter and Dr. Wharton Hood were appointed joint honorary secretaries. An executive committee was also nominated; and an opinion was expressed that the circumstances of Dr. Anstie's death, in the discharge of his duty, as well as much of the work which he had done during life to ameliorate the condition of the poor, were sufficient to justify an appeal to the general public as well as to his own profession.

THE Photographic Society invites scientific men who have turned their attention to photography to furnish specimens for their forthcoming exhibition. It is proposed to devote a room to the purely scientific applications of the subject.

WE would again draw the attention of secretaries of British scientific societies to the proposed work referred to in a recent number (NATURE, vol. x. p. 407) by M. Rauis, of the Belgian Academy—a Dictionary of Learned Societies. He is of course anxious to get full and trustworthy information, and we hope that the numerous societies of this country will lend him every assistance in carrying out his valuable scheme.

THE news of the death of M. Elie de Beaumont, in his 76th year, has thrown a gloom over the French Academy. We believe that his position of perpetual secretary to the Academy will be conferred on M. Bertrand, at present president of the Academy of Sciences. The *fauteuil* of M. Bertrand, who is a member in the section of Geometry, would thus become vacant, and would be the object of a warm contest. Since the foundation of the Academy of Sciences, the place of secretary has been permanent, while that of president has been annual. Among the predecessors of M. de Beaumont were Fontenelle, who died a centenarian after having occupied his *fauteuil* for sixty years, Condorcet, Fourrier, Delambre, and Arago, whom De Beaumont succeeded, the two together having held office for more than half a century. Since the death of Flourens, M. Dumas has been secretary for the Physical Sciences.

AT the Aberdeen Cryptogamic show referred to in last week's NATURE, p. 427, a meeting of botanists was held, when it was agreed to form a Scottish Cryptogamic Society, which, by an annual exhibition held in the larger cities by rotation, and by other means, would endeavour to promote a more general and deeper knowledge of cryptogamic plants. It is intended to hold the exhibition for next year at Perth.

THE first session of the Yorkshire College of Science, Leeds, opens on the 26th inst. There are already four professorships—Mathematics and Experimental Physics (Prof. Rücker), Chemistry (Prof. Thorpe), Geology and Mining (Prof. Green), Textile Fabrics (Prof. Walker).

THE expedition organised in June last by Captain Williams, of Sunderland, in the steamship *Diana*, belonging to Mr. Lamont, of Dundee, has returned to the latter port. The Novaya Zemlya region was the scene of the *Diana's* cruising; the Gulf of Obi was reached, and the conclusion come to that without difficulty a vessel might make Behring Strait. Capt. Wiggins, who was in command, endeavoured to assist the Austrian expedition, but was compelled to give up the attempt. Curiously, however, the *Dinaa* reached Hammerfest just an hour before the members of the Austrian expedition. Some important corrections of the geography of the region around the mouth of the Obi have been made.

THE council of the Institution of Civil Engineers have issued a list of subjects for premiums to be awarded during session 1874-75. Information with regard to the premiums, which are valuable, is prefixed to the list, and we advise those interested to apply to the secretary for information.

THE Council of the Institution of Naval Architects have had under consideration the question of providing a good series of contributions for their next session. They have accordingly prepared a list of subjects, which they desire to submit to the members and associates of the Institution, and others interested in shipbuilding, as questions on which they will be glad to receive communications for the annual general meeting in March (17th to 20th), 1875. Anyone wishing a list of the subjects should apply to the Secretary, 20, John Street, Adelphi.

THERE are several reports to hand of recent earthquakes. There was a violent shock at Randazza, Sicily, on Sept. 27, and several houses were injured. Rumbling noises are audible from Mount Etna.—Intelligence published at New York on Sept. 26 reports that the town of Antigua, in Guatemala, has been destroyed by an earthquake.—Several shocks of earthquake were felt at Delhi on Aug. 31, at 5.25 A.M.—A shock was felt near Sucklaspore, in the Madras Presidency, on the evening of the 17th Aug. The direction of the shock was from east to west, and the duration seven seconds.

A TERRIBLY destructive typhoon swept over Hong Kong about 12 o'clock on the night of Sept. 23. Many vessels were wrecked and the loss of life is estimated at 1,000, and the damage done to property is immense. The typhoon reached Macao, causing there also a fearful amount of damage.

ONE of the Limuli at the Crystal Palace Aquarium died last week from the effects of the continued attacks made on it by lobsters in the same tank. The other Limuli are now in a separate tank.

THE Swiss Society of Public Usefulness, says the *Continental Herald*, which met at Friburg from the 21st to the 23rd inst. inclusive, treated the subjects engaging its attention under two heads, viz., Public Instruction and Industry. Under the first head it discussed whether the professional teaching now given in the Confederacy should be altered; whether in the secondary schools for boys a larger share of scientific education ought not to be given, combined with practical exemplification, manual labour, and experience in industrial chemistry; whether in the secondary and superior schools for girls sufficient attention is paid to the

class of studies which will be of service in careers now open to women, and if their education is directed towards facilitating their entry into new occupations; whether it would not be advisable to introduce into secondary schools for girls commercial education and the study of drawing as applied to manufactures, such as those of ribbons, lace, printed stuffs, wall papers, &c.

A NEW horticultural garden has been opened at St. Petersburg under Imperial patronage. It is fifteen acres in extent, and is to be devoted principally to illustrate how native plants may be combined for pretty and tasteful decorations. One large portion is to be devoted to conifers, in order that there may be, even in winter, green promenades.

THE consumption of osiers for various purposes, in England especially, is very great. Besides her own production, this country imports more than 5,000 tons, valued at about 40,000*l*. About 300 varieties of osiers are known, the most important beds being situated near Nottingham; the home produce being insufficient to meet the demands, great attention is being paid to the cultivation beds in Australia, and a considerable quantity is yearly produced in that country.

THE cultivation of the Angora Goat is attracting some attention in Australia, where this animal appears to thrive very well. The hair is said to make a very good "mohair" fabric, but its quality depends very much upon the nature of the locality in which the animals are reared. Undulating prairies with a good supply of pure water are best adapted to the habits of this goat. In sandy hilly districts it thrives admirably, but the hair is inferior and falls off very quickly. The flesh is excellent, and is preferred in some parts of Australia to the best mutton. The milk is of good quality and yields a good supply of butter and cheese. The hair is worth about four shillings a pound, and one ram will yield about four pounds at each shearing; the best plan is to shear them twice a year, as this prevents the hair from falling off and from splitting; at each shearing it is about six inches long. Compared with the merino sheep, the Angora goat seems to have the advantage in the fact that the former produces only three-and-a-half pounds of wool, worth two shillings and sixpence per pound, and that six merinos will eat as much as seven Angoras. These facts are important in view of the acclimatisation of the Angora goat in other parts of the world.

THE New Zealand Flax (*Phormium tenax*) is being cultivated in St. Helena, and there seems no reason why the same thing should not be done in other countries. Hitherto no very great attention has been paid to the cultivation of this plant, but the natural supplies obtained in New Zealand are insufficient for the demands of commerce. It is a mistake to suppose that an illimitable supply can always be obtained because no cultivation has been necessary in the first crops of the wild produce. This is not to be regretted, for careful cultivation cannot fail to greatly improve the fibre, and the best kinds alone will be worth the trouble of proper rearing. Steps are however being taken to cultivate the plant in New Zealand and in other countries which have been fortunate enough to acclimatise it. In the Azores, at St. Helena, in Algiers, and the south of France, it thrives well, and has been easily naturalised. The fibre is principally used for making ropes and paper, for the caulking of vessels, for stuffing mattresses, and for coarse textile fabrics. The seeds yield a valuable oil when crushed.

THE Crystal Palace Company are to give a magnificent fête on behalf of the Hospital Saturday Fund on the 5th inst.

M. HENRY COCKERILL, of Aix-la-Chapelle, nephew of the late John Cockerill, we learn from the *Journal of the Society of Arts*, who founded the great engineering establishment at Seraing, near Liege, which until the immense extension of the Creuzot works was the largest on the Continent, has placed at the disposition of the Société Cockerill the sum of 50,000 francs, to be invested in the public funds of Belgium, the interest to be applied to the endowment of scholarships, to enable the sons of workmen, or others employed by the society, to attend the courses of study at the Mining School of Liege.

THE popular demand in America for a complete series of the annual reports of the United States Geological Survey of the Territories, under the charge of Dr. F. V. Hayden, has been so great that the Secretary of the Interior has ordered the printing of a second edition of the first three annual reports in one volume. A compact 8vo. of 261 pp. with index has in consequence been issued. The survey in its present form commenced in the spring of 1867 with the small grant of $5,000 for the survey of Nebraska, and the following year a similar grant was made for Wyoming. During these two years the survey was under the General Land Office, and the first and second annual reports were included in the reports of the commissioner. Their reprint is a great convenience for reference. In the third year (1869) the survey was placed by Congress under the Secretary of the Interior, and $10,000 was granted for the examination of Colorado and New Mexico. The volume for that year was issued as an independent volume, and was reviewed in NATURE, vol. iv. p. 24. These reports differ from the memoirs of our English survey, which are in illustration of single sheets or sometimes quarter sheets of maps of the survey, for a United States Report includes a whole State. Our own enter into detail; these give general views. Further, these reports give not only the geological and palæontological features and mineral resources of a State, but its agricultural condition and prospects are included. Speaking of the treeless prairies, Dr. Hayden expresses his belief that forests may be restored in a short time, and gives many illustrations of what planters have effected in ten years in Nebraska. Cotton-wood (*Populus monilifera*), Soft Maple (*Acer rubrum*), Elm (*Ulmus americana*), Bass-wood or Linden (*Tilia americana*), Black Walnut (*Juglans nigra*), Honey Locust (*Gleditschia tricanthus*), and Willows, are the trees mostly cultivated. English agriculturists may perhaps be astonished at hearing crops being spoken of as promising because the grass-hoppers have left a full half crop of wheat. In the first report are some interesting notes on the present condition of the Otoe Indians; and notes by Dr. Newberry and Prof. Heer, on the fossil leaves of the Dokata group; while the second report includes a sketch of the physical geography of the Missouri Valley. Although called a geological survey, climatal and meteorological observations are interspersed, as well as much information about game and wild animals. There is also much valuable agricultural information, that alone would create a large demand for the reprint.

WE have received the Eighth Annual Report of the Aëronautical Society. The report is mainly occupied with an account of experiments and calculations which have been recently made, and contains a paper by Mr. D. S. Brown on the Aeroplane, and a long and elaborate paper by Mr. James Armour, C.E., entitled "Wings for Man."

THE additions to the Zoological Society's Gardens during the past week include a Praslin Parrakeet (*Coracopsis barklyi*) and four Red-crowned Pigeons (*Erythrœnas pulcherrima*) from the Seychelles, presented by the Hon. Sir Arthur Gordon; two Burchell's Bustards (*Eupodotis kori*) from S. Africa; a Hocheur Monkey (*Cercopithecus nictitans*) from W. Africa; a Punjaub Wild Sheep (*Ovis cycloceros*) from N. W. India; two Blackish Sternotheres (*Sternotherus subniger*) from the Seychelles; a Common Octopus (*Octopus vulgaris*) from the British Seas, deposited.

THE BRITISH ASSOCIATION

Reports

Tabular View of the Classification of the Labyrinthodonta, by L. C. Miall. Summary of the Second Report on Labyrinthodonta.

AMPHIBIA

LABYRINTHODONTA.

A.—*Centra of dorsal vertebræ discoidal.*[1]—Genera 1 to 25.

I.—Euglypta. Cranial bones strongly sculptured. Lyra conspicuous. Mandible with well-developed post-articular process. Teeth conical; their internal structure complex; dentine much folded. Palato-vomerine tusks in series with small teeth. Short inner series of mandibular teeth. Sculptured thoracic plates, with reflected process upon the external border.

* *Palatine foramina large, approximated.*

† *Mandible with an internal articular buttress.*

‡ *Orbits central or posterior.*

1. Mastodonsaurus, Jäger.
2. Capitosaurus, Munst.
3. Pachygonia, Huxley (?).
4. Eurosaurus, D'Eichwald (?).
5. Trematosaurus, Braun.
6. Gonioglyptus, Huxley.

‡ ‡ *Orbits anterior.*

7. Metopias, Von Meyer.
8. Labyrinthodon, Owen.[2]

† † *Mandible without internal articular buttress.*

9. Diadetognathus, Miall.

* * *Palatine foramina small, distant.*

10. Dasyceps, Huxley.
11. Anthracosaurus, Huxley.

II.—Brachyopida. Skull parabolic. Orbits oval, central or anterior. Post-articular process of mandible wanting (?).

12. Brachyops, Owen.
13. Micropholis, Huxley.
14. Rhinosaurus, Waldheim.
15. Bothriceps, Huxley.

III.—Malacocyla. Skull vaulted, triangular, with large postero-lateral expansions. Lyra consisting of two nearly straight longitudinal grooves, continued backwards as ridges. Orbits large, posterior, irregular. Temporal depressions, passing backwards from orbits. No post-articular process to mandible.[3]

* *Teeth with large anterior and posterior cutting edges.*

16. Loxomma, Huxley.

* * *Teeth conical.*

17. Zygosaurus, D'Eichwald.

IV.—Athroodonta. Maxillary teeth wanting. Vomerine teeth aggregated. Orbit imperfect.

18. Batrachiderpeton, Hancock and Atthey.
19. Pteroplax, Hancock and Atthey.[4]

[V.—An uncharacterised group for the reception of some or all of the following genera.]

20. Pholidogaster, Huxley.
21. Ichthyerpeton, Huxley.
22. Pholiderpeton, Huxley.
23. Erpetocephalus, Huxley.

VI.—Archegosauria. *Von Meyer.* Vertebral column notochordal. Occipital condyles unossified.

24. Archegosaurus, Goldfuss.
25. Apateon,[5] Von Meyer.

B.—*Centra of dorsal vertebra elongate, contracted in the middle.*

VII. Heleothrepta. Skull triangular, with produced, tapering snout. Orbits central. Mandibular symphysis very long, about one-third of the length of the skull.

26. Lepterpeton, Huxley.

VIII.—Nectridea. Epiotic cornua much produced. Superior and inferior processes of caudal vertebræ dilated at the extremities and pectinate.

27. Urocordylus, Huxley.
28. Keraterpeton, Huxley.

IX.—Aistopoda. Limbs wanting.

29. Ophiderpeton, Huxley.
30. Dolichosoma, Huxley.

[1] This character is not of primary importance, but seems to be available for an arrangement determined by other considerations.
[2] Orbits unknown.
[3] Loxomma.
[4] The vomerine teeth are unknown, and this genus may therefore require to be removed.
[5] Of doubtful distinctness.

X.—Microsauria, *Dawson.* Thoracic plates unknown. Ossification of limb-bones incomplete. Dentine non-plicate, pulp cavity large.

31. Dendrerpeton, Owen.
32. Hylonomus, Dawson.
33. Hylerpeton, Owen.

SECTIONAL PROCEEDINGS

Section A—Mathematics

On the Photographic Operations connected with the coming Transit of Venus, by Captain Abney, R.E., F.R.A.S.

As is doubtless well known to all, there will be an application of photography to register the passage of Venus across the sun's disc, and it may not be amiss to give an outline of the processes, &c., that will be adopted. It has been determined by the Astronomer Royal that at every photographic station a photograph shall be taken every two minutes during the transit, and it has been a matter of considerable labour to work out a process that will admit of such a large number of negatives being taken in a hot climate. In Kerguelen's Land it would be perfectly feasible to adopt the ordinary wet process, the low temperature admitting of it, but in a temperature of 90° F. the evaporation of the volatile constituents of the collodion would render such a procedure inapplicable, as all practical photographers will admit. In India, where I have worked extensively, coating two or three plates in succession in a large-sized tent has sometimes proved injurious. With such experience I venture to think that it would have been madness to trust to the wet method for four hours, unless the conditions of *personnel* of the parties were considerably altered. Sir G. Airy, after much anxious deliberation, and with the advice (and that not hastily formed, by any means) of Mr. De la Rue, determined to adopt a dry process if practicable. After considerable experiments conducted at Chatham, it was determined to adopt an albumen dry process, using a highly bromised collodion, and strong alkaline development. There were several advantages in this:—(1) At the critical time the photographers would have nothing to distract their attention excepting placing the dry plates in the slide and developing every twelfth plate exposed, in order to regulate the exposure; (2) the irradiation was much diminished by the use of albumen, a point of no small importance when measurements have to be taken; (3) the shrinkage of the film is reduced to zero when the plates are properly prepared.

In regard to the first advantage claimed, it will be apparent that plates prepared at leisure will have a much superior advantage to those prepared in the hurry of the moment as would be the case with wet plates. The chances of stains and spots are diminished tenfold, and we may expect a much clearer picture.

The true explanation of irradiation has been argued of late in Nature, and perhaps I may be pardoned for dwelling an instant on that point. Irradiation may be divided into two kinds, viz., that occurring from reflection from the back of the plate, and that occurring from reflection from the particles of bromide or iodide of silver in the collodion film. The first requires no explanation. If a film be insufficiently dense and of such a colour as will cut off the most active rays of the spectrum, no irradiation on that account need be anticipated. Iodide of silver fulfils this condition much more fully than does bromide of silver, the former approaching to a yellow colour, whilst the latter is almost white. A thin layer of iodide is much more efficient in cutting off the blue end of the spectrum than is the bromide; hence, if irradiation through reflection from the back of the plate is to be overcome, it is wise to use a certain proportion of iodide in the collodion. Practically I have found that in the dry process under consideration, three parts of iodide to two of bromide give the best results without diminishing the sensitiveness of the film. The second cause of irradiation, viz., reflection from the particles of bromide and iodide, is not hard to explain. When a colloid body such as gelatine or albumen is brought in contact with a soluble salt of silver, the resisting compound is found to be one which is singularly free from this defect. If a ray of light be allowed to fall at right angles upon a very thin cell containing an emulsion of bromide of silver, the cell having worked glass sides and ends, it will be found that the ray of light will be scattered considerably, apparently in a logarithmic curve; the surface nearest the source of light will not be affected, but it will spread from that surface towards the other, a physical line of light becoming an area. If, however, a colloidal salt of silver be introduced it will be found that this area is much diminished,

and for small distances becomes inappreciable. In connection with this I may mention that bromide plates, even when backed with a non-actinic backing in optical contact with the plate, will give irradiation with alkaline development, whilst with acid development the irradiation will disappear. The explanation is not far to seek—the alkaline development reduces the silver *in situ*, the acid development deposits silver on the surface and where there is most attractive force. In the former case, the dispersed light acting on the interior of the film, causes the necessary change in the bromide of silver to effect reduction. Daguerreotype plates are not free from irradiation as has been supposed, though, owing to the extraordinary thinness of the iodide of silver, but little effect can be traced unless very prolonged exposure be given.

In the dry process selected for the transit of Venus it has then been thought desirable to have a rather dense film containing a proportion of iodide of silver and a colloid body—albumen—as preservative. I am not unmindful of the fact that different pyroxylines more or less affect irradiation, and we have altered the constitution of the pyroxyline in the collodion I shall use, by adding certain proportions of water; this materially aids the annihilation of irradiation from these plates.

For registering the time of external and internal contact of the planet with the sun's disc, the method known as Janssen's has been adopted, viz., causing a fresh portion of a plate to be exposed every second during the critical time, to the sun's limb, at that part where the contact will take place. Mr. Christie and Mr. De la Rue have both devised a slide for this purpose. The English parties use that designed by the former, whilst Colonel Tennant will use that by the latter. Shrinkage in the film has been carefully looked for by Dr. Vogel, of Berlin, and also by myself. Photographing a grating of 200 lines to the inch by contact printing, and measuring the results, I have been unable to find any alteration in the distances of the lines at any part of the film, hence I feel confident that any shrinking that can take place will be so small as to be negligible. The Russian parties are, I believe, going to use a grating material of iron wires. If shrinkage does occur this would be necessary, but it seems almost useless, in fact hurtful, where there will be none. There must be a certain error introduced due to the grating itself. The method of finding the angle of the position of the wires will be determined photographically. Two pictures of the sun will be taken at an interval of one minute on the same plate. The line forming the intersection of the sun's images will give the angle of position of the wires when measured by the micrometer. At each station the photographic party will consist of one officer and three sappers, all of whom have been trained in the use of the photo-heliograph and the process employed. A drill for each operation has been devised, and it is anticipated that the dangers of excitement during the critical times have been overcome by this arrangement. Practice on a mock transit has ensured a thorough knowledge of each phase of the phenomena; and I apprehend that discipline combined with a trust in their superiors will have annihilated one source of failure.

On the importance of improved methods of Registration of Wind on the Coast, with a notice of an Anemometer, designed by Mr. W. De la Rue, F.R.S., to furnish telegraphic information of the occurrence of strong winds, by Robert H. Scott, M.A., F.R.S.

It is hardly necessary to draw the attention of the Section to the fact that the configuration of the earth's surface exercises an overwhelming influence on the wind both as to its direction and force. Some statements and tables contained in a paper of mine in the last number of the *Quarterly Journal* of the Meteorological Society * abundantly prove this assertion, and it is therefore easy to see what an imperfect representation of the actual force of the wind at sea can be furnished by reports from a broken and mountainous coast, such as the Atlantic coasts of Ireland and Scotland, where the telegraphic stations are perforce situated in sheltered places, inasmuch as harbours are naturally found where there is as little exposure to wind as is possible.

In the practice of weather telegraphy and storm warnings, as the number of reports received per day from each station is strictly limited, on financial considerations, it is quite obvious that if the actual epoch of the commencement of a gale does not fall within the hours of attendance at the Telegraphic Office and at the Meteorological Office, which practically only extend from 8 A.M. till 3 P.M., much time will be lost in sending news of the fact to London. If it commences at 6 P.M. at Valencia, we cannot hear of it in London till 9 A.M. next morning.

On the other hand, if the observer be living in a sheltered spot, such as Plymouth, Nairn, or Greencastle, we shall not get a true report of the gale at all, inasmuch as the observer will not have felt it himself.

The first-named defect in our system can only be met by a considerably increased expenditure on the service, and that is not a scientific, but an administrative question, with which the Government can alone deal.

In order to meet the second difficulty, Mr. De la Rue has kindly devised an instrumental arrangement, by which the fact of any given force of wind having been reached at an exposed point (such as Rame Head for Plymouth, or Malin Head for Greencastle), can be at once conveyed to the reporter in his own office, or even to the central office in London. The instrument has been made by Messrs. Negretti and Zambra.

The following is the construction of the new signalling anemometer.

To the ordinary Robinson's anemometer spindle is affixed a toothed wheel, which is geared with another and larger toothed wheel fixed on a second vertical spindle which carries a centrifugal governor. The governor spindle is made to rotate at one-half or one-third of the velocity of the anemometer spindle in order that the rods carrying the governor balls may not have to be made inconveniently short. A provision is made for adjusting the length of the arms of the governors so that different wind velocities may be indicated within certain limits.

The governor balls act in the well-known way and expand when driven at a given rate, and the upward motion of these governor balls is used to raise a secondary wheel to bring into gear a third spindle on which is fixed the armature of a magneto-electric apparatus, which, like Sir Charles Wheatstone's instruments, consists of a compound permanent magnet with four soft iron cores, two of which are mounted on the north pole of the magnet and two on the south pole; these iron cores are surrounded with fine insulated copper wire, and on rotation of the armature give alternate + and — currents, in rapid succession according to the rate at which the armature is driven. These currents are conveyed inland to the observing station by insulated wires, and give warning by ringing an alarum as long as the anemometer cups are revolving at a velocity sufficient to raise the governor balls so as to bring the magneto-electrical apparatus into gear.

We see, therefore, that by adjusting the governors of the apparatus to indicate any required speed, a warning will at once be given when the wind reaches that speed, be it that of 60, 40, or 20 miles an hour, as may be required.

All the attention which the instrument requires after the apparatus is fixed is to lead two insulated wires from the anemometer into the observing station, and to connect these wires to the two terminals on the alarum.

In order to enable the observer to communicate at once and at as little expense as possible, to London, the fact of the velocity in question having been reached, the individual stations might be known by letters or symbols which might simply be telegraphed to London as an announcement that the alarum was acting at the station in question.

It is obvious that this plan is exceedingly simple, and there seems little reason why it should not be thoroughly efficacious, if only the registering portion of the apparatus can be properly protected from wilful damage by mischievous persons.

As usual, we are met by the question of cost, not only of the apparatus but of the connecting wires, and last, though not least, of the transmission of the messages. To enable us to render our service more effective than it is we must be supplied with the sinews of war. The 3,000*l*. which is the very utmost we spend annually on telegraphy, including salaries, rent, and every item, is but small compared with the 50,000*l*. *entirely exclusive of salaries* with which the chief signal office of the United States is so munificently endowed.

On the Source from which the Kinetic Energy is drawn which passes into Heat in the Movement of the Tides, by John Purser, M.R.I.A., Professor of Mathematics in the Queen's University.

Attention has of late years been directed by Mayer, Prof. James Thomson, and others, to the fact that the friction of the tidal currents on the bed of the ocean exercises an effect in retarding the earth's rotation on its axis.

The late eminent French astronomer, Delaunay, was the first, as far as I am aware, to form a numerical estimate of the possible magnitude of this effect, and to suggest that it furnishes a not

* "An attempt to establish a Relation between the Velocity of the Wind and its Force (Beaufort Scale), with some remarks on Anemometrical observations in General," by Robert Scott, F.R.S. (Quart. Journ. of Met. Soc. vol. ii. p. 109.

improbable solution of that part of the secular inequality in the moon's mean motion which remains still unexplained.

He pointed out that inasmuch as the axis of the tidal spheroid is always behind the moon's place, a couple is exerted by the forces of the moon's attraction, which on the one hand retards the rotation of the earth, and on the other increases the dimensions of the lunar orbit.

This alteration of the lunar orbit prevents us from concluding, as we should otherwise do, that the kinetic energy which passes into heat in the movement of the tides has for its exact equivalent a corresponding quantity drawn from the store laid up in the earth's rotation on its axis.

The object of the present communication is to examine whether we can assert such an equivalence to hold approximately, and if so, to what degree of approximation. The question was started some years ago by the Astronomer Royal in the Astronomical Notices for the year 1866.

It occurred to the author that we might arrive at a solution of the problem from the information given us by the equation of energy combined with that of the conservation of angular momentum.

Let us in the first place take the case of a binary system consisting of the earth and moon, but suppose the plane of the earth's equator to coincide with that of the lunar orbit. If Q denote the energy which, during a given interval, passes into heat through tidal action, then, assuming the moon spherical and her rotation consequently unaltered, $Q = -\delta$ (energy of earth's rotation) $-\ \delta$ (energy of lunar orbit). By the energy of the lunar orbit is denoted the kinetic energy of the revolution of the earth and moon round their common centre of gravity, together with the potential energy of their separation.

Now the energy of orbit $=$ constant $- \frac{1}{2}\, m\, m^1\, \mu\, \frac{1}{a}$, where $m\, m^1$ represent the masses of the two bodies, μ the unit of attractive force, and a the mean distance.

Hence $Q = -\delta$ (energy of earth's rotation) $- \frac{1}{2}\, m\, m^1\, \mu\, \frac{\delta a}{a^2}$.

Let h denote the angular momentum of the revolution of the two bodies round their common centre of gravity, H the angular momentum of the earth's rotation, then

$$\delta H = -\delta h$$

but

$$h = \frac{m\, m^1 \sqrt{\mu}}{\sqrt{m + m^1}} \sqrt{a} \sqrt{1 - e^2}$$

$$\therefore \delta h = \frac{m\, m^1 \sqrt{\mu}}{\sqrt{m + m^1}} \left\{ \sqrt{1 - e^2}\, \frac{\delta a}{2\sqrt{a}} - \frac{\sqrt{a} \cdot e\, \delta e}{\sqrt{1 - e^2}} \right\}$$

When the excentricity is small the second term in this expression may be shown to be negligible when compared with the first, and we may write

$$\delta H = -\delta h = -\frac{m\, m^1 \sqrt{\mu}}{\sqrt{m + m^1}} \frac{\delta a}{2\sqrt{a}}$$

$$\therefore Q = -\delta \text{ (energy of earth's rotation) } + \frac{\sqrt{m + m^1} \cdot \sqrt{\mu}}{Q^{\frac{3}{2}}} \delta H$$

Or if I denote the moment of inertia of the earth round her axis,

ω her angular velocity of rotation,

Ω the mean angular velocity of the moon in her orbit,

$$Q = -I\omega\delta\omega + I\Omega\delta\omega$$

$$\therefore -I\omega\delta\omega = \frac{Q}{1 - \frac{\Omega}{\omega}}$$

The left-hand member represents the loss of energy due to the slackening of the earth's rotation, and as Ω has the same sign as ω, we learn that not only is all the energy Q which is turned into heat in the motion of the tides drawn from the earth's rotation, but that, as a necessary concomitant, additional energy is transferred from the earth's rotation to the store at potential and actual energy, corresponding to the orbital motion of the system.

It also follows that when Ω is small compared to ω [in the actual case $\frac{\Omega}{\omega} = \frac{1}{27}$ nearly], the energy so transferred bears a very small ratio to Q, and that the energy lost in the earth's rotation is almost the exact equivalent of that consumed in tidal friction.

Let us now consider the case which we actually have to deal with, where the plane of the earth's equator does not coincide with the plane of the orbit.

Let G represent the resultant angular momentum of the system which will be fixed in magnitude and in direction.

θ, Θ the angles which the planes of h and H make with the plane of G.

Then, since $H^2 = G^2 + h^2 - 2\, G\, h \cos\theta$

$$H\,\delta H = (h - G\cos\theta)\,\delta h + G\,h \sin\theta\,\delta\theta$$

$$\therefore H\,\delta H = \frac{m\, m^1 \sqrt{\mu}}{\sqrt{m + m^1}} \left\{ (h - G\cos\theta) \frac{\delta a}{2\sqrt{a}} + G\sqrt{a} \sin\theta\,\delta\theta \right\}$$

$$\text{Or, } \delta H = \frac{m\, m^1 \sqrt{\mu}\sqrt{a}}{\sqrt{m + m^1}} \left\{ -\cos(\Theta + \theta) \frac{\delta a}{2a} + \sin(\Theta + \theta)\,\delta\theta \right\}$$

The author proves from a calculation of the disturbing reactionary forces exercised by the tidal protuberances that the variations $\delta\theta$ and $\frac{\delta a}{2a}$ are of the same order of magnitude, although their exact ratio cannot be determined without far more complete data respecting the tides than we at present possess.

Let the ratio of the first of these variations to the second be denoted by λ, then

$$\delta \mathrm{H} = -\frac{m\, m^1 \sqrt{\mu}}{\sqrt{m + m^1}} \left\{ 1 - \lambda \tan(\Theta + \theta) \right\} \frac{\delta a}{2\sqrt{a}}$$

$$\therefore -I\omega\delta\omega = I\left\{ 1 - \frac{\Omega}{\omega} \frac{\sec(\Theta + \theta)}{1 - \lambda(\tan\Theta + \theta)} \right\}^{-1}$$

We may therefore still infer that since Ω is small compared to ω, the energy lost in the earth's rotation is almost the exact equivalent of that consumed in tidal friction.

The same conclusion manifestly applies to the work done by a tide-mill or any other mechanism in which the tides furnish the motive power.

It would further appear that as the mean value of tan $(\Theta + \theta)$ is less than $\frac{1}{2}$, and that of λ cannot, on any probable hypothesis of the position of the tides, be supposed to exceed unity, the coefficient of $\frac{\Omega}{\omega}$ in the above expression is positive. Hence we may conclude that, as in the simpler case previously discussed, the small transfer of energy which accompanies the principal action takes place from the earth's rotation to the moon's orbit.

All these conclusions apply *mutatis mutandis* if we regard as our binary system the earth and sun.

In the case of nature, where we have to consider the three bodies acting together, the main conclusion that all the energy lost in tidal friction is drawn from the earth's rotation will not be invalidated.

Moreover, if we assume, as is generally done, that the friction varies as the velocity, the lesser effect, *i.e.* the concomitant, transfers its energy from the earth's rotation to the energy of the orbit of the moon about the earth, and that of the earth about the sun will correspond to the values separately calculated for the binary systems.

On the construction of large Nicol's Prisms, by W. Ladd.—In January 1869 I constructed two Nicol's prisms of about $2\frac{1}{2}$ in. aperture, which in the able hands of Mr. W. Spottiswoode and Dr. Tyndall have done much valuable work, and given rise to a great demand for such prisms, both in England and America; but as the length of a good Nicol should be about three times its diameter, very great difficulty is experienced in procuring pieces of spar of sufficient purity to give such a field.

This has given rise to various methods of utilising the spar by building up prisms of shorter pieces and combining them in such a way as to unite their field of view, such as utilising four prisms of 1 in. aperture, thus giving an aperture of 2 in. Another plan I adopted was to unite two whose diameter in one direction was double that of the other; these, being balsamed together, made a very good prism; but lately I had a very good piece of spar that, but for one corner of the rhombus, which was bad, would have made a prism $3\frac{1}{4}$ in. aperture. This was, therefore, too valuable a piece to be put aside.

I therefore cut it at the proper angle, which took away all the bad portion; I then took another piece half the length of the first, but of the same diameter, and cut this also at the proper angle, and the bringing the two ends together gave me another complete half; these, having been balsamed together and united with the first half, produced a perfectly good prism. I may add that it is essential that the two or more pieces constituting the half prism should have their cleavage planes exactly parallel, or the image would be bent at their junction.

SECTION B—Chemical Science

On the Specific Volumes of certain Liquids, by Prof. Thorpe.—Kopp found that the specific volumes of certain elements varied. Thus, the specific volume of oxygen "within the radicle" = 13·2, "without the radicle" = 7·8; of sulphur, "within the radicle" = 28·6, "without the radicle" = 22·6. "Within the radicle" was defined as meaning an instance where the oxygen or sulphur atom is united by *two* bonds to the binding element, while upon "without the radicle" it is united by only *one* bond. Kopp announced that members of the same chemical family have identical specific volumes. The author determined the specific volumes of vanadyl trichloride, $VOCl_3$, and phosphoryl trichloride, $POCl_3$, and found in the former case that the specific volume = 106·5, while in the latter it = 101·5. Kopp's law does not therefore hold in this instance. The following examples also show that as the atomic weight increases the specific volume also increases:—

$SiCl_4$	specific volume	= 121 1
$TiCl_4$	,, ,,	= 125·1
$SnCl_4$	,, ,,	= 132·4

Another of Kopp's deductions is that isomers have the same specific volume; but the author found a difference between the specific volumes of ethyl-amyl and heptane, both of which are expressed by the formula C_7H_{16}; in the former case the number was 162·25, while in the latter it was 157·34. The author also determined the specific volume of the compounds PCl_3 = 93·7, $POCl_3$ = 101·5, and $PSCl_3$ = 116·3. Now, 101·5 − 93·7 = 7·8; that is to say, the specific volume of oxygen in $POCl_3$, is 22·6, hence it is without the radicle in this compound. So also 116·3 − 93·7 = 22·6; that is, the specific volume for sulphur "without the radicle." Hence the structural formula of these two substances $POCl_3$ and $PSCl_3$ will be

$$\begin{array}{c}Cl\\ |\\ Cl—P—O—Cl\end{array}$$

and

$$\begin{array}{c}Cl\\ |\\ Cl—P—S—Cl\end{array}$$

respectively; that is, in each case phosphorus is most probably a triad, not a pentad element.

On the Dissociation of Nitric Acid, by Messrs. Braham and Gatehouse.—Nitric acid when passed through an ordinary clay pipe at varying temperatures is split up: at the temperature of molten tin 2·10 per cent. is decomposed; at the temperature of molten lead 22 to 23 per cent. is decomposed; when the clay pipe is heated with gas 71·72 per cent. is decomposed, while when heated with charcoal 83·4 per cent. is decomposed. The gases evolved consist of oxygen, nitrogen, and nitrous oxide; the proportion of these gases it has been found very difficult to determine accurately. The following probably represents the reaction which takes place at minimum temperatures:—

$$8HNO_3 = 4NO_2 + 4H_2O + N_2O + N_2 + O_{11}.$$

When glass bulbs are partially filled with nitric acid and exposed to direct sunlight, the acid is decomposed, the amount varying with the time and intensity of the light; the decomposition is brought about by the violet end of the spectrum. If the bulbs are entirely filled with nitric acid, no decomposition ensues. After some time the decomposition ceases; this is due to the formation of nitrous acid, and if this is expelled by boiling, the decomposition again proceeds. If pure nitric acid be boiled, even to dryness, no decomposition takes place, but if the acid contains nitrous acid, then this latter is dissociated.

On the Replacement of Organic Matter by Siliceous Deposits in the process of Fossilisation, by Dr. Carpenter, F.R.S.—The author described several cases in which the internal casts of *Foraminifera* were found, consisting of silica, generally as silicate of iron. This process is now going on at the ordinary sea-bottom. Fragments of the spines of *Echinæ*, which originally contained protoplasm, have been found, in which the organic matter has been entirely replaced by silica, thus forming exact siliceous models of the animal matter. In some cases the siliceous deposit has preserved the exact form of thin tubes less than 1-10000th of an inch in diameter. The author supposed that during the gradual decay of the animal matter there had occurred a simultaneous deposition or substitution of siliceous matter in its stead.

On the Silicified Rock of Lough Neagh, by Prof. Hodges.—The water of Lough Neagh was found to contain only 12·95 grains of solid water per gallon; of this, 10·6 grains consisted of mineral matter, while 2·35 grains of organic matter were present. Of the total mineral salts a very small quantity only—less than 1 grain per gallon—consisted of ferric oxide. Samples of petrified wood were also examined: these contained on an average about 87 per cent. of silica, and a very small percentage of iron.

On a Self-registering Apparatus for measuring the Chemical Intensity of Light, by Prof. Roscoe, F.R.S.—In this communication the author described his already well-known self-registering photo-chemical apparatus.

On certain Abnormal Chlorides, by Prof. Roscoe, F.R.S.—The author drew attention to some of the chlorides of vanadium, tungsten, uranium, and sulphur. The highest chlorides which we have been able to obtain of these elements generally do not correspond with the highest oxides; thus, although we know of the oxides V_2O_5, we know of no higher chloride than VCl_4, and even this chloride is easily decomposed into VCl_3 and free chlorine. Although the oxide of tungsten, WO_3 is stable, yet the corresponding chlorine WCl_6 is very ready to split up into WCl_5 and free chlorine. So also UO_3 is a well-known oxide of uranium, yet until lately UCl_4 was the highest known chloride. The author has recently succeeded in preparing the penta-chloride UCl_5, which occurs as a light brown powder, and also as darker acicular crystals. Again, we have SO_2 and SO_3, but it is only very lately that SCl_4 has been obtained, and the compound is so unstable as to undergo dissociation at very low temperatures.—Dr. Debus suggested that the equivalency of many of the elements depends upon the element or elements with which they are united, and that hence these and other anomalous results.—The President remarked that he did not see why we should not expect to meet with examples of change of atomicity; that if we always found elements exhibiting an even, or always an odd number of atomicities, this was very remarkable, and called for explanation, but that we should not be surprised to meet with exceptions to the rule; indeed, that we could form no distinct physical idea of what we mean by "bonds of atomicity." He remarked that we cannot well use oxygen as a measure of atomicity, from the tendency which it so often exhibits of running into chains.

SECTION D—Biology

Department of Zoology and Botany

Dr. Moore called attention to a monstrous state of *Megacarpæa*, and also to a monstrous state of *Sarracenia*; after which he exhibited specimens of grafted roots of mangold wurzel, illustrating the transmission of special characters from the graft to the stock.

Mr. E. R. Lankester read a paper *On the genealogical import of the external shell of Mollusca*, in the course of which he referred to what has been called the recapitulation hypothesis, according to which all living things in their development present a rapid series of pictures or dissolving views of their ancestors, arranged in historical order. Applying this to the human race, he said that the earliest commencement of a human being was a small speck of protoplasm of mucus-like consistency, such as existed in ponds. A later stage exhibited him as a small sac, composed of two layers of living corpuscles, which he inherited from polyp-like ancestors, and was to-day seen in polyps. Still later he was an elongated creature, with slits in the side of the neck, which, like the gill-slits of a shark, he inherited from a shark-like ancestor. Six months after birth the child continued to inherit qualities from its ancestors, viz., from those which crawled on four legs; and at a later period certain irrepressible tendencies made it clear that qualities were inherited from climbing and shrieking animals. Mr. Lankester then went into an elaborate description of certain molluscs with a view of showing that the pen of the cephalopod is homologous with the shell of the lower Mollusca.

Prof. Huxley thought that the position had been well established. Mr. Lankester's attempt to reduce to one form the immense variety of shells in molluscous animals was exceedingly important.

Dr. Carpenter also said that he was almost prepared to receive the conclusion at which Mr. Lankester had arrived.

Dr. M. Foster added his testimony to the value of Mr. Lankester's observations, and said that part of the work accomplished was due to the establishment of the zoological station at Naples.

Mr. W. Archer read a paper *On a new form of Protozoa*.

Prof. Cunningham contributed a short paper *On two Species of Crustacea*, one belonging to the remarkable fresh-water genus, the *Atya spinipes*, and the other belonging to an apparently undescribed species of the genus *Pontonia*, which are remarkable for being found as tenants of the shells of living bivalve molluscs. The two specimens were found in the Singula Archipelago.

A paper, contributed by Mr. T. Lister, *On the Spring Migrating Birds of North England*, was read by Prof. Cunningham.

Mr. E. R. Lankester brought the subject of *English Nomenclature in Systematic Biology* before the department, and said it would be a considerable gain to science if there could be introduced a series of terms distinctly English in their etymology, which would be accepted as authoritative and used throughout the country. The only question was whether it was possible, by any action on the part of scientific men, to introduce such a series of terms. He suggested the appointment of a committee of men whose names would be received as authoritative throughout the country, to draw up a list of terms which should be used for the groups of the animal and vegetable kingdom.

A discussion followed, in which Prof. Thiselton Dyer, Mr. Bentham, Mr. A. W. Bennett, Prof. Cunningham, Miss Becker, Prof. Dickson, and Dr. Sclater took part, the generally expressed opinion being unfavourable to the change proposed.

A paper was read by Mr. H. Airy *On a peculiar form of Leaf-arrangement*.

SCIENTIFIC SERIALS

Justus Liebig's Annalen der Chemie, Band 172, Heft 3.—This part contains the following papers:—Communications from the chemical laboratory of Greifswald.—86. On metatoluidine, by F. Lorenz. The author describes the preparation of this substance. Paratoluidine is first treated with acetic anhydride, and para-acettoluide thus obtained, which, by treatment with nitric acid, yields metanitropara-acettoluide. By heating with alcoholic potash this latter substance is converted into metanitroparatoluidine; this last body is acted on by nitrous acid, and the diazo-compound treated with alcohol leaves metanitrotoluol, which, by reduction with tin and hydrochloric acid, gives metatoluidine. Several of the salts of this base are described, likewise the conjugate sulpho-acids, dibrominated substitution derivatives, &c.—87. Note on the quantitative determination of paratoluidine in presence of orthotoluidine, by the same author.—88. On metabromorthosulphotoluic acid, by Dr. E. Weckwarth. The preparation of this acid, which possesses the formula $C_6H_2\left\{\begin{array}{l}CH_3\\ SO_3\\ Br\\ N\end{array}\right\rangle N$ is described. The potassium, sodium, barium, strontium, copper, and lead salts have been analysed, and the chlorine, amido, and nitro substitution derivatives examined.—89. On orthoamidoparasulphotoluic acid, by Dr. M. Hayduck. The barium and lead salts are first described; the brominated acid and its potassium, barium, and lead salts are next treated of. The amido acid distilled with potassic hydrate gives off ammonia, and aniline and a potassium salt of anthranilic acid, $C_6H_3\left\{\begin{array}{l}H\\ NH_2\\ COOK\end{array}\right.$ is obtained. With hydrochloric acid and potassic chlorate the amido acid yields trichlororthotoluquinone, $C_6\left\{\begin{array}{l}CH_3\\ O_2\\ Cl_3\end{array}\right.$, from which the corresponding hydroquinone has been obtained. By the action of bromine on the amido acid a dibrominated acid is obtained, of which the barium salt has been analysed. Diazo-orthoamidoparasulphotoluic acid, $C_6H_3\left\{\begin{array}{l}CH_3\\ N\\ SO_3\end{array}\right\rangle N$, obtained by the action of nitrous acid on the amido acid, is next treated of. This body acted on by water gives orthocresolparasulphonic acid. The nitro-diazo acid is finally described.—90. On a new nitro-toluidine, by Dr. O. Cunerth.—On paramido-orthosulphotoluic acid, by Dr. F. Jenssen. The nitro-acid, $C_7H_6(NO_2)SO_3H \cdot 2\frac{1}{2}H_2O$, and several of its salts are described, also the chloride and amide. The amido acid is then treated of, likewise its salts and substitution derivatives.—On some decompositions of pyroracemic acid, by Dr. C. Böttinger. This lengthy memoir is divided into three sections: the first treats of the decomposition of the acid in acid solutions, the second of its decomposition in alkaline solutions, and the third of its decomposition *per se*. Among other things the author describes in great detail the preparation and properties of uvic acid and its salts.—On acenapthene and naphthalic acid, by Arno Behr and W. A. Van Dorp. The authors have examined several of the salts of the acid, its methylic ether and anhydride. The constitution of the two bodies is also discussed.—Researches on the volume constitution of solid bodies, by Dr. H. Schröder.—K. Helbing contributes a paper on an examination of some benzene liquors, and one entitled "Research on a new earth resin." This resin is found in large masses in a stone quarry at Enzenau, between Tölz and Heilbrunn. Nineteen per cent. of the resin is soluble in ether, and nine per cent. in ether and hot alcohol. The insoluble portion contains iron pyrites and a hydrocarbon of the formula $C_{40}H_{62}$. The ethereal extract contains a substance of the formula $C_{40}H_{62}O_3$, melting at 192°. The hot alcoholic extract gave a substance of the composition $C_{40}H_{60}O_8$.—On cymene, by F. Fittica. The author establishes the identity of the cymenes from camphor, ptycholisol, and thymol, and furnishes evidence that the propyl contained in the cymenes is normal propyl. The isomeric oxy- and thio-cymenes are also treated of.—The constitution of benzene, by A. Ladenburg.—On derivatives of phloretin, by Hugo Schiff. The author treats of the preparation of phloretin, of phloretic acid, and phloroglucin, likewise of phloroglucide and of triphloretide. The present part contains the index for vols. 169, 170, and 171.

Zeitschrift der Œsterreichischen Gesellschaft für Meteorologie, Aug. 15.—Dr. H. Wild contributes to this number some suggestions for the consideration of the Permanent Committee of the International Congress on the question of the establishment of an International Meteorological Institution. Before the Congress at Vienna he was altogether in favour of the scheme, but now feels persuaded that one institution could hardly exercise the large functions proposed with advantage. The difficulty of directing from one spot a number of stations scattered over the globe would be great, the conditions of these stations would not be familiar, the construction of isobaric charts, &c., could only be undertaken with exact data and co-operation of the central national offices, and the modification of instruments, &c., would not be a proper task to be attempted at any one place, with its narrow range of climatic conditions. The failure of one of the central offices would cripple the results produced by the Institution, and, besides, the energetic working of these offices would be endangered if they were to delegate some of their present problems to the Institution. The national offices which now occupy themselves with general meteorology might bestow too much attention to local matters. These objections would be avoided if each central office were to attend specially to some branch of the meteorology of the globe mutually agreed upon; for instance, one to the preparation of synoptic charts, another to rainfall, and so forth. The results of the various lines of research could then be interchanged, and the failure of one office would not damage the work of the others. The establishment and maintenance at common expense of international stations proper in uncultivated countries, and the publication of their observations, Dr. Wild holds would be best undertaken by the countries to which these stand in the nearest relation. There would remain, then, for the Institution the work of interchanging the results and keeping up the relations of central offices, the arrangement of occasional Congresses, questions concerning instruments, and the like.—Among the *Kleinere Mittheilungen* we observe an abstract of the important report of Mr. Blanford to the Government of Bengal for the year 1873.

Poggendorff's Annalen der Physik und Chemie, No. 5, 1874.—In 1868 Prof. von Rath published some observations on a form of silica to which he gave the name Tridymite. It always crystallises in twin hexagonal prisms, and has a low specific gravity. His further observations show lines of division between the elements forming the twins, and in these lines the third crystal in tridymite is developed. There is a similar persistence of the division plane between crystals of humite, and analogous triple crystals in anorthite, and an interlacing of crystals in leucite; and he concludes that while two crystals cannot be united to each other in many crystal groups, yet they can be united to a third crystal. Fine specimens, three millimetres long, reaching him from the trachytes of Pachuca in Mexico, he has made full measurements. The crystals, however, are generally of small

size relatively to the accompanying minerals. They commonly occur in drusy cavities of the trachytes associated with specular iron, hornblende, and augite. Details are given of the mode of growth of the twins, their various forms and intimate combinations.—Another paper by the same author describes a remarkable crystal of calc-spar from Lake Superior. It is shown by the formulæ of the faces to be a form which is distinct from any hitherto observed. It is transparent, and occurs with native copper in amygdaloid melaphyre.—Another paper by Von Rath is on a singular combination of rutile and specular iron. The fine spiculæ of rutile are developed from between the plates of a red kind of specular iron, and may be a subsequent formation. It occurs in association with crystals of quartz and adularia in clefts or druses in a fine grained talcose gneiss.—Von Rath's next paper is On remarkable artificial crystals of pure copper. At the meeting last year of the German Geological Society at Weisbaden, Prof. v. Seebach exhibited crystalline copper which Prof. Senft of Eisenach had obtained by galvanic electricity between small rings of zinc and copper. From an aggregation of very small crystals a large mass was formed of the size of four millimetres. The crystals are always twins, with the free end most produced, and have a form which has not heretofore occurred in native copper, though it has been found in galena and binnite. The octahedral faces of the crystals are flat and shining, while those of the icositetrahedron are curved and less perfect.—Another paper discusses the hypersthene of Mont Dore, described by Des Cloizeaux, a mineral which there occurs in druses in trachyte in crystals three millimetres long, associated with crystals of sanidine and tridymite.—Von Rath's last memoir describes a new zeolite, named foresite, from the tourmaline granite of Elba.—Prof. Th. Petruschevsky, of St. Petersburg, who has devoted himself since 1862 to the phenomena of magnetism, now publishes the results of his investigation on the direct and indirect determination of the pole in magnets. Starting with the basis of Biot's curve of magnetic intensity, he points out that it is as easy to determine the pole theoretically as empirically, details his two methods, and the apparatus wherewith they are tested. He then considers the determination of the pole in electro-magnets, and finally enumerates results.—Dr. Gustav Junghann explains a simple law for the development and grouping of crystal zones. He introduces some maps of anorthite into the memoir, in which the formulæ of the faces are all set down in tabular form in square spaces.—Herr G. Hagen contributes a memoir On the resistance offered by the air to plane discs moved through it.—Herr J. J. Müller examines one of the Hamiltonian theories of movement which underlies the principles of mechanics.—Herr von Laspeyres has an interesting experimental paper On the existing and a new thermostat, and Herr Rammelsberg describes the crystalline form and modifications of selenium.—The most interesting reprinted paper is Terquem's account of the vibroscope for accurately determining number of vibrations.

SOCIETIES AND ACADEMIES

Leeds

Naturalists' Field Club and Scientific Association, Sept. 15.—Mr. Edward Thompson, vice-president, in the chair. —Mr. James Abbott mentioned that he had gathered *Butomus umbellatus* in flower at Kirkstall, on Sept. 12. The plant had not been noted in the Leeds district for upwards of twenty years past, when it grew in the stream at the foot of Woodhouse Ridge. —Mr. Henry Pocklington, in conjunction with Mr. James Abbott, demonstrated the action of the induced current upon the protoplasmic gyrations in the cells of *Vallisneria spiralis*, by means of a simple electric slide and a small inductorium. The effect produced was very marked. The circulation of the protoplasm stopped almost instantly. It was, in fact, as was described by one of the members, as though a strong "break" were put on. The protoplasm was corrugated by the rapid contractions induced, and the results taken altogether were of the most interesting character. Mr. Pocklington will probably communicate a more complete description of his apparatus and its results at an early date.

Paris

Academy of Sciences, Sept. 21.—M. Bertrand in the chair.—The following papers were read:—Note on barium sulphocarbonate, by M. P. Thenard. Since M. Dumas' proposal to use sulphocarbonates for the destruction of *Phylloxera* these salts have acquired a new interest. The barium salt is easily prepared by agitating a strong solution of barium sulphide with carbon disulphide. The author describes a process for manufacturing this salt on a large scale, and proposes to turn his attention to the manufacture of the potassium salt.—On a new mercury pump, by M. de Las Marismas. This apparatus is stated to cost 35 francs, and to exhaust a receiver of six litres' capacity to one millimetre pressure in four minutes; all pressures from that of the atmosphere up to an absolute vacuum can be obtained, the gas contained in the receiver can be collected if necessary, and a vacuum can be preserved indefinitely.—On the action of alimentary or medicamental liquids on tin vessels containing lead, by M. Fordos. The author has tried the action of wine, vinegar, lemonade, &c., upon hospital vessels containing 10 per cent. of lead; this latter metal was invariably found in the fluids used, and the author concludes that the use of this alloy may be attended with great danger.—Researches on the colouring matters of garancine, by M. A. Rosenstiehl. The colouring materials of garancine—alizarine, pseudopurpurine, purpurine, and its hydrate—have all been investigated in great detail by the author. Purpurine and its hydrate are formed at the expense of pseudopurpurine; the products of the reduction of purpurine have been studied, and two isomers of this body obtained, one of which has been prepared by synthesis starting from benzoic acid. Pure alizarine is prepared by heating the commercial substance with water to 200° C. for some hours, a small quantity of caustic alkali being added. Impurities are totally destroyed by this treatment, and the product of the operation is further purified by frequent crystallisations. Pseudopurpurine is a very unstable body; heating with water or alcohol transforms it into a mixture of purpurine and its hydrate. From the present researches it seems that garancine red and the rose colouring matter yielded by garancine flowers cannot be obtained from alizarine alone; the presence of purpurine or its hydrate is indispensable. The product of the action of reducing agents on purpurine and its hydrate is purpuroxanthine, an isomeride of alizarine.—New experiments on the nature of the sulphuretted principle of the waters of Luchon, by M. F. Garrigou. This is a reply to a paper by M. Filhol in the *Compt. Rend.* for Sept. 7.—Observations relating to a recent communication by M. Lichtenstein on some points in the natural history of *Phylloxera vastatrix*, a letter from M. Balbiani. The author again enforces his views as to the non-identity of the *Phylloxera* of the vine and of *Quercus coccifera*.—M. P. Thenard made known to the Academy the measures adopted by M. le Prefêt de Saône-et-Loire on the approach of *Phylloxera*.—M. le Ministre de l'Agriculture et du Commerce and M. le Ministre des Finances consulted the Academy on the employment of tobacco juice for the destruction of *Phylloxera*.—Communications relating to *Phylloxera* were also received from MM. J. Bond, H. de Martiny, R. Delpit, &c.—Properties of the "implexes" of surfaces defined by two characteristics, a geometrical note by M. Fouret.—On luminous diffusion, by M. A. Lallemand.—On Warwickite, by M. J. Lawrence Smith. The author assigns to this mineral the formula $\dot{M}g_5\ddot{B}_3 + (\dot{M}g\dot{F}e)\ddot{T}i_2$.—On the *rôle* played by gases in the coagulation of blood, by MM. E. Mathieu and V. Urbain.—On the movement in the bilabiate stigmata of the Scrophulariaceæ, Bignoniaceæ, and Sesameæ, by M. E. Heckel.—Observation of a bolide at Versailles on the evening of the 14th of September, by M. Martin de Brettes.

CONTENTS

ERRATUM.—Vol. x. p. 416, col. 1, line 22 from bottom, for "Norway" read "Moray."

THURSDAY, OCTOBER 8, 1874

PROFESSOR HUXLEY AT MANCHESTER

PROF. HUXLEY, whose breadth of view at once claims attention for all he utters, has utilised the opportunity afforded him by the opening of the new Medical School at Owens College to call attention to several points the discussion of which at the present time is of the most vital importance.

The rapid growth and increasing importance of Owens College are known to all our readers, and the recent addition of the new Medical School has added still another Faculty to that teaching centre, so that, as Prof. Huxley very properly points out, the College is a University in the old sense in everything but the name. A University in the new sense of course it is not, because it does not yet possess the power of granting degrees. But we imagine that the distinguished men who are directing teaching and research at Owens College can well afford to wait for this privilege, if privilege it be, especially if older foundations set an example of emphasizing this portion of their work to the neglect either of sound practical teaching or the advancement of knowledge which we regard as of still higher importance.

Prof. Huxley, by his approval of the location of the new Medical School side by side with Arts and Science Faculties, has not only brought again to the front the miserable condition of the majority of our Medical Schools, but has called into question the whole policy of Colleges of Science and Institutions for Technical Training. This part of his speech is so important and so connected, and there is so much to ponder over in it, that we give it entire :—

"Your Faculty of Arts speaks for itself; the distinction of many of its members, and the fact that they are authors of works well known and esteemed all over England, and wherever the English language is read, is sufficient to give that Faculty a high position. It certainly would not become me to speak of its operations as if I were a judge of them in any way whatever; but I may be allowed as a person whose pursuits lie elsewhere, and who has the misfortune to be accused sometimes of seeing no merit and desert in anything but his own pursuits, to say that I trust that the position of the Arts Faculty in this institution will never by a hairbreadth or shadow be diminished, but that a sound and thorough training in literature and general knowledge will be regarded henceforward, as very properly it is now, as the essential foundation in the intellectual life of every educated man; and let me say, to no person is such education and such training of greater importance than to us who are called men of science. Our occupations are very engrossing, and they can be pursued with success only by the intensest stress and attention, and we are obliged even to limit ourselves to particular fractions and particular portions of our own study if we are to make any advance therein; and unless we have the good fortune to be trained in early youth to take a broad and general view of the interests of human nature, unless our tastes are disciplined and refined, and unless we are led to see that we are citizens and men before anything else, I say it will go very hard indeed with men of science in future generations, and they will run the risk of becoming scientific pedants when they should be men, philosophers, and citizens. Still less, if possible, can I have anything to say respecting the Faculty of Law, but as regards that of Science, by which, of course, is understood physical science, I can only express my unmeasured satisfaction at the complete—I may almost say magnificent—arrangements provided for the teaching of this subject in this institution. The laboratory of my friend the Professor of Chemistry has, I take it, few parallels; and if the laboratory of my friend the Professor of Physics is not so complete, I am sure it is far better than nine-tenths of such laboratories, and I am certain that those benefactions at which I was looking just now will, before long, enable him to put his establishment on the same footing as to completeness and magnificence as that of his colleague of Chemistry. I understand—indeed I know very well, knowing how much my distinguished friend, Prof. Roscoe, has been in this institution—that he had, I believe, the advantage of being on the spot when the building went on, and although I am sure he is the last man to take any more than his own share, somehow he has got a good deal. But now I come to that which is my proper subject to-day, and that is our Medical School. I have not seen in the course of my experience—I say it deliberately—I have not met with any more efficiently organised institution than you have within the four walls of that Medical School. I have some acquaintance with such institutions, and their interests, and I undertake to say that you will not find better constructed appliances for the teaching of those branches of science which relate to medicine than you will find in that school. Everything has been very carefully considered, and everything has been done which the idea of convenience could suggest, or which efficiency requires to have carried out. Addressing myself now rather to the lay portion of my audience, it may astonish many and puzzle them somewhat to know why so elaborate an apparatus is needed for the teaching of medicine, and why men require to spend so long a period of arduous study in that most important of pursuits. I believe this surprise arises from the prevalence in the general mind of the notion which was once exceedingly common in the philosophical mind, that the human body in general is dependent upon forces and powers which are altogether different from those we find working in other kinds of matter. It is not 200 years since the notion existed that the vital processes of the body were subject to some demon, who kept the body straight, I suppose when in good temper, and let it go wrong when out of sorts; and when it was gravely supposed that there was a broad gulf between the phenomena of inorganic nature and those of life. Now let me say this, that the whole of our modern scientific study of medicine depends upon precisely the contrary assumption —upon the assumption that the living body is a mechanism infinitely more refined, and infinitely more difficult to understand, than our coarse human machinery, but still a mechanism governed by rules and laws which can be discovered and which can be applied and reasoned from, in order to understand its processes. Modern medicine, in fact, is a kind of engineering. It is the attempt to understand the machinery of the body for the purpose of being able to put it right when it goes wrong. I have seen in your great factories in Manchester some of those astonishingly complicated pieces of machinery which seem almost endowed with life, by which the products which make Manchester so famous are produced. Let me put before you the case of the possessor of one of those machines, who, finding that it has gone wrong and that it will not work properly, finds himself, as Sir Robert Peel would have said, with three courses open to him—either that he might sit down and hope that it would get better, and perhaps even offer up his prayers that it might get better; or who should send to the nearest blacksmith and tell him to bring his hammer and bottle of oil, and tap here, or oil there, in the chance of setting the machine right; or should, thirdly, send for some skilled and experienced mechanic who from long study and familiarity with it would be able to judge by the mode of action where it was wrong, and be able to put his finger on the part which

was broken or injured, and thus be able to set it right. Now, the human body is a machinery which, in complexity, stands to the spinning jenny in the same relation as the spinning jenny stands to a child's windmill. But it stands by the same laws, and those who have to deal with it must be guided by the same reasoning. Sickness is the going wrong of the machinery. Death is the destruction of part of the machinery, and the only way in which that machinery can be set right, if it goes wrong, is not by sitting down and hoping for it, and it is not by sending for the first blacksmith who will administer his purge here and his bleeding there, and who is what we call a 'quack.' I mean a person who is really ignorant of that with which he is dealing, and who yet, nevertheless, presumes to meddle with it. That is the essence of quackery. Or, thirdly, we must send our skilled engineer, who, by the help of what he calls symptoms, finds out what wheel is out of place, what cog is broken, and by his previous knowledge of therapeutics knows in what way it is possible to get this erring wheel or broken pinion into its place again. And it is in order that we may have such skilled engineers to the body that all this great apparatus which you see erected here, and all this long period of study is carried out. I do not know anything which strikes me more forcibly than the progress which this kind of knowledge has made within the last thirty or forty years. . . . I happened to take up to-day the syllabus of your sessional work here, and I turn, not unnaturally, to the class of Practical Physiology and Histology, and on looking over the various doings of this course of instruction, it struck me that thirty years ago, when I began my medical studies, there certainly was nobody in London—nay, nobody in the world—who could have given you this course of instruction. We had not the instruments which are necessary to carry it out. The whole course of medical study since that time has been completely changed—in the first place, by discoveries made by the use of the microscope, and, in the second place, by that application of delicate instruments to the illustration of the mechanism of the body, which is the very essence and a great part of modern physiology. At that time even organic chemistry was hardly in existence. It is this recognition of the fact that the study of life is essentially a question of applied physics and chemistry which has changed the whole course of our medical studies. It is that which makes elaborate appliances necessary.

The main question raised by Prof. Huxley in these remarks is, in our opinion, really this: Are we in the future to mass our Faculties as they are massed in Germany, or are we to separate them as they are separated in France?

The altogether glorious mental activity of the Germans in the present century is undoubtedly due to the commingling of the teaching of the various Faculties, and to the University teaching universally available. In Germany it may be said that there are no provincial institutions, for the smallest universities are modelled on the largest, and are as perfect, so far as they go. The metropolis is thus carried into the provinces.

Contrast this with the condition of things in France, with its single University and special scientific schools, and where outside Paris there is no institution, so far as we are aware, where all the Faculties exist side by side, and are conducted with equal vigour. Medical Faculty here, Law Faculty there, Arts Faculty somewhere else, and Science Faculty again in another region; such is the condition which is now being severely criticised by many of the best minds in France. But it must be remembered that while the whole of France besides Paris is so lamentably provincial, in Paris itself there are facilities for advancing and distributing knowledge which put London *plus* Oxford and Cambridge to shame.

In provincial England we fear it may be said with too much truth that we are at the present moment behind France. It is clear that in Owens College we have an institution which will correct the existing condition of things on the German plan; in such institutions as the Yorkshire College of Science we have attempts to correct it on the French plan, a plan condemned utterly by the most far-seeing men in France itself; while we have not in England the corrective supplied by Paris, considered as a vast centre of teaching and research.

We are glad that Prof. Huxley has called attention to the importance of the step taken by Manchester, and has so clearly stated his idea of the right thing to be done for the advancement of the higher education.

Nor did he neglect to point out the intimate connection that must exist between this and the secondary education before any real progress can be made:—"You who commence your medical studies should come prepared with the outlines of physics and chemistry as your foundations. One of the great reasons of the backwardness of medical study is that those who come to study are, by reason of the lamentable defects of their common school education, utterly unprovided with a knowledge of what those physical studies mean. I wish to stamp upon your minds, as firmly and as strongly as it is burnt into my own, that all these appliances and all these mechanical aids for the study of medicine are simply thrown away unless they have the foundation of human hard work and clearheadedness to go upon."

Still another point of the most vital importance to the future progress of Science in this country was touched upon; we refer to Prof. Huxley's statement of opinion as to the importance of the Research Scholarships established at Owens College:—

"I notice in these donations and in these sums of money subscribed for the purpose of building and endowing and providing with scholarships this great institution, what appears to me to be a peculiar feature; at least I know nothing exactly like it anywhere else: and as it appears to me to be a feature of great importance and one which it is desirable to imitate as fast as possible by other educational bodies, you will pardon me if I dilate upon it for a short time. You have two scholarships which differ from the ordinary scholarships in this, that they are rewards not merely for learning, and not merely for careful attention and diligent study of that which the student may learn in the lecture-room or from books, but they are rewards which are given to those who exhibit in some degree that most valuable and most important of all intellectual gifts, the power of advancing truth by the pursuit of original research. I refer to the Dalton Scholarship and the Platt Scholarship. I can conceive no object more important at the present time than that of encouraging original research in science, and the way of doing it, without at the same time doing more harm than good, is one which has come very seriously under my consideration as one of the Royal Commissioners for the Advancement of Science, and I earnestly wish that we could look elsewhere to the solution of that problem by means analogous to those adopted here—I mean to say by private benefactors coming forward with their endowments, which endowments should benefit those only who are engaged in original research. The introduction of scholarships of this kind into the

early life of young men, when it is so important that their attention should be directed to original research, is a new feature in this institution, and permit me to say, however important the institution may be in other respects, I am not sure that it is not one of the most important of its features."

It will be seen that while Prof. Huxley acknowledged the necessity for the endowment of unremunerative research, speaking as a Royal Commissioner, he acknowledged also that there are difficulties which surround the solution of the question. We are glad of this, because if the things were easy it would certainly not require that the machinery of a Royal Commission such as the one now sitting should be set in motion; nor, let us add, would it be worth Prof. Huxley's attention. In the fact that the question is a difficult one we see the best justification for the best minds in the country being brought to bear upon it, and we may safely anticipate a satisfactory solution.

THE REPORT OF THE METEOROLOGICAL COMMITTEE

Report of the Meteorological Committee of the Royal Society for the Year ending December 31, 1873. (London, 1874.)

THE proceedings of the Meteorological Committee of the Royal Society for 1873 are detailed in the above Report. The discussion of the meteorology of the district of the Atlantic Doldrums, known as Square 3, has now been completed, and this piece of work, which the Committee consider may fairly be termed a monograph for the district, will shortly be published. The examination of the eight squares adjacent to Square 3 has already been entered upon. The discussion of the results of Sir J. Ross's Antarctic expedition, from the observations made on board H.M.S. *Erebus* and *Terror* in 1840-43 and H.M.S. *Pagoda* in 1845, has also been completed and published, and is a paper of considerable value. Another good piece of work done by the Office is the examination, at the request of the Astronomer Royal, of the observations bearing on the meteorology of Kerguelen Island for the month of December, the results of which have been forwarded to those who are now stationed there to observe the transit of Venus.

We are glad to see that an increasing regularity in the receipt of the Weather Telegraphic Reports is notified, and we very cordially join in the regret expressed by the Committee that the Post Office authorities have declined to extend the telegraph wires so that a station might be established at Mullaghmore, near Sligo. In consequence of this action or want of action on the part of the Post Office, the Meteorological Office continues to be without daily information along the whole of the important and extended line of coast from Valencia to Lough Foyle. We hope that this blank will soon be filled up, and further, that some arrangement will be entered into by which a constant service will be maintained on the west coasts of these islands, and also at the Head Office in London; for until this be carried out, our system of weather telegraphy must, of necessity, not unfrequently fail to give warning of approaching storms. A comparison has been instituted, as in the three previous years, between the warnings issued and the weather experienced on our coasts, with the general result that the total success of warnings for 1873 was 79·2 per cent. as compared with 80·5 per cent. for 1872. In 1870 and 1871 the percentages of success were 68·4 and 63·7 respectively. The mean of these four years is nearly the same as that of the last two years when the office was under Admiral Fitzroy's management, but it will be observed that 1872 and 1873 show the largest number of successful warnings.

The restoration of Admiral Fitzroy's system of warnings, so far as to announce in the warning-message the probable direction of the apprehended storm, is a step which, we see at p. 51 of the "Report on Weather Telegraphy and Storm Warnings, presented to the Congress at Vienna," was strongly urged by the council of the Scottish Meteorological Society upwards of a year ago. The practical restoration of Fitzroy's system has been effected by the Committee, and the change took effect in March last, with, however, the very decided improvement of employing the drum simply to emphasize the warning given by the cone, instead of denoting, as it did originally, "dangerous winds from nearly opposite quarters successively." The Committee have attempted to assign the degree of probability to a storm announced by signal, thus: "Hitherto it has been found that at least *three* out of *five* signals of approaching storms (force upwards of 8 Beaufort scale, a fresh gale), and *four* out of *five* signals of approaching strong winds (force upwards of 6 Beaufort scale, a strong breeze), have been fully justified." We observe with some interest that the Committee have directed that tentative forecasts should be prepared daily in the office, and compared with the facts experienced subsequently, and that they hope ere very long to be able to afford the public the benefit of the information. For the successful development of the important question of weather probabilities, it will be necessary that the Committee investigate weather changes over a much wider area than is covered by the daily weather charts. In this direction, the reports begun to be received during 1873 from Sweden and Denmark will prove to be of considerable utility; but for the success of the experiment it will be necessary that daily reports be also received from points in the north-west of Russia, and in Germany, Austria, and Switzerland.

The anemometrical returns from Bermuda for four years have been published. These observations, and similar observations made at Sandwich, Orkney, previously published by the Committee, have been discussed by a method which cannot be recommended. The results are worth little, and altogether inadequate to the expense incurred in their discussion. The discussion of no meteorological data at all approaches in difficulty that of wind observations, and it is necessary at the outset to apprehend the difficulties to be overcome.

In several cases the language used in the Report is inexact and tends to mislead. Thus an excess of high winds on the coast of Scotland during 1873, and a deficiency on the coasts further south, are stated to be explained by the circumstance that in 1873 "the paths of the storm centres lay to the northward of the British Isles, so that our stations felt the barometrical and other meteorological disturbances, but were not exposed to the full force of the wind." Now, as is pretty well known among

meteorologists, in previous years the immense majority of British storms have had their centres to the northward of the British Isles. The proximate cause of the peculiar distribution of storms of wind during 1873 lay not in the position of the paths of the storm-centres, but in the manner of the distribution over Great Britain of the steeper barometric gradients of the atmospheric depressions of the storms of 1873 as they swept eastwards over north-western Europe.

It would have been satisfactory if the comparison which has been instituted by the Office between the observations from Valencia, in Ireland, and Angra do Heroismo, in the Azores, had been detailed in the Report, seeing that it is inferred from the result, "beyond the possibility of a doubt, that reports from a station situated at the Azores would be practically useless to the Office in giving early intimation of approaching storms." The grounds of this strongly-expressed opinion on a point of some importance in weather telegraphy, and contrary to the views entertained by not a few meteorologists, ought to have been stated.

In the Committee's Quarterly Weather Report for 1870 the position of the thermometers at each of their seven observatories was described and figured. We hope that in the next Report a detailed account will be given of the position and exposure of the thermometers at the stations from which the daily telegraphic weather reports are sent, in order that meteorologists may judge how far the observations made at these stations might be available in investigating the climate of the British Isles, and in some other meteorological inquiries. This is by many deemed necessary, especially when it is considered that the Office has not hitherto published any mean temperatures from the daily observations made at their telegraphic stations, and some of these stations, particularly in Ireland, are in parts of the British Isles, of whose climate little is yet known.

GEOLOGY AND AGRICULTURE

Applications de Géologie et l'Agriculture, par M. Amédée Burat, Engineer, Professor at the Central School of Arts and Manufactures. (Paris: Rothschild, 1874.)

GEOLOGY is one of the most interesting of modern sciences. Soon after it assumed shape high hopes were entertained as to its value to the farmer: up to the present these hopes have not been realised. And yet the study of geology is most intimately connected with agricultural pursuits. Surface geology deals with the soil which daily occupies the thoughts and labours of the farmer. There is one phase of surface geology which has been almost wholly neglected of late; we refer to the connection between soils and the rock-formations from which soils have been derived. It is here possibly that there is the widest field for original research. It was hoped that this branch of agricultural science would have received much attention from the present secretary to the Royal Agricultural Society of England, who had previously been a diligent student of geology and secretary to the Geological Society. So far, his hands would appear to have been full of other work, and he has done little where much was expected.

That there is a most intimate connection between soils and rock-formations is well known. In some places the soil is the direct product of the disintegration of the underlying rock. It more frequently happens, however, that the soil has not been derived from the rock on which it rests, but consists of drifted material. The study of this drifted material is most interesting to the geologist, and ought to be most instructive to the farmer. It enables the geologist to understand the direction and force of former water-currents; and thus throws light on obscure phenomena. A careful examination of the drift enables us to trace the origin of the soil. Thus, for example, a study of the stones and pebbly particles of the soil, enables us not only to know the rocks from which it was derived, at all events partly, but also to understand the rate at which plant-food may become liberated on the soil by the disintegration of these very stones and pebbles. On this point a word of explanation may be here offered.

If we examine a fertile soil at any time we shall find that only a very small portion of its substance (seldom more than one per cent.) is in a condition fit for nourishing our crops, the great bulk of its substance being locked up in a condition at the moment unavailable. By the action of air, of moisture, of heat, and of manure, part of this unavailable matter becomes available for crops. It is on the rate at which the process of disintegration—or liberation of plant-food—takes place that the *natural* power of production of the soil chiefly depends. The study of agricultural geology from this point of view is manifestly of the highest scientific and practical importance: it opens up a wide field for original research. We had hoped, on receiving M. Burat's little volume, that he would have taken up the subject. We have been disappointed.

The work is, not, however, without merit. The language is simple, and the style as lucid as need be.

In the introduction the author leads the reader to expect a fuller exposition of the relation between geology and practical farming than he will find in the volume. The book contains four chapters. The first is a disquisition, couched in very general terms, on the physical characters and composition of soils. As an illustration of the very general character of the matter we quote the average composition of fertile soils (p. 8):—

Every 100 parts contain—

35	gravelly particles	of the size of peas
45	ditto	ditto millets
10	ditto	of fine sand
10	ditto	of fine material, separable by washing.

We are next furnished with a general "ultimate" chemical composition of an average soil. Information of this kind possesses no value except to the junior student.

The second chapter is devoted to manures, which are treated in a popular manner. The third chapter is on the action of water, and the subject is treated in an interesting manner; the services of the Abbé Paramere are duly acknowledged. The fourth, and last, is the most interesting chapter in the work. Here the author shows very clearly that there is a connection between geology and agriculture, drawing illustrations from the primary, secondary, and tertiary groups of rocks. Soils formed from granitic

rocks are, in Great Britain and Ireland and elsewhere, deficient in lime. In our own experience we have seen most valuable results produced by the application of lime to these soils; and we learn from M. Burat that by the same means several districts in the West of France, which formerly were unable to maintain their people without extraneous supplies of food, have (*i.e.* by the use of lime) become the largest exporters of grain. All the author's illustrations are taken from France, but they have their counterparts in these islands.

On the whole, we are justified in saying that the little work will well repay perusal.

OUR BOOK SHELF

Flora of Dorsetshire. By J. C. Mansel-Pleydell. (London: Whittaker and Co. Blandford: W. Shipp.)

Flora Cravoniensis: or, a Flora of the Vicinity of Settle in Craven, Yorkshire. By John Windsor. (Manchester: Cave and Sever, 1873. Printed for private circulation.)

ALTHOUGH the boundary-lines of our counties are, as a rule, purely arbitrary, it is probably wise for the compilers of local floras to maintain them rather than to erect new ones of their own. The area of their observations is, at all events, thus rendered perfectly clear and certain. Dorset has long been famous for its palæontological wealth, both vegetable and animal; and we have here a record of its living flora, which, as might be expected from its length of sea-board and its variety of geological formations—lias, oolite, forest marble, Oxford clay, coral rag, Kimmeridge clay, Portland sand, Purbeck, chalk, and Eocene—is a rich one. The value of local floras depends greatly on the dependence that can be placed on the determination of the species by the editor and his *collaborateurs;* and on this point it seems to us that the present work can be safely trusted, great pains having been taken to establish the authenticity both of the localities and of the nomenclature. The county is divided into seven districts determined by the drainage, and therefore generally separated by high land; and a very good map of the county accompanies the volume. Among the greatest botanical rarities of the county (some of them almost unique) are—*Polycarpon tetraphyllum*, *Lotus hispidus*, *Simethis bicolor*, *Leucojum vernum* (doubtfully native), *Carex clandestina*, *Scirpus parvulus*, and *Cynodon dactylon*. The flora is confined to flowering plants and vascular cryptogams.

Mr. Windsor's "Flora of Craven" (the veteran author did not live to see its publication, or rather printing) is compiled on a different plan, the area being a somewhat arbitrary one: "about Settle and its neighbourhood to a moderate distance, generally within twelve miles, but in a few instances extending somewhat further." The district is a remarkably interesting one, whether from a geological or a botanical point of view; and the flora has been compiled with as great care as in the other case under notice, with the assistance of several good local botanists, and includes not only the flowering plants and vascular cryptogams, but also the Characeæ, Mosses, Hepaticæ, and Lichens. A district that includes among its native plants such rarities as *Polemonium cæruleum*, *Epipactis ovalis*, and *Cypripedium calceolus*, is of no ordinary interest.

Both these volumes are useful contributions to our library of local botany. We would especially commend to compilers of similar works the plan adopted by Mr. Mansel-Pleydell, of giving the geographical range of each species in the neighbouring counties of England and on the opposite coast of France.

A. W. B.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Migration of Birds

THE subject to which Prof. Newton has called attention is one of great interest to all naturalists, and requires to be studied systematically; for I can hardly think that the solution is so "simple in the extreme" as Mr. Newton thinks it may be.

It appears to me probable that here, as in so many other cases, "survival of the fittest" will be found to have had a powerful influence. Let us suppose that in any species of migratory bird, breeding can as a rule be only safely accomplished in a given area; and further, that during a great part of the rest of the year sufficient food cannot be obtained in that area. It will follow that those birds which do not leave the breeding area at the proper season will suffer, and ultimately become extinct; which will also be the fate of those which do not leave the feeding area at the proper time. Now, if we suppose that the two areas were (for some remote ancestor of the existing species) coincident, but by geological and climatic changes gradually diverged from each other, we can easily understand how the habit of incipient and partial migration at the proper seasons would at last become hereditary, and so fixed as to be what we term an instinct. It will probably be found, that every gradation still exists in various parts of the world, from a complete coincidence to a complete separation of the breeding and the subsistence areas; and when the natural history of a sufficient number of species in all parts of the world is thoroughly worked out, we may find every link between species which never leave a restricted area in which they breed and live the whole year round, to those other cases in which the two areas are absolutely separated. The actual causes that determine the exact time, year by year, at which certain species migrate, will of course be difficult to ascertain. I would suggest, however, that they will be found to depend on those climatal changes which most affect the particular species. The change of colour, or the fall, of certain leaves; the change to the pupa state of certain insects; prevalent winds or rains; or even the decreased temperature of the earth and water, may all have their influence. Ample materials must exist, in the case of European birds, for an instructive work on this subject. The two areas should be carefully determined for a number of migratory birds; the times of their movements should be compared with a variety of natural phenomena likely to influence them; the past changes of surface, of climate, and of vegetation should be taken account of; and there seems no reason to doubt that such a mode of research would throw much light on, if it did not completely solve, the problem.

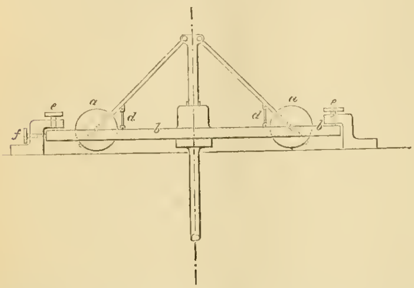
This is an appropriate opportunity for making a suggestion which has long been in my mind. It is, that it would be a valuable and interesting addition to NATURE, if we were supplied with a weekly (or monthly) "Calendar of Periodical Phenomena in Natural History," such as the average dates of appearance and departure of migratory birds, of the opening and fall of the leaf of our forest trees and common cultivated trees and shrubs; of the flowering of our common field and garden plants; and also the mean *highest* and *lowest* temperature of each *day*, the direction of the wind and amount of rainfall for each *week*, according to the Greenwich averages. None of this information is given in the usual almanacks or periodicals, and it is by no means easy to find it when wanted. Yet it is surely of much value to everyone who lives in the country, and would be the means of exciting an intelligent interest in such observations and inquiries as those to which Prof. Newton has called our attention in his interesting article.

ALFRED R. WALLACE

Regular Motion in Clockwork

IN order to ensure perfectly regular motion in the clockwork which drives the revolving dioptric apparatus made by Messrs. Chance, Bros. and Co., I have recently introduced a centrifugal governor, which might perhaps also be useful for the clocks of equatorials. Though it involves nothing new in principle, the form differs from anything I have seen, in that the governor balls have to lift a heavy weight, and that the leather rubbers or brushes are not carried by the revolving balls, but are fixed to the frame of the clock and rub against the disc which forms the extra weight lifted by the balls. The sketch shows the governor

in use on the clock of the apparatus of Cape Bon, Tunis, an apparatus exactly similar to that now standing in the International Exhibition. It consists of a shaft making 170 revolutions per minute, to which the balls *a a* are hung, and on which the disc *b b* can slide, guided by a feather key. When the clock is below speed the disc rests upon a collar fixed on the shaft, the pull exerted by the balls through the links *d d* being insufficient to raise it; but as soon as the proper speed is attained, the disc rises and comes in contact with the screws *e e*, which are tipped with leather and fixed to the frame of the clock. Spaces are cut out of the disc to admit the balls, avoiding unnecessary height. The screw *f* serves as a brake to stop the clock at pleasure. I



calculate that work to the extent of five foot-pounds per minute must be done on the governor to accelerate the clock one second per hour. This form possesses two advantages over that in which the rubbers are carried by the balls—1. It checks any acceleration of the clock more powerfully; 2. It is easier to adjust. In the older form it is necessary to ascertain by careful experiment that *each* ball shall bring its rubber into contact exactly when the speed is correct, whereas in this it is immaterial that the arms of the balls should be exactly equal; it is only needful that they should *together* raise the disc to contact when the speed is right. J. HOPKINSON

Glass Works, near Birmingham, Sept. 1

Rainbows

As a pendant to my note inserted in NATURE, vol. x. p. 437, I may mention that an exceedingly fine lunar rainbow was observed here at 8.40 P.M. on September 29.

Though the moon was near the last quarter, the bow was bright enough to appear reddish on one side and greenish on the other. It is the only one, of some five or six lunar rainbows I have seen, which appeared to show any trace of differences of colour.

I may also mention that about the end of August I saw, two hours after sunrise, a dazzlingly bright and gorgeously coloured parhelion in a small ice-cloud to the right of the sun, the rest of the sky being almost perfectly clear. There had been a sudden and considerable fall of temperature during the previous night.

St. Andrew's, Oct. 2 P. G. TAIT

IN NATURE, vol. x. p. 438, Mr. Schuster complains that in text-books no mention is made of supernumerary rainbows, and that the theory of them is to be sought in original memoirs, not generally accessible. Allow me to mention that in Sir John Herschel's Meteorology (a little work published by Black, price three and sixpence, and originally an article in the Encycl. Britann.), a complete explanation of the rainbow, and of the supernumerary bows as well, on the principle of interference, is to be found. F.M.S.

U.S. Weather Maps

IN Prof. Loomis's "Results of an Examination of the U.S. Weather Maps for 1872 and 1873" (published in the *American Journal of Science and Arts*, and recently noticed in NATURE, I am struck not only by the general agreement but by the almost verbal coincidence of one or two of his "Results" with some of the rules laid down in my work on the "Laws of the Winds prevailing in Western Europe," which was published in the beginning of 1872.

In "Laws of the Winds," Part I. p. 56 and following, I have shown that "we are unable to account for the eastward progress of depressions by attributing it to prevailing westerly upper-currents," but that "each system of depression appears to travel eastward with a kind of self-developed motion," and that the precipitation on the east side of the centre "is the principal agent in producing the change of geographical position." Prof. Loomis writes: "The progress of a storm eastward is not wholly due to a drifting resulting from the influence of an upper-current from the west, but the storm works its way eastward in consequence of the greater precipitation on the eastern side of the storm."

Prof. Loomis also appears to attribute the formation of some depressions, primarily developed in the United States, to the collision of moist air from the Pacific with the mountains in the north and west, in the same way as I have attributed the primary formation of some of our depressions to the collision of the vapour-laden atmosphere from the Atlantic with the high-lands in the west and north of the British Isles.

I am glad to observe that Prof. Loomis is no advocate of the "circular theory" of storms as still held by some meteorologists. He intimates the mean inclination of the wind towards the lower isobars as "more than 45°" in the United States. In the Journal of the Scottish Meteorological Society, No. xxxix. I have shown that at stations in the British Isles the mean inclination is 21°, but that it appears to be considerably higher in continental Europe.

In the work previously alluded to I have shown that depressions appear to travel most to the south when the atmosphere is warmer in the west than in the east, and most to the north under contrary circumstances, but that this influence is interfered with by another, viz., the tendency of depressions to travel so as to have the highest general pressures on their right. A less limited acquaintance even than I can claim with the U.S. Weather Maps would go far to show which of these two influences is the predominant, the general atmospheric conditions of the United States presenting a better field for their investigation than is to be obtained in Europe. Prof. Loomis finds that in North America storms tend most to the south in July and to the north in October. It would be interesting to inquire whether this observation holds good of depressions on the Pacific coast, as well as near the Atlantic. But a two years' average is insufficient to settle such questions.

On the whole it is satisfactory to find that some important results obtained from a study of European weather-charts are found, on good authority, to be in accordance with those derived from the U.S. maps. At the same time some of the theoretical remarks made by Prof. Loomis will not, I think, be generally endorsed by meteorologists. The statement that "it needs no argument to prove that when the wind is flowing from all quarters inwards upon a central area, there is a rapid accumulation of air, which can only escape by an upward motion," is incorrect; the depression of the barometer in the centre showing that there is no accumulation, but a rarefaction, produced in part, as Prof. Loomis has himself previously shown, by precipitation, and which is itself the cause of the influx.

Under the present conditions of anemometry all endeavours to calculate the upward movement in a storm from anemometrical data should also be accepted with much reserve. Still more hazardous (considering the inclination of depression-axes and the frequent difference of direction between currents at small and those at great elevations) is the attempt, in such an inquiry, to correct the observed velocities at sea-level by those on the summit of Mount Washington. With a depression in Eastern Canada a west wind not uncommonly blows on Mount Washington while more southerly airs are felt at the three nearest stations. If in such a case we calculate the amount of influx towards the depression-centre simply from the ratio between the velocity at sea-level and that on Mount Washington, it is obvious that the result will be the reverse of accurate.

Aug. 25 W. CLEMENT LEY

Aurora

ON Sept. 11 I was at Kyle Akin (Skye). The day had been wet and stormy, but towards evening the wind fell and the sky became clear. About 10 P.M. my attention was drawn to a beautiful auroral display. No crimson or rose tint was to be seen, but a long low-lying arc of the purest white light wa

formed in the north, and continued to shine with more or less brilliancy for some time. The arc appeared to be a double one, by the presence of a dark band running longitudinally through it. Occasional streamers of equally pure white light ran upwards from either end of the bow. The moon was only a day old, but the old landscape was lighted up as if by the full moon; and the effect of Kyle Akin lighthouse, the numerous surrounding islands, and the still sea between, was a true thing of beauty, forming as it did a quiet contrast to the more brilliant but restless forms of auroræ generally seen. I particularly noticed a somewhat misty and foggy look about the brilliant arc, giving it almost a solid appearance. The space of sky between the horizon and the lower edge of the arc was of a deep indigo colour, probably the effect of contrast.

I regretted I had no spectroscope with me, as it would have been a fine opportunity to test the spectrum of an aurora of pure white light. I had a strong impression that the bow was near to the earth, and almost thought that the eastern end, and some fleecy clouds in which it was involved, were between myself and the peaks of some distant mountains. The eye is, however, deceptive in such cases, though instances are not wanting of auroræ close to the earth's surface. I shall be glad to know if other observations of this aurora were made.

Nairn, N.B., Oct. 3 J. RAND CAPRON

The Cry of the Frog

THE fact that the common frog (*Rana temporaria*) is capable of crying out lustily when he feels himself in danger, does not seem to have been frequently remarked. In my small walled garden there is a common frog who is persecuted by three cats. His residence is a heap of slates at the foot of an ivied wall, and here he is safe. But if he ventures far abroad his tormentors soon espy him, and though they seem nearly as much terrified as himself, they cannot resist the temptation to touch him with their paws. He immediately opens his mouth and utters a prolonged cry, which appears to be very surprising to the cats, who draw back for a few moments, and then pat him again, apparently out of mere curiosity, to be again scared by the same unusual sound. This sound is a shrill and rather sibilant wail, like the note of a small penny trumpet or the cry of a new-born infant. There can be no mistake about it, as I have repeatedly touched the frog with my own hand after driving the cats away, and the same cry has immediately followed, the lower jaw being dropped so that the mouth stands open about a quarter of an inch at the tip.

Leicester, Sept. 26 F. T. MOTT

The Woolwich Aëronautical Experiment

II.

IN order to discover the laws of the vertical motion, we must suppose that the balloon is resting in perfect equilibrium when on land; which means that the ascending power of the gas enclosed in the balloon is just equal to the weight of the canvas, netting, grapnel, ballast, passengers, &c. Under these circumstances the balloon will not ascend by itself, but it will with all the weight of the sand which may be thrown overboard, if a certain space is left for dilatation and the balloon is not quite full when resting on land. If the volume is V at the surface of earth, it will be $\frac{VH}{h}$ at an altitude where barometric pressure is h, being H at departure. When the balloon is quite full, gas escapes by the lower part under the shape of a whitish steam. If v is the additional volume which can be filled by dilatation, that phenomenon will take place at an altitude where the pressure is h given by the equation $\frac{VH}{V+v}$.

We suppose that the height h is never to be attained, and in fact it is desirable for the aëronauts to limit their altitude before starting, and not to fill their balloon with a gas which they are obliged to throw away by the valve or to see escaping by the *appendice* at some risk of their own safety; one of the greatest advantages of the vertical fan being to limit at will the ascent, as will be shown.

In our calculations we suppose that the canvas is not losing gas, that the sun is not affecting the balloon, and that no water is falling upon it, or no cloud concealing the sun. All these changes of temperature can be made the subject of special calculations, and the real motion of the aërostatic globe is the *mean* between all the different circumstances of the atmosphere.

If a balloon starts in an homogeneous air because a weight p of sand was thrown overboard, P being the weight of the air displaced by the balloon when resting on land, the motive power is $g' = \frac{gp}{P+p}$ and the laws of the motions of an Attwood machine are perfectly applicable to it.

The elevation takes place with an increased velocity up to the moment where the resistance of the air is $=$ to g'. Consequently,

$$Kv^2 = \frac{pg}{P+p}.$$

K being a certain coefficient which depends on the form of the balloon, its diameter, its netting, and the density of the air. K diminishes as the altitude increases, but the diameter of the balloon enlarges gradually to its utmost. As the law of diminution of pressure is not known, we are obliged to suppose $K =$ constant.

If we suppose a balloon of 60,000 cubic feet holding 50,000 cubic feet of gas when resting on the ground, the balloon can reach without losing gas (except by the loss through the canvas, which we suppose to be perfectly gas-tight) to a level where $h' = \frac{5h}{6}$ = about 6,000 feet in round numbers. Under these circumstances the weight of the balloon when resting on land may be supposed to be about 3,300 pounds.

If we suppose 20 lbs. of sand are thrown overboard in ascending, the motive power will be $\frac{g}{115}$. The uniform motion will be $Kv^2 = \frac{g}{115}$.

Under these circumstances, as far as my knowledge goes, it is 4 ft. per second. If we suppose $g = 32$ feet.

$$Kv^2 = 16\,K = \frac{32}{115} \text{ and } K = \frac{32}{115 \times 16} = \frac{2}{115}$$

If a static effort of 20 lbs. in the vertical direction can be produced by the working of the vertical fan, it is easy to understand that the ascent can be stopped before the balloon has reached the level where the gas is beginning to escape by working in the proper direction for it. That effort is not too much for two men working on a fan which is suitably constructed.

The same thing can be said as to the descent of the balloon, but K is much larger, as the shape of the lower part is not so well suited for moving in the air as the upper half. With *appendice*, netting, ropes, and car, it exerts a resistance which is much larger and may be compared with the force exerted by a *parachute* descending in the air. The difference is very great, as I observed several times in my ascents that it was difficult to give the balloon a descending impulsion towards the land. I should not wonder if it was partly the cause of the resistance felt by Mr. Bowdler when moving his fan in the direction where it ought to have caused the balloon to descend; at least such is the opinion that I am in position to hold from the concise and imperfect narrative I found in the public papers.

W. DE FONVIELLE

Is the Rabbit Indigenous?

WOULD you permit me, through the medium of NATURE, to ask on what grounds the rabbit is considered not indigenous in this country? The best authorities on British and German Mammalia seem agreed that it is a native of the Mediterranean basin. On what facts or writings is this opinion based, and at what time was it introduced into Great Britain? I am very anxious to determine whether the above statements are founded on authentic documents or writings, or are merely suppositions which cannot be asserted with certainty. N.

Sept. 30

THE SOCIAL SCIENCE CONGRESS

THE friends of social science have had a most successful meeting this year at Glasgow, and in the various addresses and papers there has been afforded ample evidence that the importance of the introduction of more scientific knowledge into the heads and daily life of the people is becoming more and more widely acknowledged.

In the Health Section, Dr. Lyon Playfair in his address,

after referring to Franklin's aphorism, "Public health is public wealth," pointed out that taking the smallest part of the money saving, it is obvious that money judiciously spent in sanitary improvement is not unproductive taxation, but capital bearing abundant interest; and he then gave an idea of the present sanitary chaos. "In England, at the present time, there is a casual agglomeration of 1,500 separate sanitary authorities, without system or cohesion. Their areas of administration are diverse in the extreme, being neither bounded by counties, parishes, nor natural watersheds; and their duties are divided without meaning between authorities in the same district. They have been lately put under medical officers of health without preparation or qualifications for their duties, some well paid and devoting their time to this important work, others having little more than nominal payment, and giving little more than nominal time to their important duties. Notwithstanding this too sudden and unprepared universal appointment of medical officers, yet in the administration of the Health Acts there has been recently manifested a disposition to 'distrust the doctors,' and to work the Acts, at least at head-quarters, by lawyers and other persons not connected with the medical profession. This is the old error of making common sense the fetish for worship, which Archbishop Whately and others have so effectively condemned. Even the most fervent worshipper of common sense as opposed to technical training never relies on it in important emergencies of his life. He goes to the lawyer to make his will or to convey property; he consults the parson on religious doubts when on the sick bed, and he does not spurn the doctor to cure him of his grievous ailment. But it is well known that the Local Government Board are afraid of the doctors in the administration of Health Acts. Who beside them possess the knowledge? I can testify, from an experience of thirty years in sanitary work—and impartially, because I am not in the medical profession—that there is not a class of men in the country who labour so zealously for the prevention of disease as the doctors, though their training hitherto has been cure, not prevention. Certainly their private interests have never been allowed to stand in the way of their efforts to uproot disease, although their living depends upon its existence. This unselfishness in the application of their science to prevention has always been to me a source of high admiration. Why, then, is there this vulgar distrust of the doctors in the administration of our Health Acts? Extend this prejudice against technical knowledge, and how absurd it would be. Would you improve the progress of telegraphy in this country by suppressing electricians, or the law and justice of the country by putting down lawyers? Would the Secretary at War promote the conduct of war by suspecting soldiers, or the First Lord of the Admiralty the efficiency of fleets by distrusting sailors? Would our railroads and harbours be better governed if engineers were held at a discount? But this is actually the state of things at the Local Government Board—the Health Ministry of the country. The Privy Council handed over to that Board Dr. Simon and his associates, with a wealth of medical experience in public hygiene. Ever since, that wealth has been locked away from public use. Certain I am that their experience could not have guided the Board in the utter confusion of organisation in regard to medical officers of health. They have been appointed without any system. Some have a small parish to attend to, others have a thousand square miles. The last are appointed for combined districts, but are managed by uncombined authorities, and have neither assistants to aid them nor power to enforce their decisions. The officers of health are without any definite rule for obtaining available knowledge of prevailing sickness, even when it is treated at the public expense within their own districts; and they are not, universally at least, informed of the deaths as they occur. The medical officers of health have been appointed without any examination on their knowledge of State medicine, and in the majority of cases they do not possess this knowledge. I am perfectly certain that this utter confusion could not have resulted had the Local Government Board consulted the experienced State medical officers belonging to them. This distrust of the doctors in higher administration is simply a general mistrust of science. And the time has now arrived when science must be trusted in government. Science is entering into the higher education of the country, and the prejudice against it among legislators, who were educated in classical universities, will in time be removed. For the progress of a country depends upon the progress of science, and the welfare of a nation is secured by the most intelligent application of science to its manufactures and to its government. The health of the country—and that governs the productive power of its people—depends as much upon the application of medical science as the working of a machine depends upon a good application of mechanical laws. To trust the whole administration of Health Acts to Poor-law inspectors and lawyers is an amazing example of unbelief in the first principles of the laws of health. The well-being of the people depends upon physical causes, which, when intelligently understood, mean physical science, and the trained physician is the natural and most intelligent agent for extending its knowledge and application to the prevention of disease. What we want in the future is not new law, but more efficient administration of existing law. To heap up new sanitary law on the decaying mass of undigested sanitary law, which already forms a dismal agglomeration, is like the practice of our ancestors, who thought that a few clean rushes thrown upon the corrupt mass of foul rushes on the floor sufficed for sanitary purposes. What we want is superior organisation and efficient administration of existing law. But, in our happy-go-lucky style of government, are we likely to get it? I doubt whether it will be wise to continue the Local Government as a separate department of the State. Its functions in reality appertain to the Home Office, which, when properly organised, should divide itself into two great departments, the one dealing with police and justice, the other with the physical interests of the people. One Secretary of State might have the supreme responsibility, but each of the divisions should be scientifically administered. It would be as absurd to put a man trained in physical science at the head of the branch of police and justice, as it is to put a man merely trained in law in charge of the physical interests of the people. It is an exploded fallacy that only lawyers are good men of business, and that scientific men are not. Is my friend Sir John Lubbock a worse banker because he is an eminent man of science? Is Mr. Spottiswoode a worse printer because he has distinguished himself as a physicist? Is Mr. Warren De la Rue a worse stationer because he is equally conspicuous as an astronomer and as a chemist? The Local Government of the country, in as far as it relates to the physical interests of the people, will remain an example of arrested development, unless science receives a recognised position in its administration."

In the Education Section there was nothing to call for notice in the address, but Mr. C. S. Parker drew attention to the Report of the Universities Inquiry Committee, and an interesting discussion followed.

The revenues of Oxford and Cambridge were reported by the Royal Commission appointed on the advice of Mr. Gladstone to be for the University, Colleges, and Halls of Oxford, 414,000*l.*, or, including prospective increase in the next fifteen years, 538,000*l.*; and for the University and Colleges of Cambridge, 340,000*l.*, or, including prospective increase, 380,000*l.* Making certain deductions from these totals, the net income was for Oxford 350,000*l.*, and for Cambridge 300,000*l.*; or, deducting again what was levied by taxation from their own members, the net endowments for Oxford and Cambridge Universities re-

spectively were 300,000*l.* and 250,000*l.* The largest item of expenditure was to Fellows of Colleges—Oxford, 102,000*l.*; Cambridge, 103,000*l.* The smallest item was for scientific institutions, being under 2,000*l.* for each University. Mr. Parker remarked that this was hardly what might have been expected by the general public. A satirical person might even suggest as an improvement the reversal of the order. Seriously, the distribution came to this. Taking the residents in the University at about 400 graduates and 1,400 undergraduates, almost all the former and about half the latter received substantial aid from endowments. Mr. Parker examined various schemes which had been put forward, and expressed an opinion that, provided the central life were maintained with vigour, it was much to be desired that the Universities should occupy themselves with extending their connections throughout the country. Looking to their examinations in every quarter, 44,000*l.* at Oxford or 33,000*l.* at Cambridge was by no means excessive for Scholarships and Exhibitions. Some Exhibitions should be separately competed for by the unattached students who were now pursuing their studies at the Universities with so much success and at so little expense—in many cases under 50*l.* a year. To carry out needed reforms some central guidance would be necessary, either from a body appointed by the Universities themselves or, more probably, from a Parliamentary Executive Commission. But if such a Commission should be appointed, it was desirable the public should understand that it had not to deal with a retrograde, obstinate, or lethargic corporation, but to cooperate with the Universities and Colleges. Oxford and Cambridge, in respect of learning, had not held their own against the great German Universities, but a change had begun, and in Mr. Parker's opinion they were yearly commanding more respect throughout Europe.

In the discussion which followed, the Hon. G. Brodrick deprecated an attempt to subsidise, at the expense of Oxford and Cambridge, wealthy towns which, had they existed in America, would long ago have provided Universities of their own. On no account should resources which ought to be concentrated upon Oxford be frittered away upon the great cities of England and Scotland.

Sir G. Campbell said that in his belief it was these endowments which seemed to render reform impossible. They acted as an immense bribe to a continuance of the old monkish form of education, which he believed to be a mere superstition. He believed that the devotion of the time and talent of our youth to the learning of the regular verbs of Greek and Latin, and even the higher mathematics, was a gymnastic, and not a practical education. If endowments were to be continued, they must be taken in hand and, apart from the wills of founders, devoted to those branches of education which experience showed to be really useful and practical.

An important paper On the place of technical education was presented to the Section by Mr. B. Samuelson, M.P. This we shall give on a future occasion.

PITCHER-PLANT INSECTS *

THE insect-catching powers of these curious plants, the Fly-traps (Dionæa), the Sundews (Drosera), and the Trumpet-leaves (Sarracenia), have always attracted the attention of the curious, but renewed interest has been awakened in them by virtue of the interesting experiments and observations on their structure, habit, and function, that have lately been recorded, and especially by the summing up of these observations in some charming papers by Prof. Asa Gray, which recently appeared in the *Nation* and the *New York Tribune* under the title of "Insectivorous Plants."

Through the courtesy of Dr. J. H. Mellichamp, of Bluffton, and of H. W. Ravenel, of Aiken, S.C., who have sent me abundant material, I am able to submit the following notes of an entomological bearing on the Spotted Trumpet-leaf (*Sarracenia variolaris*), which must henceforth rank with the plants of the other genera mentioned as a consummate insect catcher and devourer.

The leaf of Sarracenia is, briefly, a trumpet-shaped tube with an arched lid, covering, more or less completely, the mouth. The inner surface, from the mouth to about midway down the funnel, is covered with a compact decurved pubescence which is perfectly smooth and velvety to the touch, especially as the finger passes downward. From midway it is beset with retrorse bristles, which gradually increase in size till within a short distance of the bottom, where they suddenly cease, and the surface is smooth. There are also similar bristles under the lid. Running up the front of the trumpet is a broad wing with a hardened emarginate border, parting at the top and extending around the rim of the pitcher. Along this border, as Dr. Mellichamp discovered, but especially for a short distance inside the mouth, and less conspicuously inside the lid, there exude drops of a sweetened, viscid fluid, which, as the leaf matures, is replaced by a white, papery, tasteless, or but slightly sweetened sediment or efflorescence; while at the smooth bottom of the pitcher is secreted a limpid fluid possessing toxic or inebriating qualities.

The insects which meet their death in this fluid are numerous and of all orders. Ants are the principal victims, and the acidulous properties which their decomposing bodies give to the liquid doubtless render it all the more potent as a solvent. Scarcely any other Hymenoptera are found in the rotting mass, and it is an interesting fact that Dr. Mellichamp never found the little nectar-loving bee or other Mellifera about the plants. On one occasion only have I found in the pitcher the recognisable remains of a Bombus, and on one occasion only has he found the honey-bee captured. Species belonging to all the other orders are captured, and among the other species that I have most commonly met with, which, from the toughness of their chitinous integument, resist disorganisation and remain recognisable, may be mentioned *Asaphes memnonius* and *Euryomia melancholica* among Coleoptera, *Rentatoma ligens* and *Orsilochus variabilis*, var. *complicatus*, among Heteroptera; while kyatids, locusts, crickets, cockroaches, flies, moths, and even butterflies, and some Arachnida and Myriapoda, in a more or less irrecognisable condition, frequently help to swell the unsavoury mass.

But while these insects are decoyed and macerated in order, as we may naturally infer, to help to support the destroyer, there are, nevertheless, two species which are proof against its siren influences, and which, in turn, oblige it either directly or indirectly to support them.

The first is *Xanthoptera semicrocea* Guen., a little glossy moth, which may properly be called the Sarracenia Moth. It is strikingly marked with grey-black and straw-yellow, the colours being sharply separated across the shoulders and the middle of the front wings. This little moth walks with perfect impunity over the inner surface of the pitcher, which proves so treacherous to so many other insects. It is frequently found in pairs within the pitchers soon after these open, in the early part of the season or about the end of April. The female lays her eggs singly, near the mouth of the pitcher, and the young larva, from the moment of hatching, spins for itself a carpet of silk and very soon closes up the mouth by drawing the rims together and covering them with a delicate, gossamer-like web, which effectually debars all small outside intruders. It then frets the leaf within, commencing under the hood and feeding downward on the cellular tissue, leaving only the epidermis. As it proceeds the lower part of the pitcher above the putrescent insect collection becomes packed with ochreous excrementitious droppings, and by the time the worm has attained its full size the pitcher above these droppings generally collapses. This worm when full grown is beautifully banded transversely with white and purple or lake red, which Dr. Mellichamp poetically likens in brightness to the Tyrian dye. It is furthermore characterised by rows of tubercles, which are especially prominent on the four larger legless joints. It is a half looper, having but six prolegs, and keeps up, in travelling, a constant restless, waving motion of the head and thoracic joints, recalling *paralysis agitans*. The chrysalis is formed in a very slight cocoon, usually just above or within the packed excrement. The species, kindly determined by Mr. A. R. Grote, was many years ago figured by Abbott, who found it feeding on *Sarracenia variolaris*, in Georgia. Guenée's descriptions were made from these figures, for which reason I append [the more technical matter relating to the species is here omitted] a few descriptive notes from the living material. It feeds alike on *S. variolaris* and *S. flava*, and there are two broods each year,

* A paper read by Prof. C. V. Riley, of St. Louis, Mo., before the American Association for the Advancement of Science, August 1874

the first brood of larvæ found during the early part of May, the second toward the end of June, and disappearing with the dying of the leaves, the latter part of July.

The second species is a still more invariable living accompaniment of both kinds of Sarracenia mentioned. By the time the whitish efflorescence shows around the mouth of the pitcher, the moist and macerated insect-remains at the bottom will be found to almost invariably contain a single whitish, legless, grub or "gentile," about as large round as a goose-quill, tapering to the retractile head, which is furnished with two curved, black, sharp hooks, truncated and concave at the posterior end of the body.

This worm riots in the putrid insect remains, and when fed upon them to repletion bores through the leaf just above the

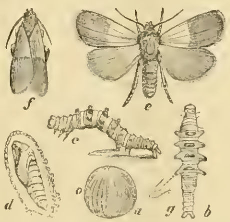


Fig. 1.—*Xanthoptera Semicrocea.* *a*, egg, enlarged, the natural size indicated at side; *b*, *c*, larva, back and side views; *d*, chrysalis: *e*, moth, normal form, with wings expanded; *f*, pale variety with wings closed.

petiole and burrows into the ground. Here it contracts to the pupa state, and in a few days issues as a large two-winged fly, which I have described in the Transactions of the St. Louis Academy of Science as *Sarcophaga sarraceniæ*—the Sarracenia Flesh-fly.

The immense prolificacy of the Flesh-flies, and the fact that the young are hatched in the ovaries of the parent before they are deposited by her on tainted meat and other decomposing or strong-smelling substances, have long been known to entomologists, as has also the rapid development of the species. The viviparous habit among the Muscidæ is far more common than is generally supposed, and I have even known it to occur with the common house-fly, which normally lays eggs. It is also possessed by some Œstridæ, as I have shown in treating of *Œstrus ovis*, the Sheep Bot-fly.

But the propensity of the larvæ for killing one another and their ability to adapt themselves to different conditions of food supply are not sufficiently appreciated. I have long since known, from extensive rearing of parasitic Tachinidæ, that when, as is often the case, a half-dozen or more eggs are fastened to some

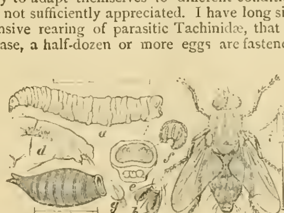


Fig. 2.—*Sarcophaga Sarraceniæ.* *a*, larva; *b*, pupa; *c*, fly, the hair lines showing average natural lengths; *d*, enlarged head and first joint of larva, showing curved hooks, lower lip (*g*), and prothoracic spiracle; *e*, end of body of same, showing stigmata (*f*) and prolegs and vent; *h*, tarsal claws of fly with protecting pads; *i*, antenna of same. All enlarged.

caterpillar victim only large enough to nourish one to maturity, they all hatch and commence upon their common prey, but that the weaker eventually succumb to the strongest and oldest one, which finds the juices of his less fortunate brethren as much to his taste as those of the victimised caterpillar. Or, again, that where the food-supply is limited in quantity, as it often is and must be with insects whose larvæ are parasitic or sarcophagous, such larvæ have a far greater power of adapting themselves to the conditions in which they find themselves placed, than have herbivorous species under like circumstances.

Both these characteristics are strongly illustrated in *Sarcophaga sarraceniæ*. Several larvæ, and often upwards of a dozen, are generally dropped by the parent fly within the pitcher; yet a fratricidal warfare is waged until usually but one matures, even where there appears macerated food enough for several. And if the Xanthoptera larva closes up the mouth of the pitcher ere a sufficient supply of insects have been captured to properly nourish it, this Sarcophaga larva will nevertheless undergo its transformations, though it sometimes has not strength enough to bore its way out, and the diminutive fly escapes from the puparium, only to find itself a prisoner unless deliverance comes in the rupture or perforation of the pitcher by the moth larva or by other means. This rupturing of the pitcher does not unfrequently take place, for Dr. Mellichamp writes under date of June 27 as follows:—"Most old leaves now examined—I might almost say all—instead of being bored, seem ripped or torn, as if by violence, apparently from without. You see occasionally shreds of the leaves hanging. Surely the legless arva of Sarcophaga cannot do this! What then—toads, or frogs, or crawfish abounding in these moist, pine lands? or rather is not the fat maggot the occasion of the visits of the quail which lately I have observed here?"

[Here follow some technical facts and descriptions of interest only to specialists.]

These two insects are the only species of any size that can invade the death-dealing trap with impunity while the leaf is in full vigour, and the only other species which seem at home in the leaf are a minute pale mite belonging apparently to *Holothyrus*, in the Gamasidæ, and which may quite commonly be found crawling within the pitcher; and a small Lepidopterous leaf-miner, which I have not succeeded in rearing. There must, however, be a fifth species, which effectually braves the dangers of the bottom of the pit, for the pupa of Sarcophaga is sometimes crowded with a little chalcid parasite, the parent of which must have sought her victim while it was rioting there, as larva.

But all other insects, so far as we know, tumble into the tube and there meet their death. The moth is doubtless assisted in walking within the tube by the spurs on the legs which it, in common with most other moths, possesses; while the Flesh-fle manages to hold its own by its widely extended legs and stout bristles. Dr. Mellichamp says that when disturbed it buzzes violently about, just as if an animated sheep-bur had fallen into the tube—not apt to go down, because it will hitch and stick, and finally, by main force, it generally emerges, but once in a while also succumbs.

Two questions very naturally present themselves here:—(1) What gives the Flesh-fly more secure foothold on the slippery pubescence than the common house-fly exhibits? (2) What enables the larva of the Flesh-fly to withstand the solvent property of the fluid which destroys so many other insects? I can only offer, in answer, the following sugg stions: the last joint of the tarsus of the common house-fly has two movable, sharp-pointed claws and a pair of pads or "pulvilli." These pads were formerly supposed to operate as suckers, and all sorts of sensational accounts of this wonderful sucker have been given by popular writers, who forgot that there are any number of minute insects having no such tarsal apparatus, which are equally indifferent to the laws of gravitation so far as walking on smooth, upright surfaces, or on the ceiling, is concerned. In reality, these pads are thickly beset on the lower surface with short hairs, most of which terminate in a minute expansion kept continually moist by an exuding fluid—a sort of perspiration. Take the human hand, moistened by perspiration or other means, and draw it, with slight pressure, first over a piece of glass or other highly polished surface, and then over something that has a rougher surface, such as a planed board, a papered wall, or a velvety fabric, and you will experience much greater adhesion to the smoother objects, and may understand the important part which these moist pads play in the locomotion of the fly; they also act, in part, like the cushions of a cat's paw in protecting and preventing abrasion of the claws, which are very useful on the rougher surfaces, where the pads are less serviceable.

Now, compared with *Musca domestica*, the claws of *Sarcophaga sarraceniæ* are much the longest and strongest, and the pads much the largest, presenting three or four times the surface. These differences are, I think, sufficient to explain the fact that while the common fly walks with slippery and unsteady gait on the smooth pubescence (the retrorse nature of this pubescence sufficiently explaining the downward tendency of the movements), its sarcophagus congener manages to get a more secure footing;

for not only does the latter present a larger adhesive surface, but the longer claws are more likely to reach beyond the pubescence and the bristles, and fasten to the cellular tissue of the leaf beyond.

In answer to the second question, I can only say that there is nothing exceptional in the power of the larva to withstand the solvent quality of the fluid; it is, on the contrary, in accordance with the facts known of many species of Muscidæ and Estridæ, some of which, like the well-known horse-bot, revel in a bath of chyme, while others are at ease in the intestinal heat of other warm-blooded animals. It is also well known that they will often live for hours in strong liquids, such as alcohol and turpentine.

Conclusion.—To one accustomed to seek the why and wherefore of things, the inquiry very naturally arises as to whether Xanthoptera and Sarcophaga play any necessary or important rôle in the economy of Sarracenia. Speaking of the Sarcophaga larvæ, Mr. Ravenel asks, "May he not do some service to Sarracenia as Pronuba does to Yucca?" And if so, may not all this structure for the destruction of insects be primarily for his benefit? Can he be merely an intruder, sharing the store of provision which the plant, by ingenious contrivance, has secured for itself, or is he a welcome inmate and profitable tenant? Self-fertilisation does not take place in Sarracenia, and the possibility that the bristly Flesh-fly aids in the important act of pollination lends interest to the facts. No one has witnessed with greater pleasure than myself the impulse which Darwin has of late years given to such inquiries; but we should be cautious lest the speculative spirit impair our judgments or our ability to read the simple lesson of the facts. My own conclusions summed up are:—

1. There is no reason to doubt, but every reason to believe, since the observations of Dr. Mellichamp, that Sarracenia is a truly insectivorous plant, and that by its secretions and structure it is eminently fitted to capture its prey.

2. That those insects most easily digested (if I may use the term) and most useful to the plant are principally ants and small flies, which are lured to their graves by the honeyed path, and that most of the larger insects, which are not attracted by sweets, get in by accident and fall victims to the peculiar mechanical structure of the pitcher.

3. That the only benefit to the plant is from the liquid manure resulting from the putrescent captured insects.

[Mr. Ravenel, in making a transverse section near the base of the young leaf, noticed large tubular cells passing down through the petiole into the root, and much of the liquid manure may possibly pass through these into the root stalk.]

4. That Sarcophaga is a mere intruder, the larva sponging on and sharing the food obtained by the plant, and the fly attracted thither by the strong odour, as it is to all putrescent animal matter or to other plants, like *Stapelia variegata*, which give forth a similar odour. There is nothing to prove that it has anything to do with pollination, and the only insect that Dr. Mellichamp has observed about the flowers with any frequency, is a Cetoniid beetle, the *Euryomia melancholica*.

5. That Xanthoptera has no other connection with the plant than that of a destroyer, though its greatest injury is done after the leaf has performed its most important functions. Almost every plant has its peculiar insect enemy, and Sarracenia, with all its dangers to insect-life generally, is no exception to the rule.

6. That neither the moth nor the fly have any structure peculiar to them, that enables them to brave the dangers of the plant, beyond what many other allied species possess.

ON EVOLUTION AND ZOOLOGICAL FORMULATION *

IN the means which he has at his disposal for expressing the relative values of the facts of his science the chemist has an advantage over the zoologist which cannot be over-estimated. By a chemical rational formula it is possible to express, in a very small compass, facts of composition and decomposition, as well as many of the other relations borne by the constituents of a compound body one to the other.

* The substance of a lecture, introductory to the evening class of Zoology, at King's College, Strand. By Prof. A. H. Garrod, Fellow of St. John's College, Cambridge.

In zoology formulation has received but little application; it has been employed to represent dental series and one or two other numerical points only; the cumbrous method of detailed verbal description being still resorted to in all cases, even when continuous observation has so accumulated facts, that it is almost impossible to retain the grasp of them without some auxiliary appliances. A method of zoological formulation, which, whilst expressing the facts of anatomical structure, attracts the attention to the relative importance of the observed differences, rather than to the details of the differences themselves, is a great desideratum; and it will be my endeavour on the present occasion to show how such a method can be made to assist in solving a problem so involved as the true affinities of a group of animals whose variable characters are fairly understood.

But the chemist has the atomic theory as a basis whereon to build; is there any principle in biology so inclusive as to yield a foundation on which to construct the desired system? Until the introduction of the theory of evolution and the doctrine of natural selection there was not. As long as the negative hypothesis of "special creation" held sway, the interest attached to the study of the mutual relations of organised beings was *nil*. No such relation could, in fact, have existed. But now, through the insight into nature arrived at by the all-embracing theories of Lamarck and Darwin—the Daltons of biology—the pedigree of the animal and vegetable kingdoms will form a problem which it will require many generations of the ablest zoologists to solve, even approximately, by the careful correlation of the undigested, unrecorded, and unobserved facts at their disposal.

Let us stop for a moment to glance at this doctrine of descent, in which, through the struggle for existence, by a process of natural selection, the fittest (for want of a better term) are said to survive. We may compare the living body of one of the higher animals to a cannon counterpoised on a Palliser gun-carriage, so fixed that it will hit a target situated at 1,000 yards distance. Before firing let marks be so made that the different parts of the whole engine can be afterwards adjusted to their former position. The gun is fired; the target is struck; a well-defined perforation or indentation is the result. A second similar shot is arranged for, by re-adjusting the engine with the assistance of the marks previously made; but on this occasion no direct aim is taken. The gun is again fired; but this time the target is missed, or it is hit in a different part. Why is this? It is because, in the former of the two firings, by the strain it caused to the whole machine, by the wear it produced in the rifling of the gun, and by the slight differences in the quality and quantity of the powder, the shot left the muzzle under different circumstances on the two occasions. The amount of this difference was sufficient, at the long range selected for illustration, to make the alteration in the course taken by the projectile perceptible. An external influence, the wind, is almost certain to have affected the result. This example shows how that minute differences, firstly in internal, and secondly in external circumstances, are sure to prevent the exact accordance of consecutive phenomena which might reasonably have been expected to be fac-similes one of the other.

As a general inference from every-day observation we are similarly led to expect that the offspring of living organisms will resemble their parent forms. But, as with the cannon, there are minor forces which in living beings come into play to produce slight changes in the progeny on all occasions. These changes are likewise of two kinds, depending on the circumstances connected with the parents themselves, and on those acting directly on the offspring from the time of its conception onwards. Amongst the former of these may be included differences in the actual and relative ages of the parents, both of which factors vary with each one of their progeny; their

states of health, and their occupations. Amongst the latter are the habits and climate to which the offspring is subject. Causes of this nature, many of which are very incompletely understood, produce variations in the individuals of a species; and as the offspring resembles its parents, unless extra forces come into play to produce differences, the peculiarities of each variety are capable of transmission to the progeny. Thus, in course of time, strongly marked varieties of a species are likely to be developed; these give rise to others, until the descendants are very different from their ancestral forms. Time, however, besides continuing on the primitive stock and developing new varieties, produces other effects with equal certainty. Animals are dependent for their existence on a certain supply of organised food. Those living forms which furnish it have also been affected in a manner similar to their destroyers; like them, they have varied, and they have tended to become more numerous (the progeny in all cases being more numerous than the parents). The area of occupation being necessarily limited, and, as we are justified in assuming, fully stocked to commence with, the multiplication of the progeny develops a universal struggle for existence, one in which each individual, for self-preservation sake, participates; and in which the weakest goes to the wall. As in other contests, however, so in this, the race is not always to the swift, nor the battle to the strong, for many of the destroying causes are not those which are overt in their attacks. The sickly blade of grass, under the shelter of an overshadowing stone, protected from the browsing herd, fructifies and reproduces itself, whilst its free-growing neighbours form a delicious mouthful for the nibbling sheep. What amount of strength or courage can protect the leader of a flock from the ravages of an intestinal parasite? or prevent the largest individual of a flight of birds from being the most likely, on account of its greater superficial area, to be killed by a random gun-shot? Specialisation of function to resist special attack or to acquire special advantage, is, therefore, on account of the struggle for existence in conjunction with the tendency to vary, a factor of vitality. Specialisation in many directions is elaboration and progress so called; and as man possesses this in the most marked degree, he is considered to be the furthest removed from the living monad which gave him origin.

The pedigree of vitality is evidently, therefore, the greatest problem of biology; for a full comprehension of it includes all the minor details of the science. How is this to be arrived at? From any collection of people which comprises nearly all the living representatives of a family, it is not difficult to obtain a large amount of information with regard to the ancestry of that family by oral interrogation. This will be facilitated by classing together in groups those of equal kinship, placing in the same sections brothers and sisters, in larger divisions those who are first cousins, and so on. It will not be hard to find who were the grandparents of each, some probably being present; the great-grandparents of most will have only been personally known to the older; and more distant relations of the same line, by hearsay alone. Pursuing the investigation, the linking of each retrograde step will be found more difficult, and the difficulty of identifying the ancestor common to them all will be almost insurpassable. When an old family has very few living representatives or none at all, the facilities for studying it will be proportionately diminished.

In zoology the method of investigation for the purpose of classification is very similar. Instead of direct interrogation, answers are arrived at by an appeal to facts of existing structure. Similarity in habits, distribution, and external characters separate off closely related forms from their more distant allies. To solve the more difficult problems of less intimate relationships, recourse must be had to internal characters in addition; to points of difference in osteological and soft-part anatomy, many of which can only be arrived at by prolonged dissection and the employment of every available opportunity.

The difficulty of appreciating the relative value of differences in any group of animals that is forming the subject of investigation, that of separating the realisation of the characters themselves, independently from the words necessary to express them, has led me in the course of my dissections to adopt a method of formulating my results in a manner which at once places them in a form available for ready comparison, and in an order of relative significance; in fact as rational formulæ, which differ in arrangement according to the phases of my general ideas. An example of the application and the applicability of this method may not be without interest, and this I will draw from the sub-order Psittaci, the Parrots.

The parrots form a well-marked, easily distinguishable group, with no outlying doubtful genera; and as with many other well-marked groups, such as the Rodents amongst mammals, and the Umbelliferæ amongst phanerogamic plants, the minor divisions are not so easily determinable. In fact, there is a very great uniformity in all the external and internal characters throughout the sub-order. There are, however, a few points in which they present variations, those best known being (1) in the vessels of the neck, (2) in the ambiens muscle, (3) in the furcula, and (4) in the oil-gland. I will notice each of these points shortly.

Firstly, with regard to the vessels of the neck. In most of the higher animals an artery, the carotid, runs up each side of the neck to supply blood from the heart to the head. In birds these vessels generally run in the middle line of the front of the neck, side by side and in contact. In some parrots, and in them only, whilst the right carotid pursues its usual course, the left, leaving its fellows, runs separately at the side along with the left pneumogastric nerve. In several groups of birds the right carotid is absent, the left alone remaining in its normal position. This is the case with one genus of parrots. Secondly, the little long and slender muscle, the ambiens, whose tendon in its unique course obliquely traverses the front of the knee capsule, is absent in some parrots, being present in others. Thirdly, the furcula or merrythought, which unites the two shoulders by an osseous bow, may be present or absent. Fourthly, the oil-gland, situated just over the tail, is wanting in some genera.

Omitting for the time being the case, which amongst the parrots is found only in the genus Cacatua proper, in which the left carotid alone is present, there are sixteen possible combinations of the four characters under consideration, of which six are found to exist. They are the following:—

1. The carotids are normal; the ambiens is absent; the furcula is present, as is also the oil-gland.—(PALÆORNITHINÆ.)
2. The carotids are normal; the ambiens is absent, as is the furcula, and the oil-gland is present.—(STRINGOPINÆ.)
3. The carotids run abnormally; the ambiens is present, as is the furcula and the oil-gland.—(ARINÆ.)
4. The carotids run abnormally; the ambiens is absent; the furcula and the oil-gland are present.—(PYHRRURINÆ)
5. The carotids run abnormally; the ambiens is absent, as is the furcula; the oil-gland is present.—(PLATYCERCINÆ.)
6. The carotids run abnormally; the ambiens is absent; the furcula is present; the oil-gland is absent.—(CHRYSOTINÆ.)

The facility for comparison afforded by a formulation of these results will be evident from an inspection of the following Table, in which the presence or absence of structures is represented by the signs + or —; in which the normal condition of the carotid arteries is indicated

by a Roman 2, whilst its abnormal state is indicated by the same figure in italics. The relative positions of the four different anatomical facts is retained throughout :—

TABLE I.

	Carotids.	Ambiens.	Furcula.	Oil-gland.
(1) PALÆORNITHINÆ	2	−	+	+
(2) STRINGOPINÆ	2	−	−	+
(3) ARINÆ	*2*	+	+	+
(4) PYRRHURINÆ	*2*	−	+	+
(5) PLATYCERINÆ	*2*	−	−	+
(6) CHRYSOTINÆ	*2*	−	+	−

On this arrangement, the Lories, belonging to the *Palæornithinæ*, their zoological formula is 2 − + + ; whilst that of *Cyanorhamphus*, which is one of the *Platycercinæ*, is *2* − − +. By this means the relations of the different groups to one another are readily recognisable.

Next, in the attempt to arrive at a correct detailed classification, the question as to the zoological formula of the ancestral Psittacine form must be one of primary importance. This can only be arrived at by a comparison of the other bird-types with that of the parrots. Taking the characters employed in Table I., and similarly formulating such birds as the fowl, duck, rail, stork, and cuckoo, they all agree in being represented by 2 + + + (1) ; others, like the kingfishers and hornbills, have the formula 2 − + + (2) ; whilst a third type, with only a left carotid, are included in the L − + + type (3). No others of importance exist. From which of them did that of the Psittaci spring? It must have been from one ; and, peculiarly enough, there are genera to be found among them which closely approach all three, for—

The formula of *Pittacus* is *2* + + +
" " *Palæornis* " 2 − + +
" " *Cacatua* " L − + +

However, this only shows that the sub-order is a very ancient one, and has undergone changes analogous to the whole class *Aves*, and it does not complicate the problem in the least.

There are parrots with two normal carotids, *e.g.* the *Palæornithinæ* ; there are others in which the ambiens is present, *e.g.* the *Arinæ ;* most have a furcula and also an oil-gland.

Now suppose that when steam-engines were first introduced they had all been constructed with steam-whistles attached. Suppose that shortly afterwards several had been exported to different colonies, and that ever afterwards each colony had, with the originals as patterns, gone on constructing them for their own use, improving upon the original design as they thought best. Suppose that by certain individual manufacturers a gong was substituted for the whistle ; in others a bell, and in a third no sounding apparatus at all. A traveller going through the different countries at the present time would probably find whistle-engines wherever he went, though in different places gongs or bells will have replaced the whistle. Knowing nothing about the history of the steam-engine, is he not justified in inferring that it was originally constructed with a whistle ; for otherwise would it be likely that each colony should have independently employed the same method of signalling, when there were several to be chosen from ?

The naturalist, similarly, as an uninitiated looker-on at the contrivances of nature, finds the same type of structure running through forms not very intimately allied ; as, for example, two symmetrical carotids, in reptiles, mammals, and some birds ; or an ambiens muscle in the fowl, the eagle, the cuckoo, and the plantain-cutter. When, therefore, these fundamental arrangements are found to exist (though perhaps not combined in any one individual) in any well-defined group like the parrots, may it not be legitimately inferred that the ancestor of that group possessed them in their full and unmodified form ? Undoubtedly it may ; and on this principle we can almost certainly assume that the ancestral parrot possessed two normal carotids, an ambiens muscle, a complete furcula, and an oil-gland ; in fact, that its formula was 2 + + + ; and that all those species in which one or other of the included characters differ from this *type formula*, they do so on account of forces having modified the ancestral form. This line of argument therefore leads us to infer the extinction of the earliest form of parrot, unless some yet undissected genus is subsequently found to correspond with it ; and all the existing genera must be referred to collateral branches, in which at least one operation of modification has been accomplished. Those which have undergone no further change from the 2 + + + type are the *Palæornithinæ* (2 − + +), and the *Arinæ* (*2* + + +). Now the question presents itself, are all those with the modified carotid (*2*), members of a single stem, and those with the unmodified carotid (2) members of another, similar losses having occurred in both to develop the subjoined series ?

TABLE II.

2 − + +	*2* + + +
2 − − +	*2* − + +
L − + −	*2* − − +
	2 − + −

Or must those types be blended in which the formulæ correspond, irrespective of the carotids ? My placing the carotid index first expresses my belief as to its primary importance ; and this is because the conformation it represents is extremely peculiar and unique among birds, and is therefore less likely to have appeared except as the operation of a specially applied force on a single collection of individuals, the power of transmission being inherited. From this it may be inferred that the ancestral unmodified stem shortly sent off a branch represented by *2* + + +, which persists as such in the *Arinæ*. The main stem and its branch must each have, before long, had a branch of its own, represented by 2 − + + and *2* − + +, which persist as the *Palæornithinæ* and the *Pyrrhurinæ*. From the 2 − + + division sprang the 2 − − + (*Stringopinæ*), and the genus *Cacatua* (L − + −), as did the *2* − − + (*Platycercinæ*) and the *2* − + − (*Chrysotinæ*) from the *2* − + + division. The genus Cacatua is peculiar in having only the left carotid running normally, it must therefore be connected with the normal 2 carotid stem, and many Cacatinnæ, like the Cockateel and the Banksian Cockatoo, are represented by the formula 2 − + +. Some of the true Cockatoos, and some only, have no oil-gland.

My object in giving this somewhat lengthy illustration on the present occasion is to show how much facility a method of formulation affords in the working out of a minor problem of the great doctrine of heredity, such as the classification of the parrots. It makes comparison easy, it facilitates the performance of operations of addition and subtraction, bringing all the stages of the process before the mind's eye without any mental effort. Is it not one to be further developed ?

THE OPTICS OF THE SPECTROSCOPE

NOW that the Spectroscope is becoming an instrument of world-wide use, we think it will be not uninteresting to call attention to some few points that appear to be often overlooked in designing the instrument for various purposes ; and in order to ascertain the best arrangement, we cannot do better than analyse the effects produced in any spectroscope by varying the proportion of its parts. We must, however, premise by saying that the power of an instrument is not altogether dependent on the dispersive power of the prisms, but also on the width of the image of the slit in the eyepiece of the tele-

scope of the spectroscope. To make our meaning clear, let us suppose that the slit is illuminated with a sodium flame, then the dispersive power of the prisms will produce in front of the eyepiece two images, or "lines," and with the same lenses the distance of their centres will depend upon the prismatic power; but it is clear that if the slit be widened, the two images will eventually widen until they touch each other or overlap. There is, then, the same dispersion, but less separation, than when we use the narrow slit; and it would follow from this that with an almost indefinitely small slit a prism of very small dispersion would give two separate images of a sodium-illuminated slit, which could be magnified so as to have their distance and width the same as would be given by using a wider slit and greater prismatic dispersion; but with an eyepiece of the large power required, the lines would be so diminished in brightness as to preclude this arrangement; and in order to see a spectrum as brilliant as possible, the eyepiece ought to be as low in power as possible consistent with reducing the cylinder of rays sufficiently small that they all enter the lens of the eye.

Let us now consider a spectroscope of any number of prisms having the focal length of the collimator the same as that of the telescope: then the image of the slit in the focus of the telescope will be of the same size and of the same brightness; for we must, for this consideration, omit the loss of light by reflection and absorption for the present, as the slit itself, which we will first suppose illuminated by sodium light, so that two yellow images of it will be visible in the eyepiece. Afterwards we will consider the case in which sun-light is used. First let us consider the effect of opening the slit wider, say double the width. By this means the images will be doubled in width and the separation diminished; the amount of light will be doubled, but will be spread over double the area, so the intensity of illumination will remain the same; therefore the slit should be as narrow as possible consistent with the image being wide enough to be visible. Secondly, let us double the length of the collimator. By this we halve the width of the image of the slit, so that the separation is increased, but the distance between the centres of the lines remains the same; the angle subtended by the collimating lens will in this case be halved, so that the amount of light passing will only be $\frac{1}{4}$ of the original amount, but as the image of the slit is reduced in like proportion, the intensity of illumination remains the same; the effect in this case is therefore the same as narrowing the slit, with the exception of the lines being shorter, thereby reducing the width of the spectrum—a matter generally of little moment, which can be altered at ease by lengthening the slit. Thirdly, we will double the diameter of the collimating lens, and with it that of the telescope and the prism. By these alterations the amount of light passing becomes quadrupled, therefore the images of the slit will be four times brighter; but the angle subtended by the telescope lens at the image is doubled, so that in order to get the whole of the light into the eye, the eyepiece must be placed at half its distance from the image, and be consequently doubled in power; the images will by this be reduced to their original brightness, but they will be magnified at the same time, and the distance from centre to centre doubled, the separation doubled, and the width of the images doubled, so that the slit may be reduced in width by $\frac{1}{2}$, and yet leave each image as wide as at first. This will increase the separation between the interior sides of the image still more, so that by doubling the size of our lenses and prisms we have obtained double separation of centres of images, and more than double separation between images, which is just what would be produced by doubling the number or dispersive power of the prisms. It is therefore obvious that in dealing with a bright-line spectrum the power of the instrument depends on the size of the prisms as much as on their number, and an increase in number means an increase in the number of reflecting surfaces and loss of light, so that within practical limits an increase of size is the more preferable. Practically, on increasing the size of the collimating lens, as in this case the focal length should be increased, otherwise the lens is injured in defining power, the effect of this increase is, as shown in the second case, only equivalent to closing the slit, so it is better to lengthen the collimator instead of touching the slit; it is also better to increase the focal length of the telescope glass, thereby straining it less, and so increasing the size of the image of the slit without altering the power of the eyepiece.

Now let us consider the effect of these alterations on sun-light or other light giving a dark-line spectrum; and there is this difference between the consideration of this spectrum and the bright-line spectrum, for in this case the dark lines are not images of the slit, but intervals between them, and therefore their width and appearance depend not so much on the separation between the centres of the bright lines as on the separation of their adjacent sides, and with the same width of any two bright lines this separation or width of dark line does not vary in the same ratio as the distance between the centres of the bright lines, or as what is called the dispersive power, varies, but in a higher ratio. For example: suppose there appear in a spectroscope the two sodium lines of appreciable width with the finest possible dark line between them; then, if the distance of their centres is doubled without increasing their width, the black line becomes increased by the increment of the distance of their centres, and with this increment the original dark line becomes much more than doubled; this will be seen better by drawing two bright lines of appreciable width on paper, and going through the process just mentioned. It is therefore separation, according to our definition of the word, that is required for dark-line spectra.

We will now consider the effect when using sun-light instead of sodium light in a similar manner to our first arrangement, namely, in our normal spectroscope, and let us widen the slit as we did before. Every image of the slit will then widen, and the separation between the sides of any two images will diminish, and therefore the dark lines will diminish in width as they are encroached on by the light on either side; the general spectrum will, however, increase in brilliancy, for although each image is only increased in size, as was the case with sodium light, still the images of each colour overlap, and so produce greater intensity. From this we gather that to obtain the greatest number and width of dark lines, the width should be as narrow as is compatible with sufficient illumination of the spectrum, to show up the dark lines; and so with a dark-line spectrum as with a bright-line one, the slit should be as narrow as possible.

Secondly, as with the sodium light, let us lengthen the collimator, say double it: then, as with the sodium light, the images will be halved and the separation increased, but only $\frac{1}{4}$ of the light passes, and the spectrum is reduced in width by $\frac{1}{2}$, so that its brilliancy is $\frac{1}{2}$ what it was originally; or we may account for the decrease in brilliancy by considering that although, as we showed in the case of the sodium light, the images of the slit are not reduced in brilliancy, still there is less overlapping and so less brilliancy. So we see that in order to keep a sufficient brightness of spectrum to show the dark lines, we must open our slit if we lengthen our collimator, and *vice versâ*, so that no power is gained by either of these methods, as was the case with the sodium light. Thirdly, we will double the diameter of the collimating lens, and with it that of the prisms and telescope object-glass. By this means the brilliancy only of the spectrum is changed, and this is quadrupled in the focus of the eyepiece, but the focal length must be halved in order to reduce the cylinder of rays small enough to totally enter the eye: this will magnify the spectrum to double its original size in every direc-

tion, and so double the width of the dark lines, but will produce no new ones ; it will also reduce the brightness of the spectrum to its original state. Now, when we were dealing with sodium light, we at this stage of proceeding halved the width of the slit, for the images of the slit had been doubled without their brightness being reduced, so we could halve them and bring them to their original size, and so increase the distance of separation still more ; but with a continuous spectrum, if we close the slit we shall, it is true, only decrease the width of each image of the slit and not their brightness, but we decrease their overlapping and so decrease the brilliancy of the whole spectrum, and this we cannot afford to do, as we have started with as narrow a slit as possible, and consequently with as small a brilliancy as possible consistent with showing the dark lines. We have therefore by this alteration of size of glasses doubled the width of dark lines originally visible, but we are not able to more than double the separation of any two images of the slit, as we did with the sodium light images, by narrowing the slit in addition to increasing the distance of the centres, and therefore no new lines are produced ; in fact, the result of our change of arrangement has been the same as a simple magnification of the spectrum without a decrease in brilliancy ; and an increase of prismatic power is exactly similar in effect, as we shall presently show, though it seems at first untrue that increase of prismatic power will not increase the number of dark lines visible. Let us now double the number of prisms ; then the length of the spectrum will be doubled, and the distance of the centre of the images of the slit doubled, and therefore more dark lines may appear in addition to the original ones being widened, but the brilliancy of the spectrum has been halved, and in order to brighten the spectrum to the original state the width of the slit must be doubled, which exactly undoes all that the extra prisms have done in producing more lines ; for the images will expand and obliterate the newly-formed lines ; the original dark lines will, however, after the widening of the slit, be double their original width ; so that, as we have just stated, the increase of prismatic power will not make a greater number of dark lines visible. If we illuminate the slit more intensely, we may decrease the width of the slit and still retain our original brightness, and so obtain a reduction in the width of the images, and consequently a greater separation between their edges, and therefore an increase in the number of dark lines in addition to increase of width of those originally visible ; so that for the same kind of light the number of dark lines depends on the intensity of the illumination of the slit.

In dealing with the spectrum of an intense light like that of the sun, where there are a large number of lines, it is necessary to use an instrument of high power, whether in number or size of prisms, in order that the exceedingly fine dark lines produced by a low power may be, as it were, magnified without loss of light, which is, as we have shown, the effect of an increase of prismatic power ; and in order that these fine lines may become visible and sufficiently separated to render their identity for measurement or otherwise complete, so there may be an apparent increase in the number of lines by the invisible ones being rendered visible by magnification without loss of brilliancy in the spectrum.

But in dealing with light like that from a planet or the moon, where the slit must be so wide that few lines are visible, it can soon be tested in practice that the increase of power does not increase the number of lines. In examining the light of the moon or of a nebula, or any object having an appreciable diameter, any increase of telescopic power for the purpose of forming the image on the slit will not increase the useful brightness of the slit ; for, supposing a spectroscope be working to its greatest advantage on a telescope, then, if the diameter of the object-glass of the telescope be doubled, the angle it subtends at the slit will be doubled, and the cone of rays on the collimator side of the slit will have its base doubled, and therefore it cannot all pass through the collimating lens ; in fact, all the rays newly added by the increase of diameter of object-glass will be wasted against the tube of the collimator, and if we try to utilise these rays by increasing the size of collimating lens or decreasing its focal length, we shall also have to increase the power of the eyepiece to get all the rays into the eye, and so reduce the brilliancy of the spectrum to its original state. In the case of increasing the focal length of a telescope as well as its aperture, the brightness of the image on the slit is not increased, but only its size ; so the spectroscope is unaffected. But in the case of viewing the spectrum of a star, matters are altered, for the image of the star does not increase in size by increasing the focal length of the telescope together with its apertures ; but its brilliancy is increased, and therefore greater prismatic power can be used without increase of width of slit, and more dark lines seen ; so that for stellar spectroscopy an increase of telescopic apertures is a direct advantage. From the foregoing remarks we gain that in the construction of a spectroscope the eyepiece should be of as long a focus as possible, so as just to cause all the rays to enter the eye ; all magnification beyond this means loss of brilliancy, and if the spectrum appears insufficiently large an increase in size of the collimating and telescope lenses, together with the prisms, or an increase in the number of the prisms should be made, until the spectrum appears sufficiently large to suit the requirements of the observer.

G. M. S.

THE SUB-WEALDEN EXPLORATION

THE Secretary of the Sub-Wealden Exploration has just issued his eighth quarterly report, in which he states that but little progress has been made during the last three months in consequence of the inability to procure lining tubes of the required size in sufficient quantity. The increased favour in which the diamond boring system is now held has caused a great demand for these tubes, and they are specially manufactured by an eminent Birmingham firm. The new pipes are required for the difficult process of enlarging and lining the bore-hole to the diameter considered requisite before attempting to withdraw the broken rods, &c. Mr. Willett says :—

"The engineers have no doubt whatever of their ultimate success, and as the extraction of the rods is not a matter involving the expenditure of our funds, we can only regret the loss of the long summer days, and take comfort from the assurance that, 'after the enlargement and lining is accomplished, there is a much better prospect of obtaining the desired depth of 2,000 ft. than there was a year ago that we should reach half the distance (1,000 ft.), provided always that the *requisite funds be forthcoming.*'"

He is anxious to dispel what he terms "the delusion" that no more money is required from the public in consequence of a Government grant to the work having been obtained. He states that the Chancellor of the Exchequer, with laudable foresight and prudence, has promised to assist on certain conditions, to do which—

"I. We must spend 400*l*. in boring tubes, &c.

II. We must bore 100 ft., which will cost 200*l*. ; and *then*, and *not till then*,

III. We can draw 100*l*. from the Exchequer, and so on, claiming 100*l*. for every 100 ft. actually explored."

The third and last year of the tenancy for carrying out the work has been entered on, and therefore the necessity of speedily resuming the operations is at once seen. The financial position is cheering, the present balance being 594*l*. 7*s*. 9*d*. The honorary secretary says :—

"We are greatly indebted to the Right Hon. the Chan-

cellor of the Exchequer, and to the Secretary of the Treasury (by whom the deputation was introduced), for having favoured us with an interview and patiently listened to our appeal for Government aid.

"The grounds of our claim were stated in our last report, and were naturally met by the remark that 'it would be a dangerous precedent to apply national funds for private purposes.' If all future applicants be compelled to

I. Raise 3,000*l.* by subscription;
II. Bore 1,000 feet; and
III. Obtain a memorial from the Royal Society, the Geological Society, and the Institute of Civil Engineers, stating that the prosecution of the work is of national importance;

they are not likely to be troublesome by their numbers, and the subject having been ventilated in the House of Commons, few reasonable minds will be disposed to doubt the discretionary wisdom of the grant with its attendant conditions.

"We are much indebted to William Topley, Esq., F.G.S., for having consented to visit Belfast, there to read our report and make personal application for additional aid from the Committee of Recommendation of the British Association for the Advancement of Science, and we are greatly encouraged by the response and the grant of 100*l.*

"The kind promise of Sir Charles Blunt to give us 50*l.* on reaching 1,000 ft. has been faithfully performed; so also will Mr. Warner's promise of 300*l.* when we reach 2,000 ft.

"In scientific research it has often occurred that the benefits accruing have been indirect and unexpected by the promoters. Not only have the rich beds of gypsum been made known, and, in consequence, are now in actual process of development, but the new facts ascertained by our work have thrown some considerable light (and that of an encouraging nature) on the problem of the feasibility of constructing a sub-marine tunnel between England and France.

"The motives which actuate our friends to subscribe are various and sometimes novel, as, for instance, one writes: 'I enclose my mite—besides the objects stated, a shaft is doubtless a safety valve against earthquakes.'"

The report concludes by thanking the directors of the London, Brighton, and South Coast, and the South Eastern Railways, for their assistance in the work, the latter company having, in addition to granting other privileges, in the use of their line, forwarded a cheque for 50*l.* The kindness of the Earl of Ashburnham, the Rev. T. Partington, and many others is acknowledged, and the honorary secretary concludes his report with an earnest hope for further encouragement, and that the results will prove that their labour has not been expended in vain.

NOTES

THE inhabitants of a vast district of London have had during the past week an opportunity of studying the phenomena of explosions on a large scale, and of noticing how closely they approach those of earthquakes in the sequence of long-rolling waves of the solid earth, loud noises, and finally long continued tremulous motion and more subdued sounds. If we could have announced last week that 100 barrels of gunpowder would explode in London, locality not defined, on a given day, the inhabitants would probably have been alarmed, many would certainly have visited their country friends; but our Government have for years been warned that such an occurrence might happen seeing that there is no legislative enactment to ensure care, and yet they have let such a state of things continue! We have it on the authority of the *Times* that the *Tilbury* might have had 500 barrels on board instead of 100, and it is clear that these might have exploded in a locality where the consequent destruction of life and property would be fearful to contemplate. It appears that, bad as are the regulations for the transport of gunpowder on board ship, there is little or no provision for the prevention of accidents at places where powder is received and delivered in large quantities. In reporting on this branch of the subject in 1865, Major-General Boxer instanced the case of Isleworth. He says:—"The powder wharf at Isleworth affords a good illustration. This wharf is situated in the town of Isleworth, on the banks of the Thames; on an average as much as 600 barrels per week is shipped there, the wharf is surrounded by houses, and the sacrifice of life would be fearful in the event of an explosion." Major Majendie, in a report to Government two years ago, wrote:—"I am quite sure that if the public were at all aware of the extent to which gunpowder is handled in large quantities, without any special regulations, in the middle of the metropolis and of large cities, they would be seriously alarmed, and would demand the adoption of measures for removing so patent a danger." Truly we are a practical people, and much superior to the Germans, who only allow the transit of large quantities of gunpowder through populous districts under military escort.

THE effect of the explosion in the Zoological Gardens was not so serious as might have been expected from the proximity of the gardens to the scene of the disaster, but several of the animals were thrown into a state of great agitation. The elands, antelopes, and deer, particularly, were very much startled, and were found running round their enclosures in a state of great alarm. The elephant, hippopotamus and rhinoceros, and the giraffes were very much excited, and the birds became much alarmed. About a dozen of the smaller birds escaped through a hole in the glass roofs of the aviary, caused by the concussion, but two or three returned during the day. The blankets and coverings were shaken off the snakes, but fortunately none of the glass in their cages was fractured. It was fortunate, too, that none of the large carnivora were liberated.

WE referred some little time ago to the fact that a sum of about 30,000*l.* had been left to the "London Academy of Sciences." We hear that already several societies and institutions have sent in, or are thinking of sending in, claims. It is stated, however, that the Royal Society, which certainly is the nearest approach to the institution in Signor Ponti's mind, has not applied. The Royal Society is of course a mere private body, and might well be held to be justified in refusing to incur the responsibility of distributing a large sum for the furtherance of science; but the miserable chaos in our scientific arrangements is none the less strongly brought out by the present juncture. In England, truly, Science is a body without a head!

FRANCE, Germany, and Austria are vying with each other in astronomical activity. In the grounds of the Paris Observatory a 4-ft. Foucault mirror is being erected, and M. Le Verrier has already obtained a grant for a 30-in. refractor. The Vienna Observatory is also making arrangements for the reception of a telescope of similar aperture. Messrs. Merz have nearly completed a lens of 20 in. aperture, for the University of Strassburg. In France, the newly-created *Ecole Spéciale des Hautes Etudes* is being taken advantage of to form a school of Astronomy; in Germany and America many such schools exist already, thanks to the rational administration of their Observatories, the assistants in which are the pupils, friends, and potential successors of the director.

M. DESJARDINS, one of the head officials in the Ministry of Public Instruction, has been ordered by the Minister to inspect the meteorological service of the Observatory and to report upon its present condition.

THE Government of Newfoundland has determined to take steps for the protection of the seal fisheries, by preventing vessels

from leaving port before a certain date, and are anxious to induce the Governments of other countries, whose subjects are engaged in other fishings, to take similar measures in respect to vessels leaving their respective ports. It is hoped thereby to establish an international convention, which will have the effect of giving the seals at least another month after the breeding season, in which the young may increase in size and value, and thus the fearful slaughter of immature seals which has threatened the total extermination of the animal will be checked.

THE ordinary business of the Paris Academy of Science was entirely suspended at the meeting on September 28, owing to the death of M. Elie de Beaumont. The burial took place on the 25th, the entire Academy attending their *confrère* to the grave. Funeral addresses were delivered by M. Dumas on behalf of the Academy, by M. Ch. Sainte-Claire Deville on behalf of the Mineralogical Section, by M. Daubrée in the name of the School of Mines, and by M. Laboulaye in the name of the French College.

THE President and Council of the Royal Society of Edinburgh, "impressed with the conviction that the progress of the sciences demands, and has long demanded, fuller and more exact tables of logarithms than any which at present exist," have memorialised Sir Stafford Northcote with the view of inducing the Government to print a nine-figure table of logarithms of numbers from unity to a million, part of which has been already calculated by Mr. Sang, who has carried a fifteen-figure table up to 300,000. The subject of undertaking the publication of logarithm tables—so long as the number of figures does not exceed ten, the limit of utility—is one well worthy the attention of the Government; but in the present case there are several reasons why, if the application is refused, the loss to science will not be so great as some might think. In the first place, a table of 1,800 large pages, whether in one, two, or three volumes, will be so unwieldy that, notwithstanding the ease of the interpolations, it would probably be very seldom used by computers; and secondly, because all who require more than seven figures will, no doubt, prefer to use ten, and consult the existing works. In fact, nearly all computers would, we believe, employ Vlacq or Vega in preference to the proposed table. Mr. Sang, in the pamphlet which accompanies the memorial, makes a remarkable error when he intimates that the great French tables have not been used to verify any seven-figure table, so that "up to the present moment we have no verification of Vlacq's great work." In point of fact, the whole of Vlacq was read with the copy of the French tables at the Paris Observatory, by M. Lefort, and the results of the comparison are published in vol. iv. of the "Annales de l'observatoire de Paris." Almost all the errors found by Mr. Sang by means of this table are among those there given by Lefort, and anyone who chooses can, without much expenditure of trouble, render his copy of Vlacq all but free from error—much more accurate than any new table could possibly be.

ATTENTION is being again directed to the cultivation of Cinchonas in St. Helena, which at one time promised so well, but which has, owing to changes in the Government, been allowed to lapse into decay. Some seven or eight years since, when the island was under the governorship of Sir Charles Elliott, Dr. Hooker strongly advised a trial of the plants to be made, and plantations were formed at Diana's Peak. So satisfactory was the progress of the plants that the Government consented to the selection of a gardener from amongst the best or most intelligent of those to be obtained at Kew. One was chosen and sent out, and, to quote from a recent number of the *St. Helena Guardian*, "All went well so long as Sir Charles Elliott was at the head of affairs: plantations were formed, and the gardener, Mr. Chalmers, was treated as one having the charge and responsibility of an important colonial experiment, and the plants grew well up to the time when Sir Charles Elliott left and Admiral Patey was appointed in his stead. The new governor at once decreed that the plantations at Diana's Peak were a mere foolish waste of money, that the gardener sent out from Kew would be better employed at Plantation House, and employed he was, chopping firewood and raising beans, peas, and radishes, and selling them for the benefit of the privy purse of Government House, and the Cinchona plantations were left to go to ruin or to flourish by their own unaided vigour, as the case might be." The result of three years' cultivation and three years' subsequent neglect seems to be, that although there are a few dead and sickly plants, nearly all the trees are in full vigour and luxuriant growth. There are about 300 flourishing plants, many of which are twelve feet high, and three to four feet in diameter. The bark is also a quarter of an inch thick, and has an intensely bitter quinine taste. Many of the plants in the St. Helena plantations have the lower part of their stems bound up with moss in order to try if the bark would not swell and increase more rapidly, but it has had the effect of showing, by the bursting out of rootlets from the part so bound with damp moss, that the plant throws forth roots readily from the bark, and thus may be easily propagated by cuttings. The Government has recently been again in correspondence with Dr. Hooker on this subject, and it is to be hoped that the cultivation will be again renewed and prosecuted continuously.

WE have been requested to publish the following extract of a letter recently received from Cambridge (Mass.):—"We have been very much amused by the pertinacity with which our friends on your side are determined to provide us with a successor to Prof. Agassiz, to fill a vacancy which has no existence and has been filled long since. Alex. Agassiz takes his father's place in the Museum, assisted by Count Pourtales and Col. Lyman, who attend more to the details; and the professorship has been divided, and separate professors appointed, one for zoology and one for geology. There is now therefore no vacant chair in Harvard, so far as I know, although Prof. Wyman is lately deceased; but I think he relinquished his duties some time since, on account of ill health. So I do not perceive the slightest chance for the numerous successors proposed in England or elsewhere."

THE French Geographical Society sent a deputation to Vienna to offer its official congratulations to the Hungro-Austrian Polar Expedition. It was very cordially reciprocated by Payer and his associates.

AN International Horticultural Exhibition will take place at Antwerp, commencing on April 4, 1875, under the auspices of the Royal Society of Horticulture and Agriculture of that town, and promises to be on a large scale. An International Exhibition of Fruits will also be held at Amsterdam in October 1875, under the management of an influential committee.

WE learn from the *Belgique Horticole* that that cryptogamic pest the *Puccinia malvacearum* is making sad havoc among the mallows and hollyhocks in some parts of Belgium.

WE are informed that the *Phylloxera* has appeared in Switzerland, and that the delegates of the wine-growing cantons met on Monday last, the 5th inst., to consider the best means of preventing its extension.

SOME excitement has been aroused in New York by the discovery of a rich vein of hæmatite iron ore in the heart of the city by some workmen who were digging foundations for a new building. The vein, which is 30 ft. wide, was found at a depth of only 4 ft. from the surface.

PROF. BENTLEY and Mr. Trimen are engaged in the production of a voluminous work on the medicinal plants of the world.

As there are not many works devoted to this important branch of botanical science, we shall gladly welcome this book, as from the well-known abilities of the authors we have every reason to anticipate that it will at once take a prominent position among standard works on this subject. It will be copiously illustrated.

DR. HUMPHREY, F.R.S., the Professor of Anatomy at the University of Cambridge, gives notice that his course of lectures on Practical Anatomy will begin on Thursday, Oct. 8, at 9 A.M., and be continued daily. The course on Anatomy and Physiology will commence on Friday, Oct. 23, at 1 P.M., and be continued on Tuesdays, Thursdays, and Saturdays, at the same hour. This course is intended for students of natural science as well as for students of medicine, and gentlemen not requiring certificates are at liberty to attend without fee.

A TELEGRAM received at Hull from the captain of the schooner *Samson*, which has just returned from a cruise in the Arctic regions, announces the discovery of large beds of coal at Spitzbergen.

THE volcanic soil in the neighbourhood of Vesuvius is stated to be an antidote to the potato disease and other fungoid diseases of plants. It is also said that it is found of great value in the treatment of *Phylloxera*; this, however, remains to be proved.

THE inaugural meeting of teachers, students, and friends of the College for Men and Women (with which is incorporated the Working Women's College) will be held at St. George's Hall, Langham Place, on Monday, October 12. The chair will be taken by Mr. Thomas Hughes, Q.C., at 8 P.M. The College is established to afford to men and women occupied during the day a higher education than has generally been within their reach. The classes are taught for the most part gratuitously, and the design is that mutual help and fellowship may be promoted between all members of the College, teachers and students, by the educational work in the classes and the social life of the coffee-room.

THE Statistical Society, that has occupied apartments at No. 12, St. James's Square, for nearly thirty years, as a tenant of the London Library, has recently changed its quarters to the house formerly occupied by the Principal of King's College, and its present address is Somerset House Terrace, Strand, W.C., London (King's College entrance). This change has become necessary by the simultaneous growth and development of both the London Library and the Statistical Society, and is therefore a matter of congratulation to both institutions.

WE have to record the death, on Saturday last, of Dr. William W. Fisher, Downing Professor of Medicine in the University of Cambridge since 1841, when he succeeded Dr. Cornwallis Hewett. Dr. Fisher, from being an undergraduate, first at Trinity and then at Downing College, became Fellow of the latter, and remained so until he accepted his Professorship. He was formerly physician to Addenbrooke's Hospital, and till his death steward and librarian of his College. The stipend of the Professorship is 400*l*. a year with a residence in Downing College; it must be refilled within two months of a vacancy occurring.

THE opening meeting of the approaching session of the Medical Microscopical Society will take place at the Royal Westminster Ophthalmic Hospital on Friday, the 16th inst., at 8 P.M.

ALPHONSE DE CANDOLLE, of Geneva, whose first botanical memoir was published forty-five years ago, has been elected one of the eight foreign associates of the Academy of Sciences at Paris, in the place of Agassiz.

M. MELSENS, a member of the Royal Academy of Belgium, has published a pamphlet describing the verification of lightning-conductors, as practised by him in several monuments of Brussels, for ascertaining if they are in a position to conduct electricity into the humid parts of the earth. The experiments were tried with a Hely machine, and with Daniel elements and galvanometers. In the first instance fifteen of the pupils of the Veterinary School were employed to ascertain if they had received any shock.

THE reptiles of the French Museum have been removed to their new home. The boas had been previously overfed, so that they were as easy to handle by the keepers as so many cables. The crocodiles were most unmanageable, and it was necessary to use nets in order to catch them. Some of the venomous snakes were tempted by food offered to them into small cages, in which they were shut up hurriedly, and removed. Now everything is right, and the several inhabitants of the reptile menagerie are happy and contented in the new building which will be formally opened within a few days by the Minister of Public Instruction.

THE death is announced of one of the most prominent and indefatigable members of Col. Gordon's expedition, Mr. Anson, who succumbed to an attack of fever on the 27th of July. The deceased was the son of Admiral Anson, and was highly esteemed by Col. Gordon for his zeal and usefulness.

M. X. DUCLOUX has discovered and given the name of *Rivotita*, or Rivotite (in honour of the memory of M. Rivot, late Professor of the School of Mines, at Paris), to a new kind of mineral, which is found in small irregular masses, dispersed in a yellowish-white chalk, upon the western slope of the Sierra del Cadi, in the Spanish province of Lerida.

WE have received the Sixth Annual Report of the Cardiff Naturalists' Society, and are pleased to notice that the year just closed has proved most successful; the number of members has increased from 190 to 288, and the finances of the society are in a good condition. During the past year, the committee have organised for the first time a series of scientific and literary lectures, which have been largely successful.

THE additions to the Zoological Society's Gardens during the past week include two Call Ducks (*Anas boschas*), European, presented by Mrs. Wilson; four Little Bustards (*Tetrax campestris*), European, purchased; a Rhesus Monkey (*Macacus erythræus*) from India; a Solitary Tinamon (*Tinamus solitarius*) from South America; three Lesser Pin-tailed Sand Grouse (*Pterocles exustus*) from North Africa; two Cornish Choughs (*Fregilus graculus*), European, deposited.

SCIENTIFIC SERIALS

THE *Journal of the Chemical Society* for August contains, in addition to the usual abstracts from foreign journals, the following papers communicated to the Society:—On ipomœic acid, by E. Neison and James Bayne. This acid, obtained by the action of nitric acid upon jalapin, has been shown by the authors to be identical with sebacic acid. This conclusion has been arrived at from a comparison of the solubility, melting-point, and composition of the acids. The potassium, barium (normal and acid), lead, and silver salts have been prepared and examined.—Note on New Zealand kauri gum, by M.M. Pattison Muir. The gum is an exudation from a coniferous tree (*Dammara Australis*) imported into this country for the purpose of making varnish. The action of different solvents and of various reagents has been tried, from which it appears that the substance is a mixture of resins with a true gum, and is therefore to be classed as a gum-resin.—On certain compounds of albumin with the acids, by George Stillingfleet Johnson. Compounds with nitric, hydrochloric, sulphuric, orthophosphoric, metaphosphoric, citric, oxalic, tartaric, and acetic acids have been obtained. The method of preparation consists in dialysing white of egg over dilute solutions of the acids. The action of water heated above its boiling point upon these compounds has been studied, and special experiments undertaken to ascertain the nature of the

action exerted by the dialyser in producing the compounds. The author concludes that the following points have been probably established by his experiments:—(1) The existence of definite compounds of albumin with the acids in simple molecular ratios (the probable formula of the nitric acid compound may be given by way of illustration—$C_{72}H_{112}N_{18}SO_{22}2HNO_3$). (2) The applicability of dialysis to the ready and accurate preparation of these compounds. (3) Probable correctness of the formula of Lieberkühn, Loew, and Liebig for albumin.—On a simple method of estimating urea in urine, by Dr. W. J. Russell and S. H. West. The authors make use of the well-known action of hypochlorites and hypobromites upon urea:—

$$CO(NH_2)_2 + 3HClO = CO_2 + 3HCl + 2H_2O + N_2.$$

The most advantageous solution for this purpose is formed by dissolving 100 grms. of caustic soda in 250 c.c. of water, and adding 25 c.c. of bromine. A measured quantity of urine is introduced into a bulb-tube of particular form, and then allowed to mix with excess of the hypobromite solution. The reaction is complete in from ten to fifteen minutes in the cold, but on warming is complete in five minutes. The apparatus is so constructed as to permit the collecting of the evolved nitrogen in a tube which is graduated in such a manner that the amount of gas read off gives at once the percentage of urea in the urine employed. A remarkable fact observed by the authors is that in the reaction between urea and the hypobromite there is invariably eight per cent. less nitrogen evolved than that required by theory. With uric acid 35 per cent. of the nitrogen is suppressed, with hippuric acid $82\frac{1}{2}$ per cent., and with creatinine 25 per cent.—The concluding paper is on Dendritic spots in paper, by Huskisson Adrian.

THE *Scottish Naturalist* for October contains the following articles:—On the Salmonidæ of the Eden, Fife, by P. Walker, F.G.S.E.—Notes on the entomology of Shetland, by the Rev. J. Blackburn and C. E. Lilley.—Concerning aquaria, by Dr. Peter White.—Tenthredinidæ in Rannoch, by P. Cameron.—Notes on Lepidoptera in Kirkcudbrightshire, by W. D. Robinson Douglas.—The occurrence of rare birds in the Carse of Gowrie, by Col. Drummond Hay.—Several articles on the fungi of Scotland, and a continuation of the lists of Scottish insects, by F. Buchanan White, M.D., and D. Sharp, M.B.

THE *Bulletin de la Société d'Acclimatation de Paris* for June opens with a paper by M. Ch. le Doux, on the yield of the cocoons of the new silkworm *Attacus aurota*, and on the best mode of winding the cocoons which are pierced by the moth on its escape, or left unfinished by the silkworm.—M. P. Chappellier gives an interesting account of the growth and preparation of saffron, with special reference to the production of new species of crocus and other saffron yielding plants in France.—The East Indian possessions of Holland, Java, Sumatra, Borneo, the Moluccas, and other islands, are the subject of a paper by M. E. Prillieux, who gives a valuable list of their principal productions, industrial and otherwise. This list includes no less than 247 timber-producing plants grown in the East Indies.—Among fishery questions perhaps no subject is of more importance than the effect produced by the use of fixed engines. Contributions to the literature on this point are made by M. Renibaud in a letter addressed to the Minister of Marine, and by Dr. Turrel, delegate of the society at Toulon.—M. Delidon continues his researches on the change of colour in the silk produced by silkworms, caused by a change of food.—M. Kemmerer, the inventor of cemented tiles for catching oyster-spat, announces that he has relinquished his patent rights in the invention which has been so successfully adopted by oyster-culturists.—The Minutes of the monthly meeting of the society, detailing the various experiments made by its members, are very interesting, including observations on many diverse subjects.—The Agricultural Society of France has offered a prize of 1,000 francs each for the best method of artificial irrigation, for the best means of destroying the *Phylloxera vastatrix*, for the best economical means of utilising the beetroot and its products, for the best horse-breeding establishment in Finistère, Côtes-du-Nord, Morbihan, Ille-et-Villaine, and Loire Inférieure, and for the educational establishment which shall have taken the best means to instruct in agriculture and horticulture.

Zeitschrift der Œsterreichischen Gesellschaft für Meteorologie, Sept. 1.—In a former number of this periodical an instrument called the nephoscope was described by Herr Braun, intended to serve for measurement of the direction and apparent velocity of clouds. He has now made an addition to the nephoscope, by which the absolute height of clouds may be determined without any calculation, and thence also their absolute velocity. Such an instrument has been wanting in meteorology, and will certainly be useful. Of course the cloud chosen for measurement must be isolated and not very high, and the place of operation must be elevated and so placed as to command a view of the cloud's shadow. It is the height of the cloud above its shadow, not above the place of observation, which is obtained. The old method may still be followed with the nephoscope, but it is more laborious. The instrument is minutely described with reference to an annexed woodcut.—Among the *Kleinere Mittheilungen* we have a notice of Prof. Lommel's book, "Wind und Wetter." His explanation of the curves of storms issuing from the region of trade winds is somewhat as follows:—The rotation of the cyclone being in the N.E. trade wind from N. through W. and S. to E., the N.E. trade wind opposes and retards the S.E. portion, but accelerates the N.W. portion of the whirl. Thus the pressure will be least in the N.W., greatest in the S.E. quarter, and progress will be made towards the N.W. Arrived in the region of variable winds, the course will be changed according to the direction of the prevailing wind. Supposing a storm to be on the western coasts of Europe, and the most common wind, S.W., to be blowing, the direction of progress will be E. or E.S.E., and this is actually the course commonly taken by European storms.

Memorie della Societa degli Spettroscopisti Italiani, July.—This number contains an announcement of the death of Paolo Rosa at Rome on the 11th of July, and a short statement of his scientific labours; it also contains a letter from P. Rosa on the connection of solar activity and rainfall, and a paper by the same author on the identity of photospheric and magnetic phenomena in connection with the proper motion of the sun. Tables are given showing a corresponding variation of the magnetic variation with the changes in the solar diameter, there being an 11-year period of both, and also a secular period of $66\frac{2}{3}$ years. Secchi writes that the spectrum of Coggia's comet corresponded with that of a hydrocarbon, and that the continuous spectrum observed therewith was due to reflected sunlight, since it disappeared on interposing a Nicol's prism. Prof. Bredichin fixes the lines at 5633, 5164, and 4742 of Angström's scale; and Tacchini at 6770, 5620, 5110, and 4800; the longest was 5620, and the brightest 5110. The chromosphere as seen in January last is shown in a drawing by Tacchini, and he adds that he has seen the chromosphere steadily at an altitude of 3° from the horizon, and when the limb of the sun was very unsteady in a simple telescope.—Tacchini sends a note that four bolides travelling together entered our atmosphere on the 27th of July, the position and drawing is given; they were seen for 40 seconds.—A number of drawings of Coggia's comet are sent by Tacchini, with a descriptive statement. Wright adds a note that the comet's light was polarised.

Journal de Physique, tome iii., Nos. 29, 30.—In these two numbers is an article by M. Berthelot on the principles of Thermochemistry. The study of the evolution of heat in chemical combinations is a new branch of science belonging partly to physics and partly to chemistry, and the number of facts already observed is sufficiently numerous to indicate certain laws which M. Berthelot proceeds to set forth. It is, he premises, admitted that in a chemical combination the molecules hit sharply one against another and give off heat, just as when a hammer strikes a bar of iron. From a study of the relations between the amount of heat evolved and the amount of work done, it is possible to establish some theorems of Thermo-chemistry. 1. First principle. The amount of heat given off in any reaction is a measure of the chemical or physical work done in that reaction. Several examples are given. 35·5 grs. of chlorine unite with 1 gr. of hydrogen and form hydrochloric acid, giving off 22 calories. The compound occupies the same volume as its component parts. Here the physical work is *nil* and the chemical is 22 E (E being the mechanical equivalent of heat.) Again, 8 grs. of O unite with 1 of H to form water. At ordinary temperatures the heat evolved is 34·5 calories. But there is a change from gas to liquid. Part of the work is chemical, part physical. It is shown, then, that the temperature affects the amount of heat evolved; this is due to the physical work of exterior pressure. All computations should, when possible, be made with both the components and the compound in the state of gas. This is not always possible; hence the importance of the second principle. 2. If a system of simple or compound bodies taken in certain conditions lead to physical or chemical changes which bring about a fresh state without giving rise to any mechanical result, then the heat given off or absorbed by these changes depends entirely on the

first and last conditions of the system. The intermediate states do not affect it. For example: $C + O_2 = CO_2$ gives 47 calories. Or, $C + O = CO$ gives 34·5; and then, $CO + O = CO_2$ gives 12·5, and 34·5 + 12·5 = 47 as before. We have not space to notice the five "consequences" from this principle. 3. Third principle. Every chemical change effected without the intervention of any external energy leads to the production of a body, or system of bodies, which give off more heat. For example: $Sn + O = SnO$ gives off in formation 36·9 Cal.; $Sn + O^2 = SnO_2$ gives 72·7. Some compounds cannot be formed by their own energy—*e.g.* acetylene is formed by the union of C and H, but it requires the energy of an electric current to induce it.—M. Laurent describes a new saccharometer.—M. Mascart contributes an article on the annealing of glass, having special reference to the preparation of objectives.—M. Blavier's paper, continued from No. 28, is concluded.—M. Marcy describes a new chronograph of a small size convenient for holding in the hand, based on the principle of Duhamel's.—There is also an article by M. Thurot on Galileo's experiments on weight.

Annali di Chimica applicata alla Medicina, No. 2, vol. lix., August.—The present number begins with a paper in pharmacy On the reactions of morphine, from researches by Hermann, Kelbrunser, Siebold, and Schneider.—In dietetics, Prof. Fr. Selmi contributes a paper entitled "New Study of Milk," and there is also one by Dr. Martin on *koumiss*, a vinous liquid obtained by the fermentation of milk.—In toxicology there is a paper by Pietro Albertoni and Filippo Lussana on the physiological criterion for medico-legal proofs of poisoning.—In physiology, Prof. G. See furnishes a paper on the action of the salts of potassium.—Under "Varieties" there are the following papers:—On the culture of *Eucalyptus globulus*, by Dr. Ledeganck.—The blue colour of linen used for medical purposes, by Louquet.—Use of chloroform and ether for stupefying bees, by Charon.—Phenol-camphorated oil for the gummy disease of fruits, by Dr. F. F. Adorni.—Bisulphite of soda as an antichlore for bleaching, by Dr. T. Schuchardt.—The part concludes with a biological notice of Justus Liebig, by G. Ruspini, and a review of the fourth part of the *Annuaris delle Scienze Mediche*, published by Drs. P. Schivardi and G. Pini.

SOCIETIES AND ACADEMIES

PHILADELPHIA

Academy of Natural Sciences, April 7.—Dr. Jos. Leidy in the chair.—"The Blue Gravel of California," by E. Goldsmith. Under the name of "Blue Gravel" the California gold miners, and especially the placer miners, understand a rock which underlies the gold-bearing alluvium of that State and part of Nevada. It is stated that whenever the gold-bearing sand in many localities in the two above-named States has been removed by the well-known washing process, the "blue gravel" appears. It also contains gold, which cannot, however, be extracted by washing, the stream of water being unable to disintegrate the rock, which is a compact composite one, and not, as the name "gravel" would imply, a loose material. This so-called "blue gravel" is composed of two ingredients widely differing in age, namely, of pebbles cemented together by a lava. The pebbles are of all sizes. From the general appearance I infer that some of these pebbles were derived from the sedimentary rock, slate, and others from hornblende rock. Entirely different in general aspect from the rounded pebbles is the other part of the rock, which I have already stated to be a lava. This appears to envelop the pebbles completely. This lava is very brittle, so much so that the preparation of a thin plate for microscopical observation is impossible. The hardness is equal to apatite. The most distinguishing crystallisation within the lava mass is a black mica, which is probably biotite. I noticed also a few grains of quartz, as well as flattened grains of bright yellow gold. The conclusion at which I arrive is that the so-called "blue gravel" of California is a conglomerate of pebbles of various kinds cemented together by an acidic lava in which crystals of mica (biotite) and grains of gold are imbedded. How the gold came into the lava is a question of some difficulty. Whether it was mingled with the pebbles before the lava ran over the bed, or whether the gold was ejected from the volcano, I am not able to decide.

April 14.—Dr. Ruschenberger, president, in the chair.—Prof. Leidy called attention to the "Bulletin of the United States Geological and Geographical Survey of the Territories, No. 2," presented this evening. It contains a "Review of the Vertebrata of the Cretaceous Period found west of the Mississippi River," by Prof. Cope. In this article he was quoted in such a way as not fairly to express his original meaning. Thus, on one page reference is made to the proceedings of this Academy, in which it is intimated that *Thespesius occidentalis* was referred to the Mammalia, and regarded, perhaps, as a Dinosaurian. "In the Proceedings I have rather expressed the reverse, as I state of *T. occidentalis*, among the collection of vertebrate remains, are two apparent caudal vertebræ and a first phalanx of some huge animal, which I suspect to be a Dinosaurian, though they may have belonged to a mammalian. I may add that Prof. Cope, quoting from the same Proceedings, indicated that I had referred Ischyrotherium to a Sirenian. This is so, but Prof. Cope appears to have overlooked the more full account of the animal in the Trans. of the Am. Phil. Soc., in which, though I still refer it with doubt to the mammalia sirenia, I state that the remains may have belonged to an aquatic reptile."

May 12.—Dr. Ruschenberger, president, in the chair.—Prof. Leidy gave a notice of some new freshwater Rhizopods, having all the essential characters of Amœba, but, in addition, provided with tufts of tail-like appendages or rays, from which he proposed to name the genus Ouramœba. It is possible that Ouramœba is the same as the Plagiophrys of Claparede, though the description of this does not apply to that.—Dr. Chapman made the following remarks on the generative apparatus of the *Tebennophorus carolinensis*:—He found both ova and spermatozoa in the organ regarded first as simply the ovary, later as the testicle.

May 19.—Dr. Kenderdine in the chair.—"The Veins of Beech and Hornbean Leaves." Mr. Thomas Meehan said that De Candolle had noticed some years since a difference in the venation between the *Fagus ferruginea* and *Fagus sylvatica*, the common American and European beeches. In the American beech the lateral veins were said to terminate in the apex of the serratures, in the European they terminate at the base of the sinus. As the statement stood, it conveyed the idea that there was a marked difference in structure between these two allied species, which did not, however, exist, as growing in this country the leaves of the European beech are almost entire; the lateral veins, in approaching the margin of the leaves, curve upwards, and connect with the lateral above them, forming a sort of marginal vein near the outer edge of the leaf. The veins of the American beech curve upward in the same way, but are easily arrested, and this sudden cessation of growth produces the serra, which are slightly curved upwards.—"Direct Growth Force." Mr. Meehan referred to some potatoes exhibited by him to the Academy a few years ago, in which the stolons of a grass had penetrated through from one side to the other, preferring, as it would seem, to go through such an obstruction to turning aside to avoid it. A potato was a rather rough-surfaced body. He now exhibited a similar case, only the obstruction was the round smooth root of an herbaceous peony. Though not more than one-third of an inch thick and round, a stolon of *Triticum repens*, the common couch grass, had pushed itself through.

May 26.—Dr. Ruschenberger, president, in the chair.—On report of the committee to which it had been referred, the following paper was ordered to be published:—"Description of two new fossil shells of the Upper Amazon," by T. A. Conrad.

CONTENTS

THURSDAY, OCTOBER 15, 1874

THE UNIVERSITIES COMMISSION REPORT

I.

THE publication of this Report has been awaited with an interest which rarely attends the issue of a Blue Book: and though the Commissioners have taken two years and a half over their labours, the result, both in its matter and its form, fully justifies their apparent delay. We have here presented to us in a concise and intelligible shape, the entire financial affairs of the Universities of Oxford and Cambridge with their Colleges. The whole property of these wealthy institutions, its sources and its application, the probability of its increase, and their annual income and expenditure, are now for the first time laid before the public.

It is in itself no small thing that these ancient corporations, with one single exception, should have been prevailed upon without direct Parliamentary pressure to reveal their most cherished secrets: for it should be remembered that only twenty years ago the first University Commission failed totally in its attempt to extract similar information from the unreformed Colleges, and that even up to the present time not even a University man had materials from which to form a reasonable conjecture as to the wealth of any other College than that of which he might happen to be a Fellow. It must be admitted that the Colleges come out from this ordeal of publicity with a better show than even their friends had anticipated. To produce the elaborate returns which the Commissioners required, an immense amount of additional labour has been thrown upon the College Bursars, who, as the Report bears witness, are not over-abundantly requited for the large amount of work they do as managers of landed estates and treasurers of the general accounts. The Master of Sidney Sussex College, Cambridge, who is also Bursar, has alone proved recalcitrant; but as to all the rest, it is pleasant to read the language in which the Commissioners express their gratitude for the ready assistance which they have received, and the spirit of marked courtesy with which they have been met. It had been generally anticipated that the system of managing estates through these amateur land-agents would not be proved to be economical, but the facts seem to have been unexpected even by the Commissioners, who report that the cost of management of the whole external income averages somewhat under 3*l.* per cent. They also state that they have no reason to believe that the condition of the estates let at rack rent is below the average, though probably less outlay is made than by private landlords who improve their properties. There is, however, a large quantity of land still let on the old system of beneficial leases, concerning which method of letting a clear description is given in the Report, and the agricultural condition of this land is confessedly bad; but this mode of tenure is universally condemned, and is in process of being rapidly extinguished.

With regard to the internal income and its expenditure, the Commissioners are unable, owing to the complicated and varying manner in which these accounts are kept, to arrive at any general conclusions, but they condemn in unhesitating terms the custom which appears to prevail everywhere at Cambridge, by which the payments of the undergraduates as caution money and tuition fees are made directly to the College tutor, who not unnaturally is induced to regard this arrangement as a private affair between himself and his pupil, so that in some cases information on this subject has been unwillingly given, and in some others altogether withheld. Some disapproval also is expressed of the general mode in which the College accounts are kept, which may be explained by the circumstance that they were never intended for publicity, and in many instances retain the old Latin nomenclature. It was only in a few cases that a correctly drawn balance-sheet was obtainable, and in some cases the accounts of Trust funds are not kept properly distinct, and the balances of such accounts seem to be occasionally borrowed for the general purposes of the College, and no interest allowed. It is further observed that there is no case of audit by a professional auditor. These criticisms, after all, are upon minor matters, but they have a certain importance as showing that the Commissioners have been both searching in their inquiries and fearless in their comments, and also because from the terms of their appointment they were not permitted to make any more general recommendations with regard to the wide question of the uses of academical endowments.

The real value of this Report of course lies in the long and elaborate array of figures which it gives, and in its impressive totals. A mine of reliable information is here afforded to University reformers and all those who are interested in the advancement of science, from which they may learn how vast is the wealth at their disposal, and from which they may securely draw materials for a comprehensive scheme. The total income of the Universities and Colleges in the year 1871, which is the year which the Commissioners have fixed upon for all their calculations, amounted to no less than three quarters of a million, and the number of undergraduates was about 3,500. Of this total, Oxford receives the larger share by more than 70,000*l.*, while the number of undergraduates is just equal. Another calculation gives the external income of Oxford (by which term the Commissioners intend the revenue from endowments) at 336,000*l.*, and the internal income of the Oxford Colleges, which is mainly derived from dues, fees, and profits of establishment, at 58,000*l.*, besides tuition fees at 30,000*l.*, whereas the sum of only 41,000*l.* is spent in scholarships, exhibitions, &c. These figures should be compared with those lately given to the public in the Fifth Report of the Royal Commission on Scientific Instruction, which dealt with such voluntary institutions as University and King's Colleges, London, and Owens College, and from such comparison the conclusion will inevitably be drawn that University education is capable of being made self-supporting, and that the University endowments can only be justified in so far as they encourage, not the teaching, but the advancement of learning and science.

This conclusion is also strongly supported by a more minute examination of the figures in this Report bearing on the income and expenditure of the several Colleges. It has long been well known that the educational utility of a College bears no relation to the value of its endowments,

but this truth can now be enforced by very definite examples. King's College, Cambridge, has a revenue from endowment of 34,000*l*., and has from 20 to 30 undergraduates; Exeter College, Oxford, has an endowment of less than 6,000*l*., and educates 180 undergraduates, from whose payments a profit is derived which exceeds the external income by nearly 6,000*l*. A comparison also between Corpus Christi College, Oxford, where the sum of 975*l*. in the year is actually drawn from the endowments to pay the balance of the kitchen and buttery accounts, and Keble College, which has absolutely no endowment and yet exhibits a profit of 500*l*. on the year's account, equally teaches the lesson that out of tutorial and other fees, and fair boarding charges, an unendowed institution is capable of paying its own way, even in the face of competition with extravagant endowments. It appears, then, that by far the larger portion of the University endowments are not applied to educational purposes proper, nor apparently is it desirable that more should be devoted to that object, so that those are proved to be not far wrong who have urged that all this wealth is in the main wasted upon sinecures, and is readily available for the direct advancement of science and pure learning. At Oxford, the Heads of Houses and Fellows, more than two-thirds of whom are non-resident, receive yearly 131,000*l*., and the remainder of the revenue is expended upon various minor charges which are probably inseparable from the possession of large landed estates and considerable buildings and grounds. It is then to this 131,000*l*. that the attention of reformers must be directed, and the question of its proper uses becomes the more important when it is added that the Commissioners anticipate that in the next fifteen years the Colleges will receive an increase, due to the falling in of beneficial leases, of 123,000*l*. It is probable, nay, almost certain, that this total will be considerably increased, partly by a general rise in the value of land, and partly through building leases, so that by the end of this century Oxford will have a yearly sum of 260,000*l*. upon which there is no present claim of more importance than those of Headships and Fellowships. If the revenues of Cambridge are treated according to the same principle of calculation, the amount paid to scholars and expended in general purposes being knocked off and the probable increase being included, the Colleges of that University will have at the same date about 160,000*l*., so that Oxford will then appear even more than now the richer of the two. In our next article we shall point out how this large sum might be yet further increased, if the connection with the Church of England, which has always hampered to so great an extent the usefulness of the Colleges, were finally severed, and if all the academical endowments were to be strictly applied to academical purposes; but even without such severance a sufficient surplus is shown to induce the much-desired agreement as to its proper application, so that it may not continue to be wasted, nor diverted, as some have suggested, to the great towns; a mode of action which will induce all towns to do nothing in order that the Universities may eventually help them, and more than ever justify the French criticism that our Universities are nothing more than *Hautes Lycées*, instead of being, as they should be, the active centres of learning and research. It is to a Liberal Ministry that we owe the Commission which has yielded this valuable Report, but according to all appearances it will be a Conservative Government that must undertake the more important task of inaugurating the work of fundamental University Reform.

METEOROLOGICAL REFORM

WE would invite our readers' attention to an article which appears in this number of NATURE on the necessity for placing Physical Meteorology on a rational basis.

It forms the substance of a paper brought before the recent meeting of the British Association by Col. Strange, who has taken, as our readers well know, a very prominent part in the reconstruction of British Science, and to whom we are indebted for the present very earnest and lucidly argued protest in favour of a more rational way of treating meteorology.

He begins by dividing meteorology into two branches—one of these relating to weather and climate and their effects on organised life; while the other deals with the great physical motions of the atmosphere and with their causes.

To know beforehand the climatic peculiarities of a watering-place or country seat is no doubt of much importance, especially for an invalid who is in search of a healthy locality, but this does not constitute physical meteorology. It forms, we venture to think, a more important and certainly a more difficult branch of inquiry to study the earth's envelope as a whole, to ascertain the nature of the movements to which the moveable parts of it are subject, and finally to investigate the physical causes of these. It is in this latter aspect that the meteorology of the day is so lamentably deficient. The great fault in the present system has been well put by Col. Strange.

Two things have been taken for granted by meteorologists. In the first place, it has been imagined that the sun affects the earth in only one way, namely, by means of its radiation; and secondly, they appear to have taken for granted that this radiant influence is a constant quantity. So much indeed have these most important factors been overlooked, that we believe no systematic effort has yet been made to measure the sun's radiant influence, and indeed no proper instrument has yet been devised by which this can be done in a satisfactory manner. Without doubt the great question for meteorologists is that put by Col. Strange: "Is the sun a constant quantity?"

Now, if the evidence in favour of the sun's constancy were absolutely overwhelming, even then the present system would be at fault, inasmuch as no systematic attempts have been made to measure the strength of the solar influence: but how much more is the system deficient when it refuses to investigate an influence which is certainly predominant and most probably inconstant. To give our readers some idea of the evidence in favour of this latter assertion, let us quote the following words from a letter contained in a report presented to the British Association by a committee appointed to consider the question of scientific organisation:—

"Recent investigations have increased the probability

of a physical connection between the condition of the sun's surface, and the meteorology and magnetism of our globe.

"In the first place, we have the observations of Sir E. Sabine, which seem to indicate a connection between sun-spots and magnetic disturbances, inasmuch as both phenomena are periodical, and have their maxima and minima at the same times.

"On the other hand, the researches of Messrs. Baxendell and Meldrum appear to indicate a relation between the wind-currents of the earth and its magnetism, and also between the earth's wind-currents and the state of the sun's surface.

"In the last place, the researches of Messrs. De la Rue, Stewart, and Loewy appear to indicate a connection between the behaviour of sun-spots and the positions of the more prominent planets of our system. Whatever be the probability of the conclusions derived from these various researches, they at least show the wisdom of studying together for the future these various branches of observational science."

A further report by the same committee tells us that "It is not enough to obtain a record of the areas and positions of the various sun-spots. The velocity of cyclonic motion, the chemical nature of the outbursts, the disposition and character of the faculæ and prominences, and many other points, are, as shown by Mr. Lockyer, even more characteristic of the nature of solar action than the magnitude of the spotted area, and are equally worthy of a careful and constant study."

The evidence in favour of some strange and variable action of the sun may, perhaps, be compared to that in favour of the existence of America before that continent was discovered by Columbus; and it might have been thought that in an age like the present the difficulty of organising solar research would be very much less than that experienced by Columbus in organising an American expedition; but this is not the case. Indeed, it is not very creditable to the scientific authorities of this country that they have not entered more readily into a subject of this importance. From the quotations given above, our readers will see that this is not the first time the subject has been brought before the British Association.

A large and influential committee, embracing in its ranks many of the most distinguished members of the Association, endeavoured to bring the subject before the Administrative Council of that body, but did not succeed in getting the Council to move in the matter, or even to pronounce any opinion upon the subject. We hardly think this was proper treatment of an important problem, which had found such advocates as Col. Strange, Drs. De la Rue and Joule, Messrs. Baxendell, Lockyer, and Meldrum, as well as the general support of the most distinguished physicists of the country.

Clearly Col. Strange is right in supposing that a problem of this importance and extent can be properly undertaken only by Government. His remarks on this subject are so well put that we will report them here. Starting with the fundamental axiom that private enterprise should be allowed the most perfect freedom from interference or competition by the State, he lays down the following conditions for Government action in any scientific problem:—

(*a*) That the probable results of the research be beneficial, in the widest sense of that term, to the community at large, or to the various departments of the State.

(*b*) That the research is too costly or commercially too unremunerative to be undertaken and vigorously prosecuted by individuals.

(*c*) That the research requires continuous, uninterrupted work, extending over very long periods, and conducted by systematically organised establishments.

It will at once be seen that all these conditions apply to solar research; and the Governments of other nations have already perceived the fact. Our readers are aware that the Governments of France and America have it in contemplation to establish solar observatories, and a recent number of this periodical informs them that the German Government has already founded one on a large scale, of which it is possible the illustrious Kirchhoff will be the Director.

In conclusion, as we are advocating a question of reform, it is desirable that something in the shape of practical suggestions should be made. Now, in the first place and with reference to the great problem of Solar Physics, we think that this should certainly be encouraged by the establishment of a distinct central observatory devoted to the purpose; for it would be manifestly unfair to our illustrious Astronomer Royal to throw upon him the additional burden of an institution so very different from that over which he now presides.

In the next place, with reference to photographical delineations of the solar disc, Col. Strange has made a suggestion, at once so practical and simple, that we cannot do better than quote his own words:—

"With respect to sun-spot researches, it fortunately happens that the photographic records need not be all taken at the same station. The record of one day taken in England can be combined with the record of the next day taken at the other side of the globe. Hence, in order to obtain this daily record it is only necessary to select a certain number of stations in localities such that there shall always be clear weather at one of them. India offers peculiar facilities for such a selection of stations, owing to the great variety of climate to be found in that country during the same period of the year. Perhaps four or five such stations would suffice for India, and if absolute continuity of record could not be obtained by them, the deficiencies could easily be made good by stations in our colonial possessions."

It is well known how slowly such things march in this country; nevertheless we look with much confidence to the forthcoming report of the Royal Commission appointed to investigate matters of this nature, and to urge upon Government such means as they consider shall tend to the advancement of science and to the good of the country.

BALFOUR STEWART

VAN DER WAALS ON THE CONTINUITY OF THE GASEOUS AND LIQUID STATES

Over de continuiteit van den gas- en vloeistoftoestand. Academisch proefschrift. Door Johannes Diderik van der Waals. (Leiden: A. W. Sijthoff, 1873.)

THAT the same substance at the same temperature and pressure can exist in two very different states, as a liquid and as a gas, is a fact of the highest scientific importance, for it is only by the careful study of the difference between these two states, the conditions of the substance passing from one to the other, and the phenomena which occur at the surface which separates a liquid from its vapour, that we can expect to obtain a dynamical

theory of liquids. A dynamical theory of "perfect" gases is already in existence; that is to say, we can explain many of the physical properties of bodies when in an extremely rarefied state by supposing their molecules to be in rapid motion, and that they act on one another only when they come very near one another. A molecule of a gas, according to this theory, exists in two very different states during alternate intervals of time. During its encounter with another molecule, an intense force is acting between the two molecules, and producing changes in the motion of both. During the time of describing its free path, the molecule is at such a distance from other molecules that no sensible force acts between them, and the centre of mass of the molecule is therefore moving with constant velocity and in a straight line.

If we define as a perfect gas a system of molecules so sparsely scattered that the aggregate of the time which a molecule spends in its encounters with other molecules is exceedingly small compared with the aggregate of the time which it spends in describing its free paths, it is not difficult to work out the dynamical theory of such a system. For in this case the vast majority of the molecules at any given instant are describing their free paths, and only a small fraction of them are in the act of encountering each other. We know that during an encounter action and reaction are equal and opposite, and we assume, with Clausius, that on an average of a large number of encounters the proportion in which the kinetic energy of a molecule is divided between motion of translation of its centre of mass and motions of its parts relative to this point approaches some definite value. This amount of knowledge is by no means sufficient as a foundation for a complete dynamical theory of what takes place during each encounter, but it enables us to establish certain relations between the changes of velocity of two molecules before and after their encounter.

While a molecule is describing its free path, its centre of mass is moving with constant velocity in a straight line. The motions of parts of the molecule relative to the centre of mass depend, when it is describing its free path, only on the forces acting between these parts, and not on the forces acting between them and other molecules which come into play during an encounter. Hence the theory of the motion of a system of molecules is very much simplified if we suppose the space within which the molecules are free to move to be so large that the number of molecules which at any instant are in the act of encountering other molecules is exceedingly small compared with the number of molecules which are describing their free paths. The dynamical theory of such a system is in complete agreement with the observed properties of gases when in an extremely rare condition.

But if the space occupied by a given quantity of gas is diminished more and more, the lengths of the free paths of its molecules will also be diminished, and the number of molecules which are in the act of encounter will bear a larger proportion to the number of those which are describing free paths, till at length the properties of the substance will be determined far more by the nature of the mutual action between the encountering molecules than by the nature of the motion of a molecule when describing its free path. And we actually find that the properties of the substance become very different after it has reached a certain degree of condensation. In the rarefied state its properties may be defined with considerable accuracy in terms of the laws of Boyle, Charles, Gay-Lussac, Dulong and Petit, &c., commonly called the "gaseous laws." In the condensed state the properties of the substance are entirely different, and no mode of stating these properties has yet been discovered having a simplicity and a generality at all approaching to that of the "gaseous laws." According to the dynamical theory this is to be expected, because in the condensed state the properties of the substance depend on the mutual action of molecules when engaged in close encounter, and this is determined by the particular constitution of the encountering molecules. We cannot therefore extend the dynamical theory from the rarer to the denser state of substances without at the same time obtaining some definite conception of the nature of the action between molecules when they are so closely packed that each molecule is at every instant so near to several others that forces of great intensity are acting between them.

The experimental data for the study of the mutual action of molecules are principally of two kinds. In the first place we have the experiments of Regnault and others on the relation between the density, temperature, and pressure of various gases. The field of research has been recently greatly enlarged by Dr. Andrews in his exploration of the properties of carbonic acid at very high pressures. Experiments of this kind, combined with experiments on specific heat, on the latent heat of expansion, or on the thermometric effect on gases passing through porous plugs, furnish us with the complete theory of the substance, so far as pure thermodynamics can carry us.

For the further study of molecular action we require experiments on the rate of diffusion. There are three kinds of diffusion—that of matter, that of visible motion, and that of heat. The inter-diffusion of gases of different kinds, and the viscosity and thermal conductivity of a gaseous medium, pure or mixed, enable us to estimate the amount of deviation which each molecule experiences on account of its encounter with other molecules.

M. Van der Waals, in entering on this very difficult inquiry, has shown his appreciation of its importance in the present state of science; many of his investigations are conducted in an extremely original and clear manner; and he is continually throwing out new and suggestive ideas; so that there can be no doubt that his name will soon be among the foremost in molecular science.

He does not, however, seem to be equally familiar, as yet, with all parts of the subject, so that in some places, where he has borrowed results from Clausius and others, he has applied them in a manner which appears to me erroneous.

He begins with the very remarkable theorem of Clausius, that in stationary motion the mean kinetic energy of the system is equal to the mean virial. As in this country the importance of this theorem seems hardly to be appreciated, it may be as well to explain it a little more fully.

When the motion of a material system is such that the sum of the moments of inertia of the system about three axes at right angles to each other through its centre of mass does not vary by more than small quantities from a constant value, the system is said to be in a state of sta-

tionary motion. The motion of the solar system satisfies this condition, and so does the motion of the molecules of a gas contained in a vessel.

The kinetic energy of a particle is half the product of its mass into the square of its velocity, and the kinetic energy of a system is the sum of the kinetic energy of its parts.

When an attraction or repulsion exists between two points, half the product of this stress into the distance between the two points is called the Virial of the stress, and is reckoned positive when the stress is an attraction, and negative when it is a repulsion. The virial of a system is the sum of the virial of the stresses which exist in it.

If the system is subjected to the external stress of the pressure of the sides of a vessel in which it is contained, the amount of virial due to this external stress is three halves of the product of the pressure into the volume of the vessel.

The virial due to internal stresses must be added to this.

The theorem of Clausius may now be written—

$$\tfrac{1}{2}\,\Sigma(m\,\overline{v^2}) = \tfrac{3}{2}p\,V + \tfrac{1}{2}\Sigma\,\Sigma\,(R\,r)$$

The left-hand member denotes the kinetic energy.

On the right hand, in the first term, p is the external pressure on unit of area, and V is the volume of the vessel.

The second term represents the virial arising from the action between every pair of particles, whether belonging to different molecules or to the same molecule. R is the attraction between the particles, and r is the distance between them. The double symbol of summation is used because every pair of points must be taken into account, those between which there is no stress contributing, of course, nothing to the virial.

As an example of the generality of this theorem, we may mention that in any framed structure consisting of struts and ties, the sum of the products of the pressure in each strut into its length, exceeds the sum of the products of the tension of each tie into its length, by the product of the weight of the whole structure into the height of its centre of gravity above the foundations. (See a paper on "Reciprocal Figures, &c." Trans. R. S. Edin., vol. xxvi. p. 14. 1870.)

In gases the virial is very small compared with the kinetic energy. Hence, if the kinetic energy is constant, the product of the pressure and the volume remains constant. This is the case for a gas at constant temperature. Hence we might be justified in conjecturing that the temperature of any one gas is determined by the kinetic energy of unit of mass.

The theory of the exchange of the energy of agitation from one body to another is one of the most difficult parts of molecular science. If it were fully understood, the physical theory of temperature would be perfect. At present we know the conditions of thermal equilibrium only in the case of gases in which encounters take place between only a pair of molecules at once. In this case the condition of thermal equilibrium is that the mean kinetic energy due to the agitation of the centre of mass of a molecule is the same, whatever be the mass of the molecule, the mean velocity being consequently less for the more massive molecules.

With respect to substances of more complicated constitution, we know, as yet, nothing of the physical condition on which their temperature depends, though the researches of Boltzmann on this subject are likely to result in some valuable discoveries.

M. Van der Waals seems, therefore, to be somewhat too hasty in assuming that the temperature of a substance is in every case measured by the energy of agitation of its individual molecules, though this is undoubtedly the case with substances in the gaseous state.

Assuming, however, for the present that the temperature is measured by the mean kinetic energy of a molecule, we obtain the means of determining the virial by observing the deviation of the product of the pressure and volume from the constant value given by Boyle's law.

It appears by Dr. Andrews' experiments that when the volume of carbonic acid is diminished, the temperature remaining constant, the product of the volume and pressure at first diminishes, the rate of diminution becoming more and more rapid as the density increases. Now, the virial depends on the number of pairs of molecules which are at a given instant acting on one another, and this number in unit of volume is proportional to the square of the density. Hence the part of the pressure depending on the virial increases as the square of the density, and since, in the case of carbonic acid, it diminishes the pressure, it must be of the positive sign, that is, it must arise from *attraction* between the molecules.

But if the volume is still further diminished, at a certain point liquefaction begins, and from this point till the gas is all liquefied no increase of pressure takes place. As soon, however, as the whole substance is in the liquid condition, any further diminution of volume produces a great rise of pressure, so that the product of pressure and volume increases rapidly. This indicates negative virial, and shows that the molecules are now acting on each other by *repulsion.*

This is what takes place in carbonic acid below the temperature of 30·92° C. Above that temperature there is first a positive and then a negative virial, but no sudden liquefaction.

Similar phenomena occur in all the liquefiable gases. In other gases we are able to trace the existence of attractive force at ordinary pressures, though the compression has not yet been carried so far as to show any repulsive force. In hydrogen the repulsive force seems to prevail even at ordinary pressures. This gas has never been liquefied, and it is probable that it never will be liquefied, as the attractive force is so weak.

We have thus evidence that the molecules of gases attract each other at a certain small distance, but when they are brought still nearer they repel each other. This is quite in accordance with Boscovich's theory of atoms as massive centres of force, the force being a function of the distance, and changing from attractive to repulsive, and back again several times, as the distance diminishes. If we suppose that when the force begins to be repulsive it increases very rapidly as the distance diminishes, so as to become enormous if the distance is less by a very small quantity than that at which the force first begins to be repulsive, the phenomena will be precisely the same as those of smooth elastic spheres.

M. Van der Waals makes his molecules elastic spheres, which, when not in contact, attract each other. His treatment of the "molecular pressure" arising from their attraction seems ingenious, and on the whole satisfactory, though he has not attempted a complete calculation of the attractive virial in terms of the law of force.

His treatment of the repulsive virial, however, shows a departure from the principles on which his investigation is founded. He considers the effect of the size of the molecules in diminishing the length of their "free paths," and he shows that this effect, in the case of very rare gases, is the same as if the volume of the space in which the molecules are free to move had been diminished by four times the sum of the volumes of the molecules themselves. He then substitutes for V, the volume of the vessel in Clausius' formula, this volume diminished by four times the molecular volume, and thus obtains the equation—

$$\left(p + \frac{a}{V^2}\right)(V - b) = R(1 + \alpha t),$$

where p is the externally applied pressure, $\frac{a}{V^2}$ is the molecular pressure arising from attraction between the molecules, which varies as the square of the density, or inversely as the square of the volume. The first factor is thus what he considers the total effective pressure. V is the volume of the vessel, and b is four times the volume of the molecules. The second factor is therefore the "effective volume" within which the molecules are free to move.

The right hand member expresses the kinetic energy, represented by the absolute temperature, multiplied by a quantity, R, constant for each gas.

The results obtained by M. Van der Waals by a comparison of this equation with the determinations of Regnault and Andrews are very striking, and would almost persuade us that the equation represents the true state of the case. But though this agreement would be strong evidence in favour of the accuracy of an empirical formula devised to represent the experimental results, the equation of M. Van der Waals, professing as it does to be derived from the dynamical theory, must be subjected to a much more severe criticism.

It appears to me that the equation does not agree with the theorem of Clausius on which it is founded.

In that theorem p is the pressure of the sides of the vessel, and V is the volume of the vessel. Neither of these quantities is subject to correction.

The assumption that the kinetic energy is determined by the temperature is true for perfect gases, and we have no evidence that any other law holds for gases, even near their liquefying point.

The only source of deviation from Boyle's law is therefore to be looked for in the term $\frac{1}{2}\Sigma\Sigma(Rr)$, which expresses the virial. The effect of the repulsion of the molecules, causing them to act like elastic spheres, is therefore to be found by calculating the virial of this repulsion.

Neglecting the effect of attraction, I find that the effect of the impulsive repulsion reduces the equation of Clausius to the form—

$$pV = \tfrac{1}{3}\Sigma(mv^2)\left\{1 - 2\log.\left(1 - 8\frac{\rho}{\sigma} + 17\frac{\rho^2}{\sigma^2} - \&c.\right)\right\}$$

where σ is the density of the molecules and ρ the mean density of the medium.

The form of this equation is quite different from that of M. Van der Waals, though it indicates the effect of the impulsive force in increasing the pressure. It takes no account of the attractive force, a full discussion of which would carry us into considerable difficulties.

At a constant temperature the effect of the attractive virial is to diminish the pressure by a quantity varying as the square of the density, as long as the encounters of the molecules are, on the whole, between two at a time, and not between three or more. The effect of the attraction in deflecting the paths of the molecules is to make the number of molecules which at any given instant are at distances between r and $r + dr$ of each other greater than the number in an equal volume at a greater distance in the proportion of the velocities corresponding to these distances. As the temperature rises, the volume being constant, the ratio of these velocities approaches to unity, so that the distribution of molecules according to distance becomes more uniform, and the virial is thus diminished.

If there is a virial arising from repulsive forces acting through a finite distance, a rise of temperature will increase the amount of this kind of virial.

Hence a rise of temperature at constant volume will produce a greater increase of pressure than that given by the law of Charles.

The isothermal lines at higher temperatures will exhibit less of the diminution of pressure due to attraction, and as the density increases will show more of the increase of pressure due to repulsion.

I must not, however, while taking exception to part of the work of M. Van der Waals, forget to add that to him alone are due the suggestions which led me to examine the theory of virial more carefully in order to explore the continuity of the liquid and the gaseous states.

I cannot now enter into the comparison of his theoretical results with the experiments of Andrews, but I would call attention to the able manner in which he expounds the theory of capillarity, and to the remarkable phenomenon of the surface tension of gases which he tells (p. 38) has been observed by Bosscha in tobacco smoke. As tobacco smoke is simply warm air with a slight excess of carbonic acid, carrying solid particles along with it, the change of properties at the surface of the cloud must be very slight compared with that at the surface where two really different gases first come together. If, therefore, the phenomenon observed by Bosscha is a true instance of surface-tension, we may expect to discover much more striking phenomena at the meeting-place of different gases, if we can make our observations before the surface of discontinuity has been obliterated by the inter-diffusion of the gases.

J. CLERK-MAXWELL

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

An Anagram

THE practice of enclosing discoveries in sealed packets and sending them to Academies, seems so inferior to the old one of

Huyghens, that the following is sent you for publication in the old conservated form :—

$A^8C^3DE^{12}F^4GH^6I^6L^3M^3N^5O^6P$
$R^4S^5T^{14}U^6V^2WXY^2$ WEST

"Manufactured Articles"

THERE are precedents to justify a hope that it would be no excursion beyond the province of NATURE, if somebody who knows that molecules possess the essential character of a manufactured article were kindly to explain how he knows a manufactured article when he sees it, in his mind's eye or elsewhere.

The answer used to be "contrivance, design; an end, a purpose; means for the end, adaptation to the purpose." This, it was said, we find in a watch; "we perceive that its several parts are framed and put together for a purpose." The same thing, it was further said, we find still more in the works of nature, "and that in a degree which exceeds all computation." And why so much more? Because "the contrivances of nature surpass the contrivances of art, in the complexity, subtlety, and curiosity of the mechanism; and still more, if possible, do they go beyond them in number and variety." This was the old answer: the new one is contained in such phrases as these: "exact equality," "exact unison," "exactly the same magnitude," "constants not approximately but absolutely identical."

Here it is hard not to stop and ask what can possibly prove that these things are absolutely so: or what can possibly contribute the smallest probability to a hypothesis that anything is absolutely anything, I do not say among the laws of nature, but among its collocations. Very likely it might be proved that the mean-square variation in the value of one of the above-mentioned constants is a prodigiously smaller fraction of its mean value than any other fraction which the molecular theory has occasion to take account of; and anyhow the fact remains that a molecule of bismuth, for instance, differs from a molecule of lead immensely more than two molecules of either can differ from one another. Perhaps this will do as well for the argument; if so, there is no excuse for the absolute; and whether or no, the argument will be the better for explanation, or perhaps it will be the worse for the argument.

However this may be, the difference between the old answer and the new one is rather instructive. An eager disputant might say the new one was contradictory of the old one; but it is safer to say that the new is at best independent of the old. Clearly a watch is about the last thing which would be cited to illustrate the new sort of manufactured article. The examples which our authors do by preference cite are coins, weights, and measures; and certainly it would be difficult to name manufactured articles which should better exemplify uniformity for the sake of uniformity. And for a very good reason (that is the worst of it); because the purposes of coins, weights, and measures are defeated, they who handle them deceived, and (as our authors are careful to say) they who manufacture them deceivers, so far as the things are not uniform. So the inference from such things only comes to this, that uniformity is a character of manufactured articles when uniformity is part of the purpose of manufacture. Is then the new argument, after all, a special case of the old one? Not so: for when men produce as a novelty a special case of an old argument, this must be because it is an especially strong case of the same; but we have seen that the old argument owes much of its virtue to complexity and variety; therefore, our modern manufactured articles, which are above all things simple and uniform, will only furnish a special case of the old argument by furnishing an especially weak one. Design, in short, has nothing to do with the new argument, and we must look for analogies among manufactured articles which are uniform, not because uniformity adapts them to their purpose, but simply because they *are* manufactured articles.

The nearest approach I can think of is to be found on a scale almost molecular, for number and sometimes for magnitude, in a London wilderness of similar and similarly situated houses. It is oppressive to walk past these boxes so nearly identical in form, and to think of the infinite variety of their contents; to think how different they would have been, and how much fitter for their purposes, if their inhabitants could have secreted them as a snail secretes his shell. And why does it make all the difference that they have been manufactured? Why did not the manufacturer vary them according to the interests connected with them? Of course because he did not care about those interests; because he could not foresee them; and because it would not answer to try and provide for them. And now we understand the sort of manufacturer the new argument reveals: a manufacturer who does not care what becomes of his articles the moment he gets them off his hands by his formulas beginning to be interpretable; a manufacturer who cannot solve his own equations except in a grossly approximative fashion; a manufacturer who could not give his constants the proper values if he knew what values to give them.

Uniformity, in short, is not as such the sign of a manufactured article, except as it may be the sign of an imperfect manufacturer. I do not suppose this is what the new argument is meant to mean: but this, I submit, is what it does mean. Perhaps, however, some competent supporter of it will kindly explain it a little. C. J. MONRO

Yorkshire College of Science

WILL you permit a few words upon your allusion to this College in a leading article of the 8th inst.?

If its promoters have confined their present efforts to the establishment of a Faculty of Science, one cause has been that the amount of their funds compelled a selection instead of a comprehension of subjects. With a capital of 26,000*l.* they could not venture to cover so large a field as Owens College commenced upon with an invested endowment of four times the amount. But already, before our doors are opened, we have cheering signs that in providing a function to which endowments may be entrusted, the College will accrete to itself aid from widely-divergent quarters. The Royal assent has been given to an amended scheme of the Endowed Schools Commissioners for the Akroyd Charity, by which an important annual residue is allotted to the College, with representation upon the Trust. By the liberality of the Clothworkers' Company, the sum of 500*l.* per annum is set apart for three years for a Professor of Textile Industries and for Scholarships. Is it unreasonable to hope that new professorships will be established by the generosity of private individuals? The existence here of a flourishing School of Medicine is favourable to your views of massing the Faculties, and already a first link of union is being forged between the two bodies in relation to the classes in Chemistry.

Do not suppose that the College adopts *Pannus mihi panis* as its motto. A thoroughly practical community must run a risk of magnifying the *practice* of science rather than its *theory*, but if the selection of professors has been fortunate, there is no doubt that students will be taught practice through theory. Your forcible remarks will doubtless strengthen the hands of certain liberal donors to the College, who have offered increased sums when an Arts Faculty can be established.

Leeds, Oct. 12 R. REYNOLDS

On the Process of Tone-making in Organ-pipes

THE natural order of harmonic progression in an open organ-pipe is well known. That there is from the same pipe an inverse order of harmonics equally natural is not equally well known. There is no intimation that I am aware of, in any treatise on sound, of this fact having been observed, and the absence of recognition is no doubt attributable to a general disregard of the study of the comparative acoustics of musical instruments. My investigations into the process of tone-making in organ-pipes and other instruments have clearly shown me that there is *an order of transitive* harmonics distinct from the *order of concomitant* harmonics or "over-tones." Why I call them "transitive" will be apparent in the argument. Certain it is that our mimaphonic power in organ-pipes and in other musical devices depends on the command we can ensure over these two orders distinctively, and also on their comparative influences on the tones produced. In this manifestation of an inversion of harmonic progression, the nature, and, without extravagance one may say, the individuality, of the aëroplastic reed is most fully pronounced. Experimental proof is easily obtained, and, whilst bringing into prominence the peculiar display, will at the same time furnish indubitable evidence of the formative power exercised by the air-reed in the process of tone-making.

By the term "tone-making" is to be understood the manner of origination not merely of a note of defined pitch emitted by a musical instrument, but also of all the constituent sounds which give colour or quality to the note, and enter into the effect perceived by the ear. The artist, according to his sagacity, seizes

on the faintest hints of nature, and with more or less consciousness of insight into law is able to control the process.

The modern theory of musical quality, or *timbre*, for which we are indebted primarily to Johannes Müller, and subsequently to Helmholtz, who by elaborate investigation has made the subject specially his own, takes account only of the varying intensities of the harmonics present in the compound tone, classed in two series, the "open" and the "stopped," or otherwise the "even" and "uneven," in regular progression. To the system of associated sounds in harmony the present inquiry has no reference; my purpose is to press the claim for recognition of another series in addition to these, to show that quality, and especially mimaphonic quality, in sounds, in whatever degree attributable to harmonics combined with the fundamental, is no less dependent for its character on the "order" in which harmonics come on or develop themselves in the growth of the tone. In plants there is a direct order of appearance—leaves, then flowers; a reversed order is as natural, and flowers come before leaves.

If an "open diapason" pipe of small scale is taken, and some slight variation made in the voicing, the pipe may be converted into a "flute harmonique," and it will give a note an octave higher than before; that is to say, the fundamental is abolished, and the octave or first harmonic reigns in its stead. The pipe will probably be now "unsteady," frequently attempting to reinstate the fundamental. This tendency we may counteract by drilling a small pin-hole at the side of the pipe, and the trifling amount of external air thereby admitted will destroy the tendency, by preventing the perfect formation of the node required by the fundamental. The perforation should be made at the true point of localisation of the node, which (as explained in a former letter in NATURE, vol. ix., p. 301) is at about $\frac{5}{9}$ of the whole length of pipe reckoned from the level of the mouth. If we next enlarge the hole at the foot of the pipe, thus allowing greater force to the wind-current, and if we have properly manipulated the pipe, we shall on the trial of its sound hear the twelfth coming on as the forerunner of the octave, most distinctly and with a perceptible interval between the appearance of the twelfth and octave. The effect is more certain if the mouth is cut to a height less than that marked by scale, which would be $\frac{1}{3}$ of the width of mouth; and if, further, the pipe is slightly coned—a provision favouring the harmonic. By other changes of treatment, the fifteenth or double octave may be brought out as the introductory harmonic, and the twelfth following, and if we will we may restore the original ground-tone. The "flute harmonique" in this style is to be chosen for this experiment, not as representative of quality, but that in this overstrained condition it clearly defines the entrance of each harmonic, the order of succession, and the interval between each. In other varieties of pipe the "quality" is characterised by these harmonics, and in this order, but so blended as it were in a "portamento" glide that even critical ears fail to detect the elements combined into the effect. It is, so to speak, "an excess" of nature, which is often necessary to open our eyes to the perception of her commonest realities.

A diapason pipe is never so strong and brilliant in character as when it is just verging on the transmutation of fundamental to octave; for good vigorous quality, therefore, it is restrained only to just within the limit; nevertheless the presence of the octave-harmonic as the precursor of the fundamental should always be felt with its jubilant energy, then afterwards, the fundamental taking full possession of the pipe, producing its own octave-harmonic with almost equal exuberance of power. The precursory harmonic is of the transitive order. We have to recognise two distinct series of open harmonics—the direct order, *over-tones of the pipe*, which are derivatives of the fundamental, and the inverse order, the tones of which may be called *stem-tones of the reed*, for they are thrown off by the reed in swift succession, and declare the non-isochronous nature of the air-reed's motion. There is nothing erratic about these stemmal harmonics or the order of their appearance; they are due to the untamed vigour of the reed, and have this distinguishing law—they are transitive, each one dies in giving birth to the next, whereas the over-tones of the pipe coexist with the fundamental, and are the direct consequence of the excess of excitation in the air-column of the pipe (see more at length in NATURE, vol. viii., p. 383), providing a safety-valve for the permanence of pitch in the ground-tone, by employing the surplus energy acquired from the reed's vivacity in new forms of growth.

Whenever from an organ-pipe we hear harmonics together with the fundamental, then the air-reed is vibrating to its fullest mplitude, for it is the superabundant vitality of the air-column that sustains the coexistent ones; but when we hear harmonics independent of the fundamental, then we may be sure that they are the expression of the higher activity of the reed itself, then working with lessened *amplitude* of motion, yet with greater *velocity* of vibration.

The genesis of these tones is due to the association of reed and pipe. Without the pipe the reed could not produce tone, would be barren as one sex. As the pipe is silent and requires some external impulses to bring it into life, so the air-reed needs something to act upon before it can vibrate or swerve from its course in minute degree; some inequality of environment is all it asks—some alliance with power distinct from its own. Take away the pipe, leave it only the mouth, and it will pull against that and begin to work according to its nature, and even in that rudimentary condition will elicit tone of definite pitch.

Many classes of organ-pipes give harmonics of the direct order without a trace of those of the inverse order; on the other hand, the several varieties of pipes which give the inverse order invariably yield the direct order subsequently with the ground tone; and why? It will be comprehended at once, if I have rendered my meaning clearly, that the initial harmonics proclaim the intense vigour of the reed, and that force, unabated in strength, although widened in scope, is transferred to the air-column of the pipes The difference of effects produced by the two orders constitute. that variety of quality which distinguishes string-tone from horn-tone, and a further modification chiefly in relative times of sequence asserts its peculiarity as reed-tone; yet, again, there are in both series departures from truth of pitch, in some qualities an over-flatness of one or more harmonics, and in some an over-sharpness. The blast of the trumpet combines both flat and sharp harmonics strongly. The *direct* order of harmonics may be likened to an ascending arpeggio coalescing into a chord—the *transitive* to a descending arpeggio, in some instances having intervals regularly defined, in others starting abruptly and with wayward intensity, and in other displays passing swiftly onward to the fulness of tone, imperceptibly blended as is the "portamento" glide of voice or string.

In all the "Geigens" and "Gambas" and similar organ-pipes mimaphonic of "stringy quality," the transitive harmonics are the true cause of their speciality. Numerous experiments prove this to the eye as well as to the ear. I shall be able to show that the "Gambas" are characterised also by an over-sharpness of these transitive harmonics, and this paper is a necessary introduction to my proposed examination of the mode in which the peculiar quality of tone is built up in this attractive class of pipes.

HERMANN SMITH

Can Land-Crabs Live under Water?

PERMIT me to inform Mr. J. C. Galton that the authority for my statement in the "Outlines of Physiology" is also derived from "some book or other;" and that this "turns out" to be the classical "Hist. Nat. des Crustacés" of Milne-Edwards, vol. ii. pp. 16, 18, with which perhaps your correspondent is unacquainted.

Milne-Edwards, in his turn, refers (p. 19) to those who have studied the land-crabs in the Antilles and on the South American coast, viz., Rochefort, Feuillée, Labat, and Brown. He elsewhere, also, treats the subject as a comparative anatomist and physiologist (Ann. des Sciences Nat.; Todd's "Cyclopædia").

Whether the land-crabs of the east differ in their habits from those of the west is of course open to inquiry; and also in what ways (either anatomically or physiologically) they differ; but the question is clearly not whether they can survive for a few hours under water, but whether practically they can live in that element or are at last asphyxiated in it.

10, Savile Row, Oct. 6 JOHN MARSHALL

Bright Meteors

AT 8.55 this evening a party of six observed a meteor in the constellation Aries, or below it, which emitted light sufficient to cast a bright gleam on the neighbouring trees. The body of the meteor shot rapidly along a course extending about 20°. It then seemed to explode suddenly, and its track was luminous for a short time. The granular *débris* of the meteor continued to pursue, with very much retarded velocity a path slightly deflected from its former course: it continued to do so for several degrees' and it was, I think, fully a minute after the explosion that several of us almost simultaneously exclaimed, "It is falling." It resembled the expiring light of one globe of a rocket charged

with golden rain. The falling motion was very slow. I think it was visible for two minutes after the explosion, but though we tried more than once to consult our watches, the light was insufficient. HENRY H. HIGGINS

Rainhill, Oct. 11

AN exceedingly brilliant meteor was seen here about 8.50 on Sunday evening, which was so bright that it attracted general attention, the light from it being as strong as an unusually bright flash of lightning, but more white. On looking up I saw, near the zenith, a long almost straight and uninterrupted ribbon of light, somewhat pointed at the end towards the north-east. After watching it for some time and noticing that it retained its brilliancy, I began slowly counting, and counted up to twenty before there was any noticeable diminution of luminosity. The last portion visible was the end opposite the pointed end, which appeared as a faintly luminous patch as large as the apparent disc of the moon. I consider that, from its first appearance, it was visible from 80 to 100 seconds.

Wisbech, Oct. 11 A. BALDING

Rainbows

AS a supplement to the description of a "Double Rainbow," published by Prof. Tait in NATURE, vol. x. p. 437, the following diagram may be of interest to your readers. It represents a phenomenon which was seen here a few days ago, and one which I should think must be of very rare occurrence.

FIG. 1.

It will be observed that all the four bows were incomplete, but this only arose from the accidental cause mentioned by Prof. Tait. The two extra bows were due to reflection from a calm sea.

It may perhaps be remembered that about eighteen months ago I published in NATURE a verbal description of a rainbow similar to that now figured by Prof. Tait; only I was fortunate enough to see the bows complete and extraordinarily brilliant. Hence there were three bows, thus:—

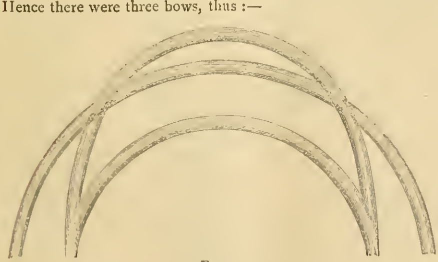


FIG. 2.

I presume that the presence of the fourth bow, as shown in the first diagram, is to be accounted for by the reflection from the sea having been sufficiently bright to give rise to a double concentric bow. GEORGE J. ROMANES

Dunskaith, Ross-shire, Oct. 3

IN reference to Mr. Tait's letter in NATURE, vol. x. p. 460, it may interest some of your readers to hear that our party saw a very perfect lunar rainbow at North Malvern, Worcestershire, on the evening of July 27, this year. The bow was so perfect that the colours were easily distinguishable—that is, of course, the main colours. The appearance lasted about five or ten minutes (10.35 to 10.45 P.M.) JOHN LATCHMORE, JUN.

Leicester, Oct. 12

The Cry of the Frog

WITH reference to the power of the frog to cry out, I may mention that while in India, as I was walking in my garden after dusk during the rainy season, when a peculiar kind of enormous green frog make their appearance for a few weeks, I was surprised to hear a cry exceedingly like that of a baby. On sending for a light I found a large frog, with a small one in its throat which it was apparently swallowing, while the small frog, the snout of which was just perceptible, was shrieking in the way I describe. On tapping the big frog sharply on the back, the little frog jumped out and made off.

Leamington, Oct. 10 J. P. G.

I HAVE on three different occasions heard a frog expostulate in the manner described by Mr. Mott. One did so on being patted inquisitively by a cat; the two others on being examined by a little dog. In each case the frog was of so unusually vivid a yellow as to suggest that it was either a variety of the common frog, or that it was in some unusual condition. Is Mr. Mott's frog equally brilliant? I may add that my three were also Leicestershire frogs. E. H.

Oct. 13

IT may interest your correspondent who has elicited what he believes to be a cry of fear from a frog, to know that an explanation of this cry—which is probably but the croaking experiment or *Quackversuch* of Goltz—is given at p. 201 of the recently issued volume of the West Riding Asylum Reports in the very remarkable paper by Dr. Lauder Brunton, on "Inhibition, Peripheral and Central." The extract is too long for quotation. H. W. P.

Oct. 13

I REMEMBER as a boy being rather startled by a shrill wailing cry which proceeded from a small pond, and on running to the spot I found a common snake in the act of swallowing a frog. They were on the surface of the water in the middle of the pool; the hinder part of the frog had already disappeared, and the terrified creature was crying piteously. He proved, however, too big a mouthful to be readily disposed of, and when by the aid of a long stick I interrupted the banquet and released him, he dived away apparently unhurt.

Though I have lived much in the country, I never heard a frog cry but on this occasion. I have often seen them played with, tumbled about, and patted by dogs and cats, as described by your correspondent F. T. Mott, but they have always borne the indignity in silence. F. BADEN BENGER

Manchester, Oct. 10

The Edible Frog

IT is stated in Bell's "History of British Reptiles," 2nd edit., p. 111, that the Edible Frog (*Rana esculenta*) was captured for the first time in this country in Foulmire Fen, Cambridgeshire, in 1843. Mr. Bell received some specimens which on comparison he identified as belonging to the continental species, he having at that time some living ones obtained from France. Mr. Bond, who had written to the *Zoologist* on this subject, said "the whole fen was quite in a charm with their song." Their very remarkable and sonorous croak had procured for these frogs the name of "Cambridgeshire nightingales."

I have recently been informed that this reptile was introduced from France some fifty years ago, and turned loose in the south of Cambridgeshire; and that very recently some one who is partial to the dish called "Frog-pie" has introduced the animal into Norfolk. But I cannot obtain any satisfactory information as to the naturalisation of the reptile. Are those brought into this country dying out? If not, they do not seem to have reached Norfolk, and I cannot find any in this neighbourhood. Is, then, the *Rana esculenta* to be regarded as a British reptile? If any of the readers of NATURE can inform me whether they have obtained it in the Fen district, I should be much obliged.

Wisbech, Oct. 9 SAML. H. MILLER

SOUNDINGS AND CURRENTS IN THE NORTH PACIFIC OCEAN

PREVIOUS accounts of the soundings of the U.S. steamer *Tuscarora* in the North Pacific Ocean, with reference to laying a cable between America and Japan, have described the work accomplished sailing from the Asiatic coast up to lat. 41° 09′ N., long. 144° 01′ E., after two projected routes had been tried and abandoned. From that point the *Tuscarora* went to Hakodadi to obtain a supply of coal, and thence sailed to lat. 46° 38′ N., long. 151° 47′ E., from which point soundings were taken on a backward line to the position which was left to go to Hakodadi; the backward line skirting the shores of the Kurile Islands. All the soundings are taken at intervals of 29 or 30 miles. Upon the new route thus surveyed from Yokohama, for a distance of 1,000 miles, the depths range from 300 to 2,270 fathoms, the greatest declivity being 161 ft. to the mile, between lat. 40° 10′ N., long. 142° 57′ E., and lat. 41° 09′ N., long. 144° 01′ E. The depth gradually increased between lat. 47° 44′ N., long. 154° 15′ E. and lat. 50° 19′ N., long. 159° 39′ E. (a distance of 260 miles), at the rate of about 60 ft. to the mile; the depth at the point last named being 3,754 fathoms. The course thence was through open water between the Kamschatkan coast and the Aleutian Islands; but just before entering the latter group the steepest declivity was found that has been met with during this survey. The preceding and succeeding coasts, each at a distance of 29 miles, gave depths of 2,460 fathoms, while this one, in lat. 52° 06′ N., long. 171° 15′ E., gave 4,037 fathoms, a slope of at least 326 ft. to the mile. Thence to lat. 51° 58′ N., long. 174° 31′ E. (about three miles from Atchka Island), the water shoaled to 332 fathoms, rising at the rate of 187 ft. to a mile. From the last-named position to Tanaga Island the depths ranged from 200 to 1,800 fathoms, including only one remarkable declivity, which was between lat. 51° 08′ N., long. 178° 35′ W., and lat. 51° 28′ N., long. 177° 57′ W., where the slope was 250 ft. to the mile.

Between Tanaga Island and Illiouk, a distance of about 500 miles, the depths nowhere exceeded 1,500 fathoms. The latter place will afford facilities as an intermediate station for the projected cable. Thence the course surveyed was to the north-east, afterward veering to the eastward through Ounimak Pass, toward the locality at which the survey proceeding from Cape Flattery westward left off last autumn, lat. 53° 58′ N., long. 153° W. From Illiouk to lat. 54° 10′ N., long. 162° 39′ W., the depths were small, being at the latter point 44 fathoms. Thence to lat. 54° N., long. 158° 22′ W., a distance of 151 miles, there was a descent of 130 ft. to the mile, the depth at the last-named being 3,359 fathoms. From this point the bed rises, reaching about the same level as that of last autumn's stopping-place—2,520 to 2,530 fathoms—when within 30 miles of that location. The great depth of 3,359 fathoms can be avoided by selecting a line some 30 miles to the northward, where only 2,900 fathoms' depth is found. A series of observations south of the line already surveyed gave greater depths.

Numerous observations were made on currents and temperatures. Along the shores of Kamschatka and the Kurile Islands, in lat. 51° 39′ N., there is a counter-current setting to the south-west, extending to long. 164° E., with a surface temperature of 42° F. Thence to long. 174° E. in the same latitude, with a surface temperature of 46° to 47° F., is the Kamschatka current (a branch of the Japan stream, setting through Behring Straits), which is here about 350 miles in width. It lost 22° F. between the Japan coast and lat. 51° 39′ N. The counter-current within the same limits gained 6° F. The atmosphere lost 18° F. From long. 174° E., proceeding eastward, the cold Behring Straits current with about 42° surface temperature was found, having for its western limits St. Lawrence and St. Matthew Islands. It is inferred that the counter-current of long. 164° is part of the Behring Strait current, having the same temperature, and that it flows

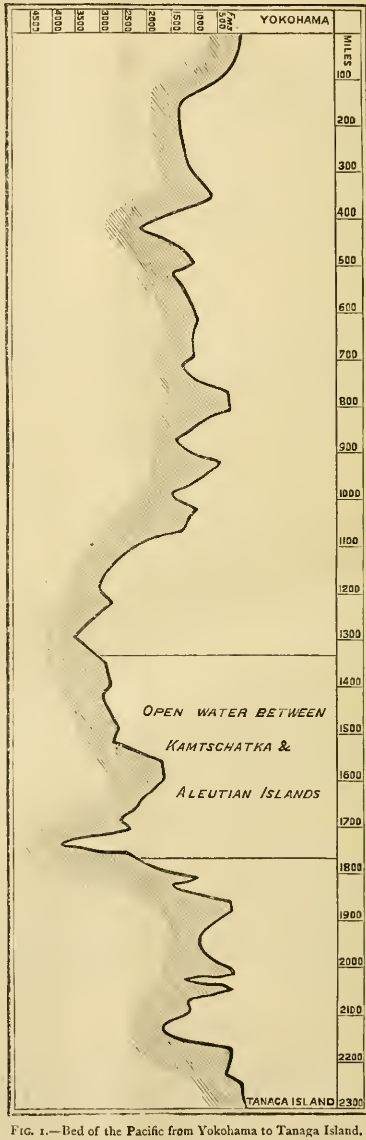


FIG. 1.—Bed of the Pacific from Yokohama to Tanaga Island.

beneath the Kamschatka current; and this belief was confirmed by finding at 30 fathoms' depth and below the latter current one setting to the south-west. On this

theory the excess of loss of heat on the part of the Kamschatka current over that of the atmosphere, as stated above, may be explained by attributing it to the cooling

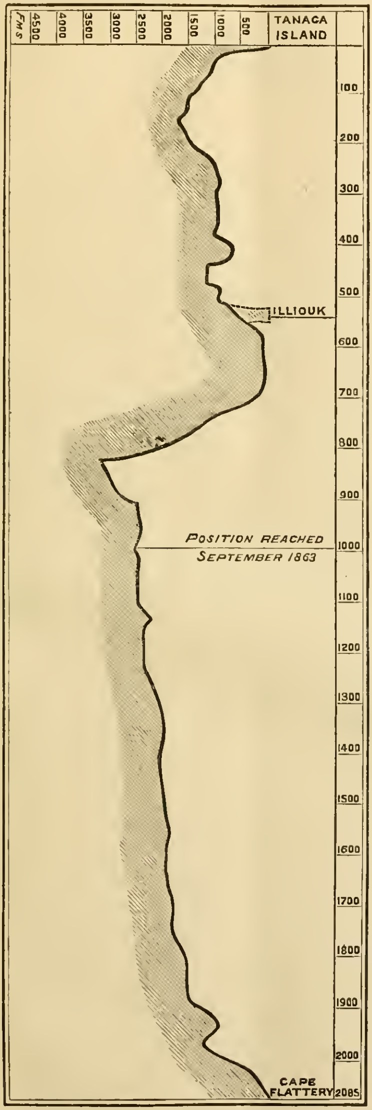


FIG. 2.—Bed of the Pacific, Tanaga Island to Cape Flattery.

effect of the counter-current beneath. It may here be mentioned that the northernmost limit of the Japan stream was 51° 12′ N., long. 178° 20′ E.

The coincidence of observations on temperatures and currents was very noteworthy. There was found, for instance, at lat. 42° 51′ N., long. 148° 14′ E., a north-east surface current of a half-knot per hour; at 5 to 15 fathoms' depth the temperature was 40·3° F., and in this space the current was marked. In the next 5 fathoms the thermometer fell 6°, and correspondingly the current ceased to be observable at this 20 fathoms' depth. At 200 fathoms a steadily increasing current to the south-west was observed; while from 20 fathoms' depth all the way to the bottom—upward of 4,000 fathoms—the fall of temperature was only 1°. A cold stratum of water was discovered, coming down from Behring Straits as an under-current. Between lats. 51° and 52° and longs. 159° and 169°, this current is at 150 ft. below the surface, and itself of 400 ft. depth. It was perceptible at lat. 42° 47′ N., long. 148° 23 E., but south of that it disappears: lat. 51° 22′ N., long. 162° 20′ E. is believed to be nearly its centre. Now, at the last-named location, at 22 fathoms, the thermometer marked 35·7°; at 75 fathoms, 32°; at 100 fathoms, 35·5°. This current was again satisfactorily defined at lat. 51° 43′ N., long. 165° 25′ E., and there the temperatures were, at 25 fathoms, 37·7°; at 60 fathoms, 34·7°; at 100 fathoms, 37·7°. The bottom temperatures vary from 32° to 33·9°.

Reviewing the results of the entire investigation in respect to currents, the following deductions may be summarised:—The Kuro Siwa or Japan current extends on an easterly course toward the American coast, its northern limit nearly reaching the southern shores of Vancouver Island; and it passes down to the southward in what has been incorrectly denominated the "California cold current." Beneath this an under-current sets to the north-west, and in lat. 50° reaches the surface, after which it sets northward along the shores of British America and the outstanding islands, thence gradually turns to the westward, its direction being affected by the outline of the coast, and exhibits at Sitka a strength of one knot per hour and a northward flow. In lat. 53° 30′ N., long. 157° W., the current, to a depth of 5 fathoms, set to the south-east, and this continued while observations were made during sailing to the south-east; but between that position and the line of the islands the current was to the south-west, and close to the islands to the westward. It is believed that a part of the water carried to the north-west by the under-current, returns in long. 157° to the northern portion of the Japan stream, and mingles with it, returning to the southward along the western shores of America, as part of the surface current; and that the part to the westward of long. 157° which sets toward the south-west, passes as an under-current beneath the Japan stream. A rapid fall in temperature—from 57° to 47° in a few miles—in the Ounimak Pass, shows that the north-west shores of the Aleutian Islands are washed by the cold Behring Straits current, which is somewhat modified in temperature by the inflow of part of the westerly current from the eastward of the islands.

Many observations were made which indicated the relation of prevailing winds to surface currents. The material obtained from the sea bottom off the Kurile Islands had, in addition to the usual ooze, greyish-black sand, gravel, and lumps of lava. Similar sand and gravel were found, and also sponge, in the neighbourhood of the Aleutian Islands. The northern route for a telegraph cable, as finally indicated by this survey, is 4,200 miles in length; the southern, about 6,000 miles. The former route will present great though probably not insuperable difficulties, such as that of the sudden declivity off the Aleutian Islands, the frequent fogs which made even the survey tedious, the embarrassments incident to a northern region, where there are few of the means provided on more civilised shores to meet the requirements of working parties and occasional repairs. The chief merits of the northern route are its comparative shortness and its propinquity to United States territory.

NATURAL HISTORY NOTES FROM SOUTH AFRICA

MR. J. P. MANSELL, of Brooklyn, near King William's Town, Kaffraria, has sent us the following notes, the results of his own observation in the district in which he dwells :—

In November 1869 I was looking for some louries in the Bedford forest. My gun was loaded with a very small charge of dust shot. A large troop of monkeys was disturbing my birds, and, annoyed with them, I fired among them at random. One fell on the branches of a bush, shrieking piteously. I ran up to put the poor thing out of its agony, when to my great surprise I saw the whole troop (about twenty) rushing down the trees and screaming savagely. They came so close to me that I had some trouble in killing the wounded one, as I was afraid they would attack me. Were monkeys substituted for toucans in the frontispiece to Mr. Bates's Travels, the scene would be almost identical.

A few days ago, while working in my garden, my attention was drawn to a part of the kloof by the angry screams of birds, indicating a snake. On approaching the spot where the birds were collected, I noticed several dashing at a low shrub. As I approached the dark underwood an Ahætulla, whose characters do not agree with any published description, rushed out. I struck it with a spade, and then, curious to see how the birds would act, I flung it half alive over a branch of a tree, still holding it by the tail.

There were a great many bush birds, but especially noticeable were *Turdus olivaceus* and a Campephaga.

The first-mentioned birds kept flying round in a wide circle, dashing with open wing and beak at the snake, and screaming with the utmost fury. With such violence did these birds dash at their enemy, that more than once the bird fell on the ground from the branch against which it struck. The birds continued attacking the snake for some minutes.

While at the Koonap in 1865 I saw the common *Juida phœnicoptera*, which had a nest in the trunk of an Euphorbia, screaming with fury, and attacking boldly a red mierkatje, which was endeavouring to plunder its nest.

We have heard so much of the mysteries of fascination, &c., that I think a comparison of the cases I have given, together with the well-known way in which birds pursue owls, cats, and cuckoos, shows that it is more fear than anger which gives the subtle snake an easy prey, than any mysterious mesmeric influence ; and I believe the immunity of the mongoose from the poison is owing to its closely-pressed, tight, wiry hair.

The wattles of turkey-cocks are a decided disadvantage to them in a warm country like this. I have lost two from the flies laying their eggs in the wounds inflicted by rival birds.

Some four or five years ago, when in Fort Beaufort, a friend of mine amused me by bringing a stuffed leopard to a pet monkey he had. The monkey would scream with terror, shut its eyes, and hide away in my friend's coat. On touching it with the claws its terror was piteous. On removing the leopard it would slowly peep out, and on catching sight of it close its eyes tight.

I do not think it is generally known that baboons in Karoo districts, such as Richmond and Hopetown, destroy in dry seasons numbers of lambs. A farmer told me that they were more destructive than any other wild animal in the district.

There are likewise two varieties of the leopard called respectively Berg and Rivière Tiger, from frequenting mountains or rivers ; and the baboons are said to vary according to their locality. It is said that baboons will kill a leopard. A friend of mine at the Koonap had a tame baboon which shouldered arms and wrapped itself in a sheepskin like a Kafir.

South African Birds which eat Butterflies.—As some doubt was thrown on this subject in your journal a year ago, I now give the result of a year's careful observation, and I have little doubt the number could be greatly increased. *Cypselus caffer* eats *Pieris hellica* and *Terias rahel*, also numerous small Heterocera.

Zosterops capensis eats Pieridæ and small moths. On April 30, 1871, I saw a pair trying to capture a butterfly, which very cleverly eluded them.

Motacilla capensis—Pieridæ and moths, but prefers flies and bees.

Anthus capensis—*Pieris hellica* and *P. charina.*

Oriolus capensis—*Pieris charina* and *P. gidica* or *P. severina.*

Tchitrea cristata—*Pieris agathina* and other Pieridæ, and, I think, other butterflies too, but am not certain.

Dicrurus musicus. I saw this bird dart at and capture last year so large and rapid a butterfly as *Philogroma varanes* ; it also destroys Pieridæ.

Lanius collaris. I have seen this bird take butterflies, but do not know whether it is in sport or for food.

The above instances are from actual observation, made in some cases more than once.

Migrations of Insects and Plants.—I have especially remarked, since my attention was drawn to it, how few conspicuously coloured and hairy caterpillars are attacked by birds. Some of these conspicuous caterpillars, on being touched, eject a nauseous liquid in large quantities ; this is especially the case with *Antherea tyrrhea*, the larva of which every year strips my thorn trees (*Acacia horrida*) quite bare. The eggs are large, enclosed in a hard, bluish white shell, and fastened in large clusters at the end of branches. They appear to be never destroyed by animals.

The moth generally issues in abundance after the first heavy warm rains of September or October, and is seldom to be found after a week. This is also the case with several allied moths. Hundreds may then be seen like small bats, and the next morning the ground is often strewed with their fragments, as they appear to be highly attractive to nocturnal birds. The larva is often attacked by ichneumons, but still the quantity is unappreciably diminished, and hundreds may be seen travelling from tree to tree. They are more numerous in wet than dry seasons.

We have had this year some remarkable visitations of Pieridæ. In October, November, and December I have seen enormous swarms, principally composed of *Pieris charina*, *severina*, *gidica*, and *hellica*. The early part of the summer was very cool, but just before Christmas and at present the heat has been most oppressive. On December 24, I found the shady inside of the kloof alive with *Pieris agathina*, in all the varieties, as far as I could judge, principally males. This butterfly is usually abundant in September, but I had observed only a few specimens in the early summer.

I tried to make a calculation as to their numbers, and selected a damp spot where most of the insects had settled. I counted on a spot about three yards square about fifty; many were hidden by stones and leaves. They were about equally abundant in other parts of the kloof, and I think, therefore, that fifty would be a fair average. As the kloof is 500 yards long, or thereabouts, and in some parts thirty yards broad, I think the following calculation (allowing for the extra attractiveness of the moist spot observed), namely, twice the quantity, calculated at three yards broad, would give a quantity of 16,666 for the entire kloof. The kloof was full of birds chasing these insects, and two days later the number was greatly diminished.

As far as my observations go, I am led to believe that there are three kinds of migrations among butterflies. The principal relates, for the most part to Pieridæ, such as *Pieris hellica*, *gidica*, *severina*, *mesentina*, and *Colias electra.* These butterflies seem to be attracted to

cultivated ground, old kraals, or cleared forest. On all these spots vast numbers of weeds—many introduced plants—spring up, and appear to be particularly attractive to these insects. These migrations take place as often against as with the wind.

Papilio merope, *Philogroma varanes*, *Pieris eriphia*, *Pieris zochalia*, and *Terias rahel* appear to migrate in the direction of the wind, and there are one or two others which perhaps do so also, such as *Junonia pelasgis*. When resident at Bedford I never saw these butterflies in seasons of drought, but so soon as the southerly winds with rain became abundant a few stragglers might be met with.

P. gidica, *mesentina*, and *severina* likewise share in these southerly and northerly migrations.

Lastly, there are the sudden and almost inexplicable appearance and disappearance of certain species, such as *Callidryas rhadia*, *Diadema misippus*, &c., although I see Mr. Bowker mentions having seen vast swarms of the former in the Drakensberg taking a south-easterly course. During the last two years I have hardly seen a specimen of these two butterflies. The year before they were most abundant. I would here remark that I do not remember to have noticed in any entomological work, although the shapes of butterfly wings are accurately described, an account of their peculiar and finely graduated modes of flight.

Thus, in Pieridæ, *P. hellica* flies generally in open ground from flower to flower, but alternately rises and falls and shifts from side to side. *Terias rahel* has a similar flight, but slightly more direct; *Colius electra* a similar flight, but I think a trifle swifter.

Cypselus caffer, which preys on these, generally describes semicircles, flying backwards and forwards over the grass in the manner of a scythe working, and it is curious to see how artfully these butterflies, by a slightly higher or lower flight, escape their much swifter winged enemy.

The different varieties of *P. agathina* in like manner vary. The whiter specimens (♂) frequent more the open, and are a trifle swifter in their flight than the gamboge and ochreous varieties, or their ♀. The latter frequent wooded spots, and rise and fall through the foliage like dead leaves, and it is surprising to see how with sluggish movements a slight change of direction saves their lives. *P. gidica*, *mesentina*, *severina*, and *zochalia* in like manner vary among themselves in their varieties and in different localities.

I was particularly struck, when on a visit to Cradock in 1867, by the difference of size and colour and flight in *Mesentinas* in the Karoo from that of those in the Bedford Forest.

Papilio cenea, which my observations confirm as being the female of *merope*, as so admirably indicated by Mr. Trimen, changes its flight in a remarkable manner when quitting the forest for the open plain. In the forest its flight is remarkably weak, especially if contrasted with that of its mate; whereas over open plains it rapidly rises out of sight, and soars away like some bird of prey with scarce a flutter of the wing.

Junonia pelasgis, *archesia*, and *amestris* are in like manner very similar in their flight, but differ with the difference of the localities they frequent; *J. archesia* being intermediate between the forest-frequenting *J. pelasgis* and the plain-loving *J. amestris*. It is also remarkable that where *J. archesia* frequents the same spots as *J. pelasgis*, its markings approach that species; where it delights in open country, about Kaffraria, it is bluer, and slightly more like *J. amestris*.

Nymphalis xiphares.—The ♀ of this species is much weaker in its flight than the male, and its coloration, as is known, differs remarkably. Last year I captured it in company with *P. merope* and ♀ *P. echerioiaes*, and was much struck at the time by the similarity of colour and pattern, although its imitation is much coarser than that of the other two butterflies.

A long series of ♂ and ♀ *Meropes* shows a remarkable variation, hardly two specimens being alike, and in one ♂ a small oblong black spot closes the discoidal cell of the fore-wing.

On some occasions plants of different orders seem suddenly to increase and then almost disappear for a season or so. This is notably the case with some Compositæ.

As I mentioned in a letter to Mr. Darwin, two species of Gramineæ, *Tragus aliena* and *Briza geniculata*, appear to spring up in the course of locust swarms. I at first was rather sceptical on this subject, but by carefully watching the locusts and examining *sour veld*, where these grasses do not generally grow, I believe that the opinion of the farmer who first called my attention to it is correct.

Mr. Darwin, I believe, raised plants from locust dung which I sent him, but I am not aware to what species they belonged.*

JEFFRIES WYMAN, M.D.

IN the death, on the 4th ult., at Bethlehem, N.H., of Prof. Jeffries Wyman, American biological science has lost one of its most able comparative anatomists. Prof. Wyman was born on Aug. 11, 1814, at Chelmsford, Massachusetts, and had therefore just completed his sixtieth year. His father was a well-known physician. He graduated in Arts at Harvard University in 1833, whereupon he commenced his medical education, and took his degree in 1837, after which he for two years continued his studies in Paris. Returning to Boston he became for some time curator of the Lowell Institute, where he commenced his career as a teacher by delivering two courses of lectures on comparative anatomy and physiology, in which he first gave indications of the lucid and well-ordered expository powers which throughout his life made him so great a favourite with all hard-working students. In 1844 he became Professor of Anatomy and Physiology in the Medical School of Richmond, Virginia, in connection with the Hamden-Sidney College. In 1847 he succeeded Dr. Warren as Professor of Anatomy in Harvard University; at which time, from the materials brought from Africa by Dr. Savage, he had the earliest opportunity of describing that naturalist's new genus of anthropoid apes, the Gorilla (*Troglodytes gorilla*, Savage). This professorship he held till 1866, and it is to him that Cambridge, Mass., almost entirely owes the development of its excellent Museum of Comparative Anatomy.

Prof. Wyman had for many years been a sufferer from phthisis, which necessitated his removing to the warmer climate of Florida during the winter months, and the cessation of his lectures and practical work. When the Peabody Museum of American Archæology and Ethnology was established, the founder appointed Prof. Wyman one of his trustees, and the board committed the incipient museum to his charge and direction. The seventh annual report of this institution, just issued, was his last production. Most of his written contributions to science are contained in the Journal and Proceedings of the Boston Natural History Society, of which for many years he was the president; and in the "Smithsonian Contributions to Knowledge."

Prof. Wyman was a man of singular modesty and truthfulness. His bad health was always in the way of his will to work; and his desire of completely mastering whatever he undertook, together with a certain over-cautiousness, has limited the number of his works. It is not remembered that he ever had a controversy. In his death a gap has been caused which it will be difficult to fill.

* See "Origin of Species," 6th ed., p. 327.

LECTURES IN NATURAL SCIENCES AT CAMBRIDGE

THE following lectures in Natural Science will be given at Trinity, St. John's, Christ's, and Sidney Sussex Colleges, during Michaelmas Term 1874.

On Electricity and Magnetism.—By Mr. Trotter, Trinity College, in Lecture Room No. 11. (Mondays, Wednesdays, Fridays, at 11, commencing Friday, Oct. 16.) Students desiring to attend this course are requested to call upon Mr. Trotter at his rooms on or before Thursday, Oct. 15. Students of Colleges other than Trinity, St. John's, Christ's, and Sidney, can be admitted on payment of a fee of 1*l.* 1*s.*

On Elementary Organic Chemistry.—By Mr. Main, St. John's College. (Tuesdays, Thursdays, Saturdays, at 12, in St. John's College Laboratory, commencing Tuesday, Oct. 20.) Instruction in Practical Chemistry will also be given. Students desiring this instruction are requested to call upon Mr. Main on or before Monday, Oct. 19. For members of Trinity, St. John's, Christ's, and Sidney, the fee for the lectures in Chemistry is 10*s.* 6*d.*, and for instruction in Practical Chemistry 1*l.* 1*s.* per term; for others the fees are respectively 1*l.* 1*s.* and 2*l.* 2*s.* per term.

On Palæontology.—(The Protozoa and Cœlenterata.) By Mr. Bonney, St. John's College. (Tuesdays and Thursdays, at 9, commencing Thursday, Oct. 15.)

On Geology.—(For the Natural Sciences Tripos. Preliminary matter and Petrology.) By Mr. Bonney, St. John's College. (Mondays, Wednesdays, and Fridays, at 10, commencing Wednesday, Oct. 14.) A course on Physical Geology will be given in the Lent Term, and on Stratigraphical Geology in the Easter Term. Papers will be given to Questionists every Saturday at 11, but the first paper will be set on Wednesday, Oct. 14, at 11, when arrangements will be made for further instruction, should it be required. Students desiring to attend any of these courses are requested to call upon Mr. Bonney on or before Wednesday, Oct. 14. Students of other Colleges can be admitted to these lectures on payment of a fee of 1*l.* 1*s.* for the course. An Elementary Course will be given in the Lent and Easter Terms.

On Vegetable Morphology.—(For the Natural Sciences Tripos.) By Mr. Hicks, Sidney College. (Tuesdays, Thursdays, and Saturdays, at 11, in the Taylor Lecture Room, beginning on Tuesday, Nov. 3.) The lectures during this term will be on the Morphology of Phanerogamia. For members of the above Colleges the fee for this course is 1*l.* 1*s.*; for others 2*l.* 2*s.*

A Course of Practical Physiology and Histology.—By the Trinity Prælector in Physiology (Dr. Michael Foster) at the New Museums. Lectures on Tuesdays, Thursdays, and Saturdays, at 10, commencing Tuesday, Oct. 20. Fees for the Practical Class, 3*l.* 3*s.*; for the course of two terms, 5*l.* 5*s.* This course is intended for those who have gone through a course of Elementary Biology similar to that given last Easter Term.

Also a short course of lectures on the *Physiology of Nutrition*, on Wednesdays, at 10, commencing Oct. 21.

On the Comparative Anatomy of Invertebrata.—By Mr. Martin, Christ's College. (Mondays, Wednesdays, and Fridays, at 12, commencing Friday, Oct. 16.)

NOTES

AMONG the Fellowships at Trinity College, Cambridge, awarded on Saturday last, one was given for proficiency in Natural Science. Although thrown open to the whole University, it was gained by a member of Trinity College, Mr. Francis M. Balfour, B.A., the circumstances of whose election are worthy of notice. The Fellowships at Trinity College are awarded according to the results of an examination held specially for the purpose, and not as in other Colleges, according to the positions gained by the candidates in the University Examinations or Triposes. The Natural Science Fellowship was no exception to this custom: a special examination in Physics, Chemistry, and Biology, was held in order to test the proficiency of the candidates. But it had previously been announced that the examiners were prepared in estimating the proficiency of the candidates to take into consideration records of original work in the shape of published memoirs or unpublished dissertations, and to be guided by the value of these as well as by the ordinary examination answers. In other words, the authorities of Trinity College formally declared that they were prepared to bestow a Fellowship *as a reward for, and thus as an encouragement to, research.* Mr. Balfour's success in his candidature was, we understand, due to the value attached to the original memoirs, chiefly on embryological subjects, sent in by him, as well for their actual worth as for the future of which they gave promise. We congratulate him and the Natural Science School at Cambridge on the result. The deadening influence of the examination system at Cambridge, great as it is in mathematics, bears with fearful effect on all Natural Science studies. The cramming necessary for success in a competitive examination such as the Natural Science Tripos, renders original research for the time being impossible, and goes far to destroy all power for it in the future. Mr. Balfour had the courage to commence original work before he had taken his degree. In spite of warnings that he was endangering his position in the Tripos, he chose the better part, and spent in research the time he might have frittered away in cramming for an examination. Incidentally he has thereby won a Fellowship. We trust that his example will be followed by other students, and the example of Trinity College by other Colleges, so that henceforward on the one hand early research may be the rule at Cambridge instead of the exception, and on the other the injurious effects of the Fellowship system may be lessened as much as possible.

THE following changes are proposed to be made in the Council of the Mathematical Society for the ensuing session:—Dr. Hirst, F.R.S., the retiring president, will become a vice-president, and be succeeded by Prof. H. J. Stephen Smith, F.R.S. Mr. Spottiswoode, F.R.S., having served his term of office as vice-president, will become an ordinary member of the Council. The vacancies caused by the retirement of Prof. Henrici, F.R.S., and Mr. J. J. Walker, have been filled up by the selection of Mr. R. B. Hayward and Mr. W. D. Niven. The Society has nearly completed its tenth year, and has had as presidents De Morgan, Sylvester, Cayley, Spottiswoode, and Hirst. It would, we think, be difficult to find more fitting representatives of the mathematical ability of this country, should the day ever arrive, in this day of congresses, for holding an International Congress of Mathematicians. When the Society started into existence on Jan. 16, 1865, there were, we believe, not more than two similar societies in the world; now, each year adds to the ever-lengthening chain. It is a singular and sad coincidence that as the present president on his accession to the chair had to announce to the members the great loss the Society had sustained through the death of the lamented Dr. Clebsch, so, too, as he vacates his office will it be his last task to tell of the decease of Dr. Otto Hesse; though in this sad case mathematicians have to mourn the loss of a man full of years and honours. The Society is thus left without a representative of the great body of German mathematicians in its list of foreign members. The election of the new Council will take place on Nov. 12. The above-named changes are those suggested by the present Council, and will be submitted in the usual way to all the members of the Society for their approval.

ANOTHER College for Working Women is about to be opened. Its inaugural meeting is announced for Friday evening, at No. 5, Fitzroy Street, Fitzroy Square. The committee aims

at enabling women who can spare a few evenings a week to obtain gradually a liberal education. The fees are very low, and the classes numerous. A library and a coffee and conversation room will, it is hoped, promote friendly intercourse amongst the members. Many have promised to teach or occasionally lecture, amongst whom we see the names of Mr. J. G. Fitch, Mr. Thos. Hughes, Q.C. (Principal of the Working Men's College), Mr. Litchfield, Prof. Seeley, Mr. George Macdonald, Miss Chessar, Miss Keary, and Dr. Morell.

IN connection with the *conversazione* held at the opening of Owens College, Manchester, there was an interesting loan collection brought together through the energy of Mr. W. B. Dawkins and Mr. R. D. Darbishire. A large series of plants of the coal measures was exhibited, with specimens of the nearest known living representatives systematically placed among them to convey an idea of the kind of vegetation from which coal was formed. Near these was a geological model of a boring for coal. A quaint set of stone mining tools from the abandoned workings of the Alderley Edge copper mines, and wooden and iron tools found in Derbyshire, were of especial interest. The local geology was well illustrated, and there was a fine collection of fossil bones which have been recently discovered in a fissure at Windy Knoll, near Castleton, by Mr. Pennington. A well-supported endeavour was made to illustrate the latest stage of vertebrate life in England as known by the remains found in bone caves and river deposits; and an extensive collection of mammoth, bear, lion, and other bones was the result. Near these were cases containing early implements fashioned by man. A Manchester paper says of these cases: they "include all the evidence as to the antiquity of man given by both river and cave, and we need little scientific assistance to find out that these constitute the most complete set of stone implements ever got together. To make their evidence clearer, illustrated and explanatory diagrams are placed near them. . . . The collection of neolithic flints is wonderfully complete. A case sent by Mr. John Evans carries us from the rough model to the same instrument more exquisitely finished and moulded."

THERE is hope for scientific education when a sporting correspondent of the *Field* discourses on it. The gentleman in question has recently visited the Mining Academy of Freiberg, which he thus describes :—"Students of every nationality are found here, and there is no doubt that if a man likes to work he can learn a great deal, as some of the most celebrated professors in Germany are teachers. The only requisite for a student entering the Academy is that he should know a little German. This rule is not very strictly observed, and anyone of ordinary intelligence ought to pick up the requisite amount in a month, or six weeks at the outside. There are different courses open to the option of the student, such as an assaying course, chemical course, surveying and mining course, &c. These are each charged separately for, the fees ranging from 3*l.* to 5*l.* each. The blow-pipe course, given by the famous Prof. Richter, is 6*l.* Foreign students are charged 5*l.* yearly extra; German students are exempt from this tax. Living in Freiberg is excessively cheap. The whole course lasts three years, but I imagine that a man would do far better by picking out a few particular lectures and finishing in eighteen months or two years. Now, after the course, what return has a man for his money? I unhesitatingly answer that a man who has worked hard for two years at Freiberg ought to be able to go anywhere in any mining district in the world and command his 500*l.* a year. So many people are troubled with questions as to what to do with their younger sons, that I am sure that sending them to Freiberg, and giving them a first-class profession in two years for 375*l.* or 400*l.*, is well worth their consideration. To such a man, *i.e.*, one well educated at Freiberg, the whole of the American continent, and, indeed, most of the world is open. Now that England is so 'blocked' it has become a necessity to go further afield, and probably mining engineering and assaying offer about the very best openings to an enterprising man. Immense deposits of metal are daily being discovered in Colorado and the south-western States, while Chili and Peru are short-handed." The sporting correspondent is correct as far as he goes, and it is perfectly true that many young Englishmen have gone to Freiberg, but he does not seem to know that the British Government has just fitted up a small cellar in Jermyn Street, and that with such a national metallurgical laboratory as this, of which of course the country should be justly proud, there is no fear that more young Englishmen will seek to perfect their studies in a foreign land.

FROM a paper on "Some indigenous Tuscan Remedies," read by Mr. H. Groves before the recent Pharmaceutical Conference, it would seem that plants furnish a considerable portion of the medicinal products in use in that country. Many of the plants enumerated are well known as medicinal plants in other parts of Europe. The Chamomile (*Matricaria chamomilla*), for instance, is said to be found in the cupboard of every housewife, being used as a calming antispasmodic, and also applied hot externally for relieving pain. A custom very prevalent in Tuscany seems to be the administration of herb-juice in spring, which is prepared daily by many herbalists, and is also ordered by medical men. *Nasturtium officinale*, known as Crescione, is used in conjunction with *Cochlearia officinalis* in the composition of herb-juice. This latter plant, though indigenous, is also cultivated to some extent. The flowers of the Wallflower (*Cheiranthus cheiri*), under the name of *Viole gialle*, or Yellow Violets, are boiled in olive oil and used for enemata. With regard to products other than plants, the writer remarks that viper-broth is gone out of fashion, and the pharmacist is spared keeping those reptiles and the pincers with which they were handled. Snail poultices are still used in the country. The snails are applied alive, the shell being crushed or partly removed, and the snails set upside down on a piece of coarse paper; they are then sprinkled with a little vinegar and applied at once to the soles of the feet, on which they produce an irritation greater than mustard, and which is supposed to be efficacious in some cases of fever.

THE British Association partook this year somewhat of the nature of a Church Congress; the real Church Congress has, *en revanche*, partaken somewhat of a British Association meeting, Prof. Pritchard having communicated a paper to it giving his view of certain conclusions to be drawn from our present knowledge of molecules, and quoting in support of it the honoured names of Herschel and Clerk-Maxwell. As we are informed that the paper will be published *in extenso* elsewhere, we need not refer to it at any length here; but there is one bit of it which, coming from a clergyman and a professor at Oxford, we cannot refrain from quoting. He suggests that it would be a good thing "if in the study of every manse throughout England there were found a well-used microscope, and on the lawn a tolerable telescope; and, best of all, if those who possess influence in our national universities could see their way to the enforcement of a small modicum of the practical knowledge of common things on the minds of those who are to go forth and do battle with the ignorance and failings of our population, and to spread light throughout the land. A little knowledge of the ancient elements, fire, air, earth, and water, would save many a young clergyman from the vanity of ridiculous extremes, and from the surprise of the more wisely and widely educated among his flock." Surely no one will think that with regard to the Universities Prof. Pritchard is asking too much! He then goes on: "Depend upon it, whatever may be our suspicions or our fears, the pursuit of the knowledge of the works of nature will increase, and increase with an accelerated velocity; and if our clergy decline to keep pace with it, and to direct it into wholesome

channels, they and their flocks will be overtaken, though from opposite directions, by the inevitable Nemesis of disproportion."

A SEVENTH edition of "The London Catalogue of British Plants" has just been issued. The chief differences between this and the preceding edition is in a renumbering of the specific names, and in those changes of technical arrangement which have now rendered it necessary to abandon the original series of numbers. The first edition of 1844 was closely adapted to the "British Flora" of the late Sir Wm. Hooker. This seventh edition is made to correspond with the "English Botany" of Dr. Boswell-Syme, third edition, as far as to the grasses. For the ferns and allied orders, the arrangement and nomenclature of Dr. Hooker's "Student's Flora" are closely followed. The species of Chara are taken from Prof. Babington's "Manual of British Botany." Mr. Backhouse is followed in the species of Hieracium; Prof. Babington in the Rubi; Mr. Baker in Wild Roses.

THE *Gardener's Chronicle* quotes from the *Illustration Horticole* that the recent International Botanical Exhibition at Florence yielded a net profit of 1,000*l.*, and that the disposal of this sum to the best advantage of horticulture is under consideration.

A SCHOOL of Mines has been established by the Territorial Government at Golden, Colorado, one of the best places in the country for practical instruction.

THE Sixth Annual Report on the noxious, beneficial, and other insects of the State of Missouri has been issued.

MR. EDWARD BELLAMY, of the Charing Cross Hospital, has been appointed to deliver the course of lectures on the Anatomy of the Human Form, at the South Kensington Museum.

"ELEMENTARY Astronomy, or Notes and Questions on the Stars and Solar System" (Van Voorst), a small text-book for the use of schools, by C. C. Reeks, contains a great deal of recent and accurate information in small space, and seems calculated to serve the purpose for which it is intended.

THE additions to the Zoological Society's Gardens during the past week include an Australian Rail (*Rallus pectoralis*) from New Holland, presented by Mr. J. Harris; a Gannet (*Sula bassana*), European, presented by Mr. R. R. B. Norman; a White-winged Trumpeter (*Psophia leucoptera*) from S. America; a Dusky Monkey (*Semnopithecus obscurus*) from Malacca; a Pinche Monkey (*Midas œdipus*) from New Granada; a Bonnet Monkey (*Macacus radiatus*) from India, deposited.

*ON THE NECESSITY FOR PLACING PHYSICAL METEOROLOGY ON A RATIONAL BASIS.**

I WISH at the outset pointedly to disclaim originality in the main ideas to which I propose here to invite attention. The subject of my paper has occupied the thoughts of many men of science, with some of whom I have been in communication regarding it for several years. But though the conclusions to which I wish to lead you are the product of many minds, I am bound to accept to the fullest extent the self-imposed responsibility of bringing them forward at the present time and in the present form.

The branch of inquiry which has been very unsignificantly named Meteorology (meteoric phenomena being but slightly and remotely included in it) deals with the climate of the globe, and seeks to explain the vicissitudes of temperature and moisture, storm and calm, to which that globe is exposed. It is a subject of the highest importance to mankind generally, as affecting health, navigation, and agriculture; and possesses an interest acknowledged by every individual, from the savage to the *savant*, influencing as it does the personal well-being and daily comfort of all. Everyone discusses, and thinks himself competent to discuss, the weather.

* By Lieut.-Col. A. Strange, F.R.S., Inspector of Scientific Instruments to the Indian Government; a paper read at the British Association.

My present object necessitates a broad classification of this department of inquiry into two main branches. The more obvious one of these, for which a fitting name has yet to be proposed, relates to changes of weather from day to day, and to the varieties of climate found in different localities. I shall not say much on this branch of Meteorology, but shall confine myself principally to the other main division, which has been named—I believe, first by Prof. Balfour Stewart—Physical Meteorology. Under this term are included, amongst other important matters, fluctuations in the seasons; the causes, external to the earth, which occasion or contribute to them; and the laws which regulate these fluctuations. The opinion is daily gaining ground that this branch of Meteorology has been unduly neglected, that it offers a magnificent field of inquiry and discovery, and that its vigorous cultivation must greatly aid the solution of those more limited and local inquiries to which observation has been hitherto more particularly applied. My present object is to urge the cultivation of this wide and almost unoccupied field of research and to point out some of the steps which should now be taken to that end.

It will be necessary for my purpose first to advert to some of the most elementary facts connected with Meteorology. Speaking in general terms, there are but four principal elements concerned in the production of all meteorological phenomena—the familiar elements of antiquity—fire, water, earth, and air. The part played by each is obvious to every observer.

Water, sucked up by heat from the ocean, and from the land which has imbibed it, falls again from the clouds in the form of rain, undergoing alternately, through excess of heat, evaporation and condensation. *The earth*, a great recipient of both heat and moisture, gives up each gradually and silently, and helps to maintain equability of temperature and of humidity. *The air*, set in motion by heat locally applied, becomes breeze, or wind, or storm, according to the amount, duration, and locality of that heat. In each of these three cases we see that an external force, heat, plays a conspicuous part. Can either of the three named elements, Water, Earth, or Air, perform its functions without the aid of that external force? Have they any innate power, enabling them to act independently of each other, or of all external forces? Will water, if left to itself at an unchangeable temperature, rise into vapour and fall in rain? What power resides in the earth to cause meteorological phenomena? It may possibly be replied that it boasts volcanic power, but as this exists only locally, it can play but a small part in the great economy of the whole earth. The internal heat of the globe may also be claimed as an independent attribute of the earth, and it may be so—but on this question we have as yet but very little reliable knowledge, though much interesting speculation. It may, however, be stated that, as an explanation of leading meteorological phenomena, the internal heat of the globe has not as yet been allowed much, if any, weight, though its use as a modifier of such phenomena may be considerable. As to the air, no innate power has hitherto been assigned to it. We may therefore, without much risk of error, regard water, earth and air, for the purpose of the present inquiry, as three forms of inert matter, capable of exercising independently no force whatever, but when acted upon, either separately or in combination, by heat, capable of producing the most stupendous results.

We come now to this heat—the sun. Has this any innate power? It seems almost needless to answer the question. The most familiar occurrences attest his paramount influence: the alternations of day and night, the march of the seasons, the daily variations of warmth—all bear testimony to his all-pervading and tremendous power.

It might seem superfluous to state facts which are almost truisms. But would it not seem to follow as a matter of course, needless to dwell upon, that such being the paramount influence of the sun, its study must be the first and most anxious object of solicitude to the meteorologist? Yet such is not the case. Obvious as are the facts I have briefly indicated, they have led to no such result. The reports and volumes of observations emanating from bodies and institutions charged with meteorological researches often do not contain even the name of the sun, and it may be broadly stated that the great central source of heat, and therefore of all meteorological activity, receives little or no attention in that capacity. I do not prefer this as an indictment against those to whom I refer. Many reasons may be assigned for their total neglect of the sun. Perhaps amongst the most valid is the fact that instrumental appliances fitted for the purpose have not, until within a comparatively recent period, existed.

Another powerful reason no doubt is to be found in the difficulty with which even cultivated scientific minds can be brought to recognise, as a truth to be practically acted on, that no science stands alone, that all are intimately connected by nature, and that the classification and separation of various branches of inquiry is an artificial arrangement of man, adopted for the more convenient division of labour.

The time seems to have arrived when we ought to apply this truth to the science of meteorology, and to bring to its aid a class of researches calculated to provide it with that secure and rational basis of which at present it is absolutely destitute.

Before passing to a consideration of the steps which seem necessary to this end, I will touch slightly on one of the objects the hope to attain which fully justifies their being taken. I allude to the hope that we may thereby find some explanation and some law for the fluctuations of the seasons.

In a given locality, on a given date, the sun, to whom we ascribe so predominating an influence, attains, year after year, the same elevation above the horizon, and being at the same distance, presents the same angular area. If the sun, as that date annually recurs, were in all other respects the same, we should have a right to expect an annual recurrence of the same weather, unless some disturbing cause, of which we have at present no knowledge, were known to exist. I do not say positively that the sun being a constant force, we should have this constancy in the seasons—but what I do say is, that if the sun be not a constant force, we have no right to expect constancy in the seasons. The first question, therefore, should be: Is the sun a constant force? Does it, year after year, at the same date, present the same unvaried surface? We know that the contrary is the case.

We know that the surface of the sun's disc is never free from spots, and that these spots are constantly changing in number, size, and position: we know that whatever law may govern them, their period of change and return is certainly not annual.

We know also that the general surface of the sun is covered with markings called faculæ, which are perpetually changing, and which have not an annual period. We have also learnt, within two or three years, by the aid of the spectroscope, how at any time to examine the exterior gaseous envelope of the sun, which formerly could only be seen during a total eclipse, and we now know that the famous red prominences of which on those rare occasions we obtained only a fleeting glimpse, on being studied at our ease, without interruption, reveal evidence of activity in those regions of the most stupendous sublimity, darting out, in a few seconds, flames many thousands of miles in extent. Further, in examining the spectrum of the solar light with improved spectroscopes assisted by photography, we find that thousands of lines exist there of which hitherto we had no knowledge—and quite recently the researches of Norman Lockyer tend to throw a doubt on the fixity and constancy of some of these lines.

We have here evidence which conclusively proves that the sun's surface and surroundings are not maintained in a constant condition. The evidence may not justify us in asserting that as his surface changes so must the force which he pours out on the earth necessarily change also; but it certainly justifies us in entering on a systematic examination of that question with the appliances which modern physical astronomers have contrived for the purpose.

In what, then, should this systematic study of the sun consist? Up to the present time the spots have been the main object of study. Most valuable observations on these have been made, of which those of Carrington, of Howlett, of Selwyn, and of the Kew Observatory under the auspices and direction of Warren De la Rue and Balfour Stewart, may be mentioned as the most complete and most long-continued. But excellent as these series are, and great as is their value, this consists chiefly in their having shown the extent and character of the work that has to be done. They labour under the unavoidable defect of frequent interruption by cloudy weather—about two-thirds of the year are thus lost in England, and the evidence afforded by the remaining one-third is diminished in value. But even some of these researches have now been discontinued—in the case of Kew, for want of the requisite funds.

The conclusion arrived at by those who have devoted themselves to the subject is that *a daily record* of the changes taking place on the sun's surface is necessary. I will here advert only to the changes in the spots. These we already know do not take place arbitrarily: they gradually increase in aggregate area to a maximum, and as gradually decrease to a minimum—their period having been provisionally fixed at about $11\frac{1}{9}$ years. But this period has been derived from observations of all the spots visible, without discrimination—and the "spotted area" is the aggregate area of all such spots. There is, however, reason to suspect that if it were possible to trace each individual spot throughout its existence, from its first formation to its final disappearance, there would be found to be different classes of spots having very different durations and perhaps very different maximum and minimum periods; and a reduction of these classes separately might, and probably would, result in a considerable modification of of the present $11\frac{1}{9}$ years cycle, and possibly in the discovery of other cycles, at present masked in the period determined from all spots taken indiscriminately. But hitherto the absence of anything approaching a daily record of the spots has precluded any attempt to classify them. What is true of the spots is also probably true of all other manifestations of solar energy.

With respect to sun-spot researches, it fortunately happens that the photographic records need not be all taken at the same station. The record of one day taken in England can be combined with the record of the next day taken at the other side of the globe. Hence, in order to obtain this daily record it is only necessary to select a certain number of stations in localities such that there shall always be clear weather at one of them. India offers peculiar facilities for such a selection of stations, owing to the great variety of climate to be found in that country during the same period of the year. Perhaps four or five such stations would suffice for India, and if absolute continuity of record could not be obtained by them, the deficiencies could easily be made good by stations in our colonial possessions.

I think it hardly necessary that I should state that in advocating this system of continuous solar record I do not intend that other methods of meteorological research, now in use, should be abandoned. It is obvious that both methods must be employed. Whether present methods do not admit of considerable extension and improvement, is a very important question, on which, however, I do not here propose to enter. Nor do I intend to discuss the question whether the sun stations now advocated should not also be meteorological stations in the ordinary sense. This, like many other such questions which will have to be settled, is an administrative detail, which I shall not step aside from the consideration of fundamental principles to discuss.

It is scarcely necessary to point out that such a system of daily solar record as I have indicated is beyond the reach of individuals, and must, if attempted at all, be established and maintained by the State. The degree and direction in which the State should aid the advancement of science has been much debated of late, and the British Association has contributed powerfully, by obtaining a Royal Commission presided over by the Duke of Devonshire, to the solution of this difficult problem. As I have taken a part in these discussions, and have given considerable attention to the subject, I may perhaps, without impropriety, here state what appear to be the principles applicable to the particular case we are now concerned with.

The first principle is that private enterprise should not only be allowed the most perfect freedom from interference or competition by the State, but that it should be encouraged and aided in every possible way.

The second principle is that the State should step in where private enterprise fails, and itself conduct scientific research, whether observational or experimental, subject to the following main conditions:—

(*a*) That the probable results of the research will be beneficial, in the widest sense of that term, to the community at large, or to the various departments of the State.

(*b*) That the research is too costly, or commercially too unremunerative, to be undertaken and vigorously prosecuted by individuals.

(*c*) That the research requires continuous uninterrupted work extending over very long periods, and conducted by systematically organised establishments.

Probably no case could be mentioned as so completely satisfying these three conditions as that of researches affecting closely every interest in the community, needing for their conduct a number of well-equipped establishments, maintained, not merely for many years, but certainly for generations—possibly for centuries. This is work which it is futile to demand from individuals.

I wish to guard against being thought to assert that the study of the sun will certainly solve all the enigmas of meteorology. I do assert that the strongest possible *primâ facie* has been made out against the sun as the principal ringleader in meteorological

agitation—and that there are ample grounds for putting him on his trial. Let us however suppose the impossible case of his absolute acquittal, I maintain that this negative result would be worth all the labour of obtaining it—eliminating, as it would do, one, and that the most conspicuous of probable causes, and so narrowing our inquiries to those that remain. The more likely event, however, will be that whilst the sun will be proved to be the chief promoter of these disturbances, his accomplices, and their various degrees of participation, will be dragged more prominently before the light.

Nor do I desire that the "innate power" I have attributed to the sun, and denied to other elements, should be misunderstood. I have used the term as the only one available to mark strongly the relative influences at work. I by no means intend to use the word "*innate*" in an absolute sense, or even to imply that the forces of the sun are self- enerated and self-maintained. The object of this paper is a strictly practical one, and is not to be taken as intended to contribute one word to speculations on the constitution of the sun. But though disclaiming speculation, I may, on behalf of my practical object, point out that we already possess what may at least be claimed to be presumptive evidence that the sun is not exempt from external influences. I allude to the remarkable apparent connection which the researches of De la Rue, Stewart, and Loewy have established between the behaviour of the sun-spots and the positions of some of the planets, particularly Venus, the Earth, and Jupiter. I say that the mention of a result so well calculated to excite speculation, aids my practical object. I mean that by following up the hint given us by these most remarkable researches, we may be led to a more complete knowledge and more philosophical conception of the structure of the universe.

And I would here remark that I have urged the study of the sun from the meteorological point of view in order to give a practical justification for the adoption of definite practical steps. But that study is recommended by even higher considerations still, by the insight it must give us into cosmical relations, and the help it will afford us in seeking to understand something, if not of first causes, at least of causes of the highest order that our limited intelligence can grasp and reason on.

The more one reflects on the neglect of the sun justly chargeable against us, the more one wonders at it. It is like the case of a man placed before a steam-engine for the first time, and seeking to learn its principle and action by counting and measuring the bolts, screws, and rods, without giving a moment's attention to the source of power—the furnace and boiler. What they are to the steam-engine the sun is to us, and it is astounding that men should dare to undertake a solution of the complex and mysterious fabric which surrounds us without giving a foremost place in their investigations to the source of all material life and power.

Civilisation has been variously described and defined. It seems to me to imply above all things *completeness*. It aims at supplying all wants, at removing all obstacles to thought and to action, at making good all deficiencies, at remedying all evils moral and material, at guarding against all dangers, at promoting all beneficence, at extending and perfecting all knowledge. Science, as the most potent guide and instrument of civilisation, needs also to be complete. A harp with broken strings can discourse no music,—a chain with unconnected links can sustain no weight. Science, as our President so eloquently impressed upon us in the address with which he opened this Section, is one and indivisible. It has been broken up by man into its various recognised branches to serve his convenience and to assist the weakness of his intelligence; but nothing, as the same authority told us, is more subversive of truth and more hindering to progress than to regard these subdivisions as representing the actual order of nature. There must be doors of communication between the observatory, the laboratory, and the mathematician's study. The isolation of particular fields of research is no longer tolerable: each passes, however indirectly and insensibly, into the other through that "border land" which, as our President reminded us, "recent investigation has shown to be so fertile of discovery."

The study of the sun stands on this "border land." It belongs but very partially to the domain of the ancient astronomy, it possesses some holding in the provinces of chemistry and geology, and more still in that of physics, it claims as its right (as what branch of science does not?) the devotion of the mathematician, and it rules almost supreme in meteorology.

This study asks to be recognised and provided for. How much longer will the demand be disregarded?

*IN WHAT WAY AND AT WHAT STAGE CAN TECHNICAL INSTRUCTION BE BEST INTRODUCED INTO OUR SYSTEM OF NATIONAL EDUCATION**

IT will simplify the consideration of the subject, the discussion of which I have been requested to introduce, if we admit frankly that in England at any rate (I am glad to believe that Scotland is more fortunate) we do not possess a system of national education. Such a system, as I conceive it, should afford to all the children of the nation adequate elementary instruction, and, moreover, should offer to all, so far as their capacities and other circumstances will enable them to take advantage of it, full opportunity for further mental cultivation. There are lying before me the calendars of two German schools for boys of the middle class intended for a mercantile or industrial career: the Friedrich-Werder Gewerbe, or Trade School of Berlin, and the Real Schule, under the direction of Dr. Schellen at Cologne. The courses of each of these institutions following after some preparatory teaching in an elementary school or at home, where reading and writing together with a little arithmetic have been acquired, retain their pupils during nine or ten years; and boys who, according to the reports, were to become mechanical engineers, builders, postmasters, merchants, and chemists, left those schools last July, having attained the ages of seventeen to twenty years. The Real Schule of Cologne, the average number of whose pupils is 580, has 28 masters; the Gewerbe Schule of Berlin, averaging 540, has a staff of 32 masters. In every German town of the least importance there are, in addition to the Gymnasium or Classical School, one or more technical schools resembling those of Berlin and Cologne; the numerous Universities and Polytechnic Institutions furnish the requisite staff of teachers. The fees are small. I have no information as to those of the schools which I have quoted, but I find from the prospectus of another very celebrated trade school, that of Barmen in Westphalia, that its school fees for the year are from 3*l*. in the lowest to 6*l*. in the highest class, and that boys whose friends do not reside in the town are boarded for 25*l*. The governments, the municipalities, and private persons vie with each other in placing at the disposal of poor scholars of the elementary schools who have shown superior capacity, the means of continuing their studies in these secondary schools.

I need not describe the elementary schools of Germany and Switzerland; it is now well known that, in them, the children of the poor receive, up to the age of fourteen years, sound elementary instruction, not confined to reading, writing, and arithmetic, but including geography, the outlines of the history of their own and other European countries, a modern language, some elementary teaching in science, and instruction in the religion which their parents acknowledge.

As contrasted with a system of education such as I have referred to and excluding the great public schools, available only to the rich, we have in England for the middle classes schools like those attached to King's and University Colleges, the City of London School, the Bristol Trades School, and, thanks to the Endowed Schools Commissioners, a few efficient or at any rate progressive grammar and endowed schools, amongst which I would more particularly name the school at Giggleswick, near Skipton, as one where instruction in science has been included in the general plan of instruction; and a small number of exceptional private schools in which a praiseworthy attempt is made to adapt the instruction to the requirements of industrial and commercial classes. These schools however rarely retain their pupils beyond the age of fifteen to seventeen years, and when all are reckoned they are utterly inadequate to the wants of the population.

Of elementary school buildings we shall soon have a sufficient number, and it is probable that the duty of the parent to send his child to school will, in some way or other, be in all cases made a legal obligation; but so long as the necessity of rendering our training schools for elementary teachers thoroughly national and efficient is not acknowledged, and so long as the instruction of the children in elementary schools is left in a great measure to the care of other ill-taught children, called pupil-teachers, of from thirteen to seventeen years of age, we cannot hope that our poor will receive proper elementary instruction.

Until the English approach the German schools in number and value it would be vain to expect that technical instruction will be universally accessible, and we can only hope for its gradual

* A paper read before the Social Science Association, Oct. 1, by Mr. B. Samuelson, M.P.

introduction, availing ourselves of existing resources, with such improvements as may be looked for under the stimulus of the increasing interest evinced by some of our great corporations, by the parents themselves, and consequently by the Legislature.

One important step in the right direction has lately been taken :—Although the political chief is still a species of odd man whose duties include the passing of Ballot Acts, the suppression of foot-and-mouth disease, and the negotiation of Washington Treaties, the Government departments of literary instruction and of Science and Art have been placed under the control of a single permanent administrative head.

I understand technical instruction to include, besides the teaching of industrial manipulation, which for our present purpose we may exclude, firstly, drawing, mathematics, and the physical sciences, which are the bases of the industrial arts ; and secondly, the application of those sciences and of the art of design to industrial purposes. I should place in the first division such subjects as :—

Pure Mathematics.	Chemistry.	Physical Geography.
Geometry.	Physics.	Biology.
Theoretical Mechanics.	Geology.	Astronomy, &c. ;

and in the second—

Building Construction.	Machine Construction.	Metallurgy.
Naval Architecture.	Chemical and Manufacturing Technology.	Agriculture, &c.
Applied Mechanics.		

Although this list is incomplete, it will be obvious that the field is too wide to be covered within the school period, even when the pupils remain at school to the age of adolescence ; bearing in mind always that instruction in technical subjects to the exclusion of other branches of a liberal education would defeat its own object. Much more is this the case with children leaving school between the ages of thirteen and sixteen. The choice of subjects must vary with the age at which school instruction is to terminate, and with the future career of the scholar.

A condition precedent, however, to the possibility of technical instruction is a due provision of science teachers. For these we must look, in the main, as to elementary schools, to our training colleges, assisted by such institutions as the Science School of South Kensington, and as to secondary schools, to the Universities, and to institutions like King's College, University College, and Owens College. The training colleges should add a third year to their curriculum ; instruction in mathematics and in some of the other subjects which I have included in the first division should be part of the obligatory course ; and no elementary school containing, for example, 100 children and upwards should, after a certain date, receive the Parliamentary grant on results, unless it had a teacher who had passed satisfactorily in Geometry, in Physical Geography, and in Physics or in Biology. A man thus qualified, having become familiar with the method of science, could, if he chose, afterwards acquire other theoretical subjects as well as those of application, included in the second division ; for instance, machine construction, chemical technology, or agriculture—availing himself for that purpose, as to the first class of subjects, of the annual courses for elementary teachers at South Kensington, or of any other means of instruction which may be within his reach. But if he stopped short at the limited but exact instruction in theoretical science which I suppose him to have obtained in the training college, he would be infinitely better qualified as a teacher than if during that course he had taken up a greater range of subjects superficially. Whether he be competent to teach many subjects or not, the children of the elementary schools whom he is to instruct have not time to acquire more than the rudiments of one or two theoretical sciences. At the same time an elementary teacher, who is qualified to give instruction in the applied sciences, will find employment in adult classes, such as those in connection with the Science and Art Department.

Assuming, then, that every elementary school for 100 pupils and upwards, which would include the principal village schools, had a master or assistant qualified in science, the course of such a school should include, for all the children, linear drawing and lessons on common objects which would be illustrated by locally accessible specimens ; the ordinary reading-book should also describe in familiar language the phenomena of nature. Those who are acquainted with the admirable text-books on Elementary Science of Prof. Balfour Stewart, Dr. Roscoe, and others, cannot doubt that the task of compiling such a reading-book will be undertaken by competent hands, as soon as the want of it becomes felt. Indeed, I am not sure that it does not already exist amongst the publications of the Irish National Board. The older children, those between the ages of ten and thirteen, should receive instruction in Physical Geography, in the elements of Trigonometry, and, from the age of eleven or twelve, in the rudiments of Biology or of Physics, perhaps, in some exceptional cases, of both. More cannot be done for them in the elementary school ; a few should be drafted into the secondary school ; but the greater number would at the age of thirteen become full time-workers in the field, at the bench, or in the factory ; possessing, however, as is now but rarely the case, the elementary instruction required for taking advantage in their leisure hours of the science classes which are to be found in almost every district of the United Kingdom. How much may be done there is evident from the success of the Andersonian University in your city, with its 1,400 students, to whose founder belongs the honour of having been, more than a century ago, the originator of scientific instruction to the working classes. Children thus taught from the commencement by such masters, when they afterwards receive instruction in science, would not be subjected to, and would revolt against, cram like that recorded in the Report of the Science and Art Department for the present year, in which Prof. Ramsay, the examiner in Geology, says that "candidates answer one of last year's questions in place of one of this year's, as if they had been specially crammed in last year's examination ;" and Prof. Carey Foster, acting with Dr. Tyndall as examiner in Acoustics, Light, and Heat, states that a good number of candidates in the advanced stage "suppose that in order to *damp* the vibrations of a string it is needful to *wet* the string," and "that a ship is the kind of vessel that would usually be employed for containing air."

Amongst other conspicuous examples of adult instruction in science given to the class whose education has been received in elementary schools I may name the lectures for working men of Owens College, numbering more than 600 students, under the gratuitous tuition of the professors of that institution, and those of the Miners' Association of Cornwall and Devon, organised some dozen years ago by Mr. Robert Hunt, F.R.S., Keeper of Mining Records, whose teachers seek out the working miner in his village and make him familiar with the laws of the forces and the properties of the matter with which he is brought into contact in his daily work. But time is wanting to allude further to the subject of adult elementary instruction in science, nor will I enter into the question of science teaching in our great public schools, which has been inquired into by Mr. Norman Lockyer, F.R.S., the secretary of the Royal Commission on Scientific Instruction, whose report will doubtless be forthcoming before long.

In secondary schools, assuming the existence of competent teachers, and that they retain their scholars from the age of eight or nine to sixteen or seventeen—I should commence, as in the elementary school, with lessons in drawing and on familiar objects, and in Physical Geography ; and introduce Mathematics, beginning with Geometry at the age of eleven or twelve, continuing it until the pupil leaves school ; systematic instruction in the elements of natural science might begin at the age of ten to eleven with Natural History, including Geology ; and the six years until the pupil leaves at the age of sixteen or seventeen could be made readily to include successively the elements of that science and of Physics and Chemistry. With the exception perhaps of applied mechanics, it would not in my opinion be possible to include the applied sciences, but the teacher would illustrate his instruction by practical applications. Work in the laboratory is a necessity if a thorough appreciation in kind, however limited in extent, of natural science is to be acquired ; but the experience of the Rev. W. Tuckwell, of the College School at Taunton, communicated to the British Association, and of others, shows that a school laboratory need not cost more than 200*l*. to 400*l*.

Only in those cases where school education is continued to the age of eighteen or nineteen years would it be desirable to introduce such subjects as building, or machine construction, or chemical technology. In all other cases more real progress would be made by devoting all the available time to theoretical science. The scholar who enters into active life as an apprentice at the age of sixteen or seventeen, would see in the workshop the application of the principles which he would have learnt at school, and, if diligent, he would find opportunities of further study in adult classes, in factories, and in text-books on special subjects. For instruction in the entire range of theoretical and applied science it would be necessary that the student should

continue the course, commenced during the school age, at the University or at a Polytechnic Institution such as there is now some hope that the Science School at South Kensington may become.

Although I have excluded instruction in technical manipulation from the subject of this paper, I think it right to add that the students of King's College and of King's College School save much time and drudgery during their pupilage by the practical skill acquired in the workshops attached to the College, and that according to competent observers like Mr. Nussey, of Leeds, the artisans of Elberfeldt, Crefeld, and other continental towns derive great advantage from the schools of design and so-called weaving schools.

I should not fulfil my duty if I were to conclude this paper without acknowledging, though no alarmist in regard to foreign competition, that other nations, less energetic, less rich in accumulated capital and practical experience, and without the advantage of our great mineral resources, are, thanks in a great measure to their superior technical training, making relatively greater advances than ourselves in many branches of industry, and that the conviction of the necessity for such training has not arisen amongst ourselves a day too soon. Happily it has arisen, and in the most desirable quarters. Manchester, by the judicious enlargement of Owens College, to which its merchants and manufacturers have quite recently contributed a sum approaching 200,000*l.*; Yorkshire, by the establishment of the College of Science at Leeds, to which secondary schools of science are to be affiliated; the Company of Clothworkers, by the foundation of scholarships, and the endowment of a chair of textile technology in the Yorkshire College; the University of Durham, and the coal-owners and manufacturers of the North of England, by their joint foundation of the School of Science at Newcastle; Oxford, by its patronage of the College to be established at Bristol; and the Company of Merchant Adventurers, by the aid which it is giving to the Trade School of the same city—are not only directly promoting the higher technical instruction amongst the populations in which their work is done, but will furnish competent teachers to the elementary and secondary schools of their own and other localities. I think there is no fear that a work of such national importance once so actively begun will suffer any relapse; but it will be in the power of this Association to promote by discussion and advice its intelligent and economical organisation.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, Oct. 5.—M. Bertrand in the chair.—The following papers were read:—Researches on the conditions of resistance in cylindrical boilers, by M. H. Resal.—On the exact values of the angles in the crystals of titaniferous iron, by M. N. de Kokscharow.—Report on the machine for freezing by the evaporation of methylic ether, invented by M. Ch. Tellier; and on the preservation of meat in the air, cooled by this apparatus, by the Commissioners, MM. Milne-Edwards, Peligot, and Bouley.—On the temperature of the sun, by M. J. Violle. The author starts with the fundamental equation $\alpha^{\theta} - \alpha^{t} = \frac{\omega}{s} \alpha^{x}$, and from determinations of the intensity of solar radiation assigns the value 1550° to what he calls the *effective temperature* of the sun. The true mean temperature of the surface of the sun is estimated at 2,000°.—Note on magnetism, by M. J. M. Gangain, a continuation of former researches.—Seventh note on the conductivity of ligneous bodies, and of other substances which are bad conductors, by M. Th. du Moncel.—Experimental researches on explosive substances, by MM. Roux and Sarran.—On a register giving continuous indications for the determination of the law of variation of pressures produced by the gases of gunpowder, by M. Ricq.—On the synthesis of purpurine, and of some analogous colouring matters, by M. A. Rosenstiehl.—New observations on the chemical composition of the waters of Bagnères-de-Luchon, by M. E. Filhol.—Method of determination of copper by means of titrated liquids, by M. Pr. Lagrange.—Comparative and critical examination of the hypotheses which have been advanced to explain the figure of comets and the acceleration of their motion, by M. H. Champion. The author attempts to show in this memoir: (1) that a force directed along the radius vector develops in the two opposite parts of an elliptical orbit separated by the major axis, two tangential components of contrary signs, of which the effects are exactly compensating; (2), that the force gives rise to a third component opposed to gravitation, of which the final result is to increase the dimensions of the orbit; (3), it is shown that at the distance at which comets' tails commence to be seen, the rays of the sun would not produce an appreciable elevation of temperature in a highly rarefied substance.—On the comparative chemical composition of the different parts of the vine when healthy and when attacked by *Phylloxera*, by M. Boutin.—Experiments made at Cognac on phylloxerised vines with the coal-tar recommended by M. Petit, by M. P. Mouillefert.—Experiments made at Montpelier with the same substance, by M. Alph. Rommier.—Observations on the points gained by science concerning the known species of the genus *Phylloxera*; a letter from M. Signoret to the perpetual secretary.—Observations concerning the recent communication of M. Balbiani on the different known species of the genus *Phylloxera*, by M. Lichtenstein.—Trial of infection of a healthy vine by putting *Phylloxera* in contact with its roots, by M. Delorme.—On the means proposed to check the propagation of *Phylloxera*, the method of uprooting in particular, by M. P. Naudin.—Experiments on a method of treatment of phylloxerised vines, by the sap of a Euphorbia, by M. L. Balme.—On the appearance of *Phylloxera* in the canton of Geneva, and on different curative measures proposed, by M. E. Ador.—The Minister of Foreign Affairs transmitted further details of the recent eruption of Etna.—M. Dumas announced that the news received from the first four Transit of Venus expeditions was satisfactory on all points.—On the pretended Saharan Sea, by M. A. Pomel.—Observations on the ancient central sea of the Tuniso-Algerian Sahara, by M. Virlet d'Aoust.—On the theory of curves in space of n dimensions, by M. C. Jordan.—Electro-diapason of variable period, by M. E. Mercadier.—Electro-spectral tube, or "fulgurator," for the observation of the spectra of metallic solutions, by MM. B. Delachanal and A. Mermet.—Note on supersaturation, by M. Lecoq de Boisbaudran.—On the action of bromine on certain alcohols, by M. E. Hardy.—Note on the production of oxamic acid by the oxidation of glycocol, by M. R. Engel.—Action of heat on diphenylmethane and phenyl-toluene; on the products of the reduction of benzophenone, by M. Ph. Barbier.—Curious association of garnet, idiocrase and datholite, by M. J. Lawrence Smith.—Balloon meteorological observations, by M. G. Tissandier.—Note on the spectroscopic observations made during the balloon ascent of Sept. 24, for studying variations in the extension of the colours of the spectrum, by M. W. de Fonvielle.—On the feeble influence which diluvian waters have exercised on the formation of the valleys of the Paris basin, by M. E. Robert.

BOOKS RECEIVED

BRITISH.—Synopsis of an Arrangement of Invertebrate Animals in the Free Museum of Liverpool, with Introduction by Rev. H. R. Higgins (Marples).—Babington's Manual of British Botany. 7th edit. (Van Voorst).—Mineralogy: Frank Rutley, F.G.S. (T. Murby).—The Sanitary Condition of Oxfordshire: G. W. Child (Longmans).—Symond's Rainfall for 1873.—Sixteenth Report of the East Kent Natural History Society (Canterbury).—Amateur's Photographic Guide Book: Stillman (Smith, C.D.).—The Principles of Modern Pantheistic and Atheistic Philosophy: C. A. Row (Hardwicke).—Micrographic Dictionary. Parts xiii. and xiv.: Griffith and Henfrey (Van Voorst).

CONTENTS

PAGE

THURSDAY, OCTOBER 22, 1874

*THE UNIVERSITIES COMMISSION REPORT**
II.

IT has of course been always well known that the endowments of Oxford and Cambridge have been by law restricted, till within the last few years, to members of the Established Church; but to the outside world it will probably be a surprise to learn from this Report how far-reaching have been the consequences of this restriction, and how deep is the ecclesiastical character which has been thus imprinted upon a large portion of the academical wealth which the nation imagines to be at its own free disposal. It must be premised that in this respect, as in so many others, Oxford furnishes far more matter for comment than Cambridge, so that the following illustrations will be mainly taken from the former University; and also that it is regularly in the most wealthy Colleges that ecclesiastical objects receive a disproportionate amount of pecuniary aid: two circumstances which point to the conclusion that it is superfluity of income which causes the interests of education and learning to be cast into comparative neglect.

The synoptical tables at the end of this volume state that the Oxford Colleges have in their gift or annexed to their Headships 436 benefices of the returned annual value of 187,000*l.* It is notorious that these returns are considerably below the gross amount actually received, but as they stand they represent a sum equal to more than two-thirds of the total amount which these same Colleges receive from their corporate endowments. The proportion at Cambridge is not quite so large. Some of the Colleges have exercised their statutory powers of selling their advowsons, but to no great extent, and it is yet a moot legal point whether the money produced from such sales can be diverted to purely secular objects. It is noticed, however, by the Commissioners, that in one or two cases such money has been carried to the ordinary account, and that in others it has been appropriated to purposes which otherwise must have been paid for out of the corporate revenue. The proper disposition of the wealth represented by these advowsons is clearly one of those questions which should not be left to the varying and self-interested action of the individual Colleges, but must be resolutely faced by Parliament, and if it be decided in the way which the progress of modern opinion seems most disposed to favour, there will result a very large increase on the total of 260,000*l.* a year mentioned last week as the clear sum available in the reconsideration of the endowments of Oxford. According to another heading in the synoptical tables the total sum of 8,600*l.* is expended upon the College chapels at Oxford, a total which will probably not be considered too large, when it is also stated that out of it are maintained the great choral services at Magdalen, New, and Christ Church, at an average of more than 2,000*l.* each. This sum, however, deserves quotation, if only out of contrast with the item which follows under the head of "Library," which amounts at Oxford to the bare pittance of 1,300*l.* Here also the amounts expended at Cambridge upon the ecclesiastical and secular establishments stand in a similar proportion. It is true that the libraries are awarded something besides from Trust funds and from fees on graduation, but the circumstance that their wants are so conspicuously put into the second place is most significant of the general tone of feeling prevalent at the Universities on these matters.

Another item in these tables is headed "Subscriptions and Pensions," amounting at Oxford to close upon 9,000*l.*, which may not perhaps seem an extravagant expenditure for the owners in fee of so much landed property; yet it will be viewed with much suspicion by those who know how feeble College meetings are in their resistance to the importunities of past members of their body seeking pecuniary help for all those objects which the Church of England takes upon itself to perform in rural parishes. The part of this subject, however, which is destined to attract the largest amount of public attention is that which has reference to the augmentation of College benefices out of corporate income, a process by which, as was before tolerably well known, the clerical fellows, forming as they do a majority in the governing bodies, provide comfortable pensions for their own declining years, and at the same time evince their interest in the general welfare of the Church. The extent, however, to which this process has been carried on is now revealed for the first time, though it is not quite apparent whether all has yet been disclosed, for in the course of their inquiries on this topic the Commissioners have not unnaturally been met with considerable reluctance, and in some cases apparently even with evasion. The synoptical tables for the Oxford Colleges give the amount thus annually devoted as just 9,000*l.*, which may be thought a fully sufficient charge for this item, being more than is set apart for College officers, for the management of estates, or for investment. This figure, however, it cannot be too widely known, is a totally delusive one, and probably does not represent one quarter of the amount which is really squandered in this way. This conclusion would be at once suspected by anyone who has an inkling of the facts, when he reads that Queen's is credited in this table with nothing at all, and Magdalen with only 17*l.* 10*s.* A more particular examination of the full returns made by the individual Colleges amply confirms these suspicions by proving, though in a roundabout way, that Queen's really pays away to incumbents 3,000*l.* a year, and Magdalen no less than 9,000*l.* To this it may be added that Christ Church, which in the tables is only credited with 2,000*l.*, does as a matter of fact spend just four times that amount; and that since 1835, and chiefly within the last few years, has given away 28,000*l.* for cognate ecclesiastical purposes. In connection with this subject, it may be mentioned that Magdalen possesses a certain benefaction called the Sheppard Fund, subject to no specific conditions, except that the proceeds are to be appropriated "to such uses as are likely to promote piety and learning in Magdalen or any other College." Out of a net 2,000*l.* a year received from this fund, 300*l.* is spent on management, &c., the ambiguous item of subscriptions runs away with 470*l.*, while 720*l.* is swallowed up in ecclesiastical objects, leaving a bare 540*l.* for Magdalen College and other schools. The accounts of the Hulme Trust connected with Brasenose teach the same lesson, for in that case no less than 4,000*l.* per annum out of a

* Continued from p. 476.

net revenue of 6,000*l*., under the authority, it is true, of recent Acts of Parliament, is devoted to livings and churches; a considerable deviation, as the Commissioners observe, from the intention expressed in the will of the benefactor. The returns of the value of the Professorships are equally significant, for the five Divinity Chairs are each endowed with 1,500*l*. and a house, whereas the average of the remaining Professorships cannot be more than 500*l*. without a residence. It may here be incidentally mentioned that the collective income of the Oxford Professors from all sources amounts to 25,000*l*., of which only 450*l*. comes from fees, and more than half of this latter sum from the fees of the four Science Professors.

Concerning the number of Fellowships confined to those who have taken or who have promised to take orders, this Report is entirely silent, on the same principle apparently as it omits to state what proportion of the College endowments is appropriated to the encouragement of Physical Science. For information on this latter topic, recourse may be had to the Report of another Royal Commission lately published, and the University Calendars yield some evidence on the former point. As to Oxford, it has been calculated that with the exception of Merton, where for the future all Fellowships, as well as the Headship, will be entirely open, nearly half the Fellowships are what is commonly called clerical, and all the remaining Headships are confined to clergymen. The proportion in the different Colleges is very irregular, but the reader will hardly be surprised to learn that, in accordance with what has been intimated above, at the four wealthiest Colleges the proportion is as high as two clerical fellows to one lay.

All these facts, and there are more of the same character, seem to point one way: that when the reconstruction of the Universities becomes a matter of public and not special interest, and when the uses to which their endowments are put shall be fundamentally reconsidered in the light of modern experience, one of the first questions which the nation will have to decide for itself will be whether so large a portion of academical property shall in the future be limited to purposes which certainly are not educational, and nowhere else than in England would ever be thought to be academical. That the Colleges themselves cannot be permitted to settle these great questions at their own sweet will is abundantly made clear by the facts recorded in this Report. It may be granted that the reformed statutes of a few of the Oxford Colleges, which are appended at the end of this volume, promise to abolish certain of the more prominent evils in their constitution, which evils indeed nowhere find any active defenders; but in none of these schemes is adequate importance attached to the duty of encouraging original research, the one part of its academical functions which Oxford neither performs nor regrets to have left unperformed. Moreover, the well-intentioned activity of some three or four of the less wealthy Colleges affords no guarantee that the greater institutions will not continue in their wasteful courses, and permit fresh vested interests to be acquired daily. Perhaps public opinion is not yet fully ripe, and perhaps those who have interested themselves in these subjects are not yet sufficiently unanimous; but for the future, at any rate, no excuses of this kind ought to be tolerated. The Commission on Scientific Instruction and the Advancement of Science has thrown into shape a scheme of reform which, though primarily adapted to the case of original research in the physical sciences, is capable of being extended to similar branches of genuine study, and to the outline of that scheme many prominent men, statesmen and others, have given in their adhesion. This Commission has now in its Report given us all the materials requisite for discovering where the necessary funds shall come from; and from henceforth it will be only due to laziness, or to individual perversity, if a definite scheme of University Re-organisation, conceived in the interests of unencumbered investigation and mature study, is not soon presented for the acceptance of the public.

SEDLEY TAYLOR'S "SOUND"

Sound and Music: a Non-mathematical Treatise. By Sedley Taylor, M.A. (London: Macmillan and Co.)

FINDING from the title-page and preface that this work, though non-mathematical, undertakes to give an account of the acoustical discoveries of Helmholtz, we acknowledge having felt some misgivings when we commenced the perusal of it. We will presently inform our readers whether we found our fears justified or not by the book itself; but we must first state why we felt them.

The recent reasonable and even necessary outcry for popular scientific education in this country has led to the publication of a perfect shoal of elementary treatises. Everyone who has a smattering of knowledge or who has access to a consulting library considers himself thereby fitted to write a treatise. For one such that is written by a man thoroughly competent as far as knowledge and experience can qualify him, we have half a dozen written by popular lecturers, or rather showmen, in whose eyes sensational experiments sensationally described form the really attractive portion of science! Besides these, we have a dozen others—some the work of those fluent writers who can master a new subject in a week, complete an octavo treatise on it by the end of the month, see it through the press, and proceed immediately to repeat the process on something newer still; the others, the original work of uninstructed but aspiring men, who have learnt too little to be aware either of what science is or of their own utter ignorance of it. This is no fancy sketch, but, as all competent to judge will allow, an exceedingly unpleasant reality. In some subjects, no doubt, competent men have the field (as yet) left almost to themselves. It is only now and then that an ignoramus ventures to produce a treatise on Hyperdeterminants, Vortex Motion, or Specific Inductive Capacity. Yet, if books on such subjects could command a host of eager *and ignorant* purchasers, there would soon be a supply from quarters hitherto undreamt of. But anyone and everyone can write on such simple matters as heat, light, electricity, or (more to our present purpose) sound and music. "Bother Helmholtz, and Clerk-Maxwell, and Thomson," cries a public athirst for sensation, and whose palate is already dead to all but the most potent spices; "we want excitement, knowledge too if it comes painlessly, but excitement;" which (viz. the sensation and the excitement) are precisely what that same public will

not get from Mr. Taylor's work. Not once, in the whole course of his 219 pages, has he condescended to cater for the mere amusement of his reader. We hope, but almost against hope, that this will not interfere with the sale of his book.

The book, with the exception of a few slight blemishes, to some of which we will presently advert, is a very good one indeed: lucid, comprehensive, and accurate. Many of the more difficult ideas introduced are illustrated very happily by analogy; and, so far as the first half of the volume is concerned, there is nothing which should present a difficulty to any reader of average intelligence. It is necessarily otherwise with the second half, which treats mainly of music, for this is a subject which mere intelligence, however acute, will not enable a man to master. One may as well discourse of colours to the congenitally blind, as of music to a man devoid of "ear." It has often struck us as one of the most remarkable of phenomena in the physical world, that while we ourselves were only greatly annoyed by the discordant grinding of some street-organ miscreant, one friend beside us has been almost in a state of frenzy, while another, on the contrary, listened with the most stolid indifference. [We leave it to the psychologists to consider whether the mind itself may not, in certain individuals, have similar excess or defect in some particular quality, and if so, to explain by it the existence alike of sceptics and of fanatics.] Considering that this extraordinary difference is often found to exist between individuals nearly related, and in all other particulars closely resembling one another, it is not to be wondered at that even among those who possess in a special manner an ear for music, individuals should be found to differ widely from one another on many of the less important points. In such a case who is to decide? *Ceteris paribus*, we should be inclined to side with the mathematician, who has, as it were, an extra sense in addition to those possessed by his antagonist. Wherever, then, we find that Mr. Taylor's view is not exactly in accordance with that of Helmholtz (though the discrepancies, so far as we venture to think we understand them, are few, and, with one exception, of apparently small importance), we are inclined to take the side of Helmholtz. But, we repeat, this is not to be considered as a demerit of Mr. Taylor, for the main point of variance (if we be correct in supposing it to exist) seems to be an æsthetic one, upon which only a comparatively small number of persons (and these not only exceptionally gifted, but also highly trained) are competent to form an opinion. We outsiders may judge of the value of such opinions by comparing the verdicts of different art critics on the same picture; though in the case of sound, where the physical processes (in the external ear at least) are thoroughly known to the mathematician, he ought to have a decided advantage over those who have not his physical insight. The following passage (§ 75), seems particularly happy:—

"That *two sounds should produce absolute silence* seems, at first sight, as absurd as that two loaves should be equivalent to no bread. This is, however, only because we are accustomed to think of sound as something with an external objective existence; not as consisting merely in a state of motion of certain air-particles, and therefore liable, on the application of an opposite system of equal forces, to be absolutely annihilated."

There is, however, considerable objection to be taken to the word *forces*. Had Mr. Taylor said *motions*, or still better *disturbances*, the passage would have been not only clearer but more correct.

A closely-connected mistake occurs, in two different forms, in §§ 22, 50. In the former, the word *force* is used in place of *energy*; in the latter, *energy* is used where *force* is obviously the correct word. But here, though in all probability unconsciously, Mr. Taylor is only following the metaphysicians and other quasi-scientific men, who give what they call a "broad basis" to the meaning of a word by using it now in one sense and anon in quite a different one.

Another curious statement, occurring in § 8 and repeated in § 37, seems to show that Mr. Taylor's clock has a half-second pendulum, for he speaks of a *complete* oscillation (from side to side and back again) as taking place in one second!

The inherent defect of all non-mathematical treatment of a subject undoubtedly mathematical shows itself in the elaborateness of Mr. Taylor's explanation of wave-motion. We are quite sure that a very slight amount of the most elementary geometry, properly introduced, would have enabled him to condense the whole of this part of his work into one-third of its present bulk or even less, and this with a decided increase of simplicity and intelligibility to the ordinary reader.

We object entirely to the word *strictly* in the foot-note to § 5, for, instead of being *not strictly accurate*, the statement referred to is not even approximately accurate. In the same section there is an illustration of wave propagation by the alternate kneeling and standing of the individuals of a line of men, where the reader is likely to be much puzzled by the printing of "two, six, and nine," instead of "twenty, sixty, and ninety." This, however, may be called hypercriticism, so we proceed to point out that in § 23 there is a genuine blunder. Mr. Taylor says that in the diminution of loudness and dying away of the sound of a pianoforte wire once struck, "the effect produced is the same as if our harmonium had, while sounding out its note, been carried gradually further and further away from us," forgetting altogether what, indeed, we do not find in his book, the lowering of pitch which accompanies diminution of intensity when the source of sound moves away from the observer.

In § 54 the word *submission* (subdivision ?) produces a curious effect, due probably to the printer.

We conclude by repeating that the work is a very good one, worthy of the subject; and that we are glad to see that (in default of an English translation of the "Tonempfindungen") the beautiful discoveries of Helmholtz have found in this country an able and congenial expositor. Had we thought less of the work we should not have been driven to criticism of mere isolated words or phrases which easily escape detection by an author himself. Yet, after all, we must conclude with an expression of amazement that a man who shows himself to have so thorough an appreciation of harmony as does Mr. Taylor, should tolerate for a moment in his pages a foreign word such as *timbre*, when we have an excellent and generally received English equivalent for it; or employ for a concord such a hideously inappropriate word as the English *clang*.

MAREY'S "ANIMAL MECHANISM"

Animal Mechanism. By E. J. Marey. "The International Scientific Series." (London: Henry S. King and Co., 1874.)

I.

ON more than one occasion during the last year or so, we have drawn attention to a small French physiological treatise by Prof. Marey, entitled "La Machine Animale." It is not only to a passage here and a passage there that we have had to refer, but to the thorough exposition of intricate problems of mechanical physiology, which have been worked out with a degree of ability rarely to be found in a single author. It is a translation of this work which forms the subject of the present review.

Prof. Marey divides his subject into three parts: the first devoted to general principles; the second to terrestrial locomotion; and the third to aërial locomotion. It is to the last two of these that we wish to draw attention both in this and the succeeding notice.

Terrestrial locomotion comprises that of bipeds and that of quadrupeds: man and the horse, exemplifying them respectively in their most complicated forms, serve as excellent examples. Human locomotion is a subject which admits of more scientific treatment than might at first sight be supposed. There is no better proof of this than the fact that until Prof. Marey quite recently disproved it, the theory of the brothers Weber was generally accepted, namely, that the non-supporting leg moves pendulum-like in walking.

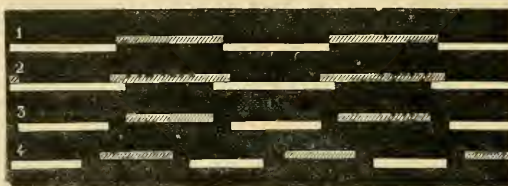


FIG. 1.

Whilst, with the mind otherwise unoccupied, anyone sets to work to study the different movements of his legs in hopping, jumping, walking, and running, there are many points that he can make out without further assistance, such as the fact that in walking the feet are never both off the ground together, whilst in running the body is unsupported between each two steps. Our author and one of his pupils, M. G. Carlet, have, however, succeeded in putting down the results of their carefully conducted experiments in a form which allows of their being studied by others as well as by the subjects of the experiments themselves. By means of elastic air-bags with connecting tubes they have transferred the movements they discuss to paper, and have had these tracings copied as woodcuts.

After having proved that the intensity of the pressure of the foot upon the ground is not solely dependent on the weight of the body, it being greater at the end of the step than at its commencement on account of the muscular effort then added, Prof. Marey describes the vertical and horizontal movements of the body in walking, and shows that the former oscillations are twice as numerous as the latter. This can be verified by observation; at all events, the rise of the body can be seen to be as rapid as each step, whilst the slowness of "the waddle" is proverbial. Next, the greater pressure at the end of each step is proved, by a very ingenious contrivance, to increase the forward movement of the body during that time, and to be least at the moment when the foot reaches the ground.

FIG. 2.

In describing the rhythm of the different modes of progression adopted by man, the tracings obtained by the recording instrument are transcribed into a notation which is a modification of that employed in music. Two horizontal lines form the staff on which this simple music, consisting of only two notes, is written. A broad white line expresses by its length the duration of the pressure of the right foot; a similar shaded line does the same for the left; any interval between the two indicates the time during which the body is suspended above the ground. On this method the diagram in Fig. 1 will represent the formula of the rhythm of the walking pace (1), of ascending a staircase (2), of running (3), and of rapid running (4). From these it may be gathered that in walking the contact of one foot with the ground follows that of its fellow without any interval; that in climbing a hill or going upstairs there is this difference, namely, that the one foot does not leave the ground until its fellow has been in contact with it a perceptible time; that in running there is an interval at each step during which the body is quite off the ground; and fourthly, that in rapid running, though the duration of each step is shortened, that of the interval is lengthened.

Fig. 2 represents the gallop of children, (1) being what may be termed left gallop, and (2) right gallop, according to which foot is in front. This rhythm will be found instructive when we come to refer to the same in the horse.

The upper of the two portions of Fig. 3 represents a series of leaps with the feet together, whilst the lower is the notation of the hop on the right leg, in which, from fatigue, the duration of the time of contact with the ground increases ; it will be observed that the time of suspension, nevertheless, does not vary. All these diagrams are so instructive in themselves that they need no further detailed explanation.

Fig. 4 will give an idea of the instrument employed in studying the complicated problem of quadrupedal action, in which it will be seen that the movements of each foot communicate, through elastic tubes, movements to the levers of the recording apparatus held in the hand of the rider. In interpreting the tracings thus obtained into the musical notation above employed to describe the different rhythms of human progression, the only thing necessary is to introduce a second pair of bars below that previously employed, to represent the hind feet. A diagram like Fig. 1 is the result. Before the introduction of this graphic method, the action of the horse, which used to be an endless subject of dispute, was made out from the imprint of the shoe-marks left in soft ground ; this, however, varies for any given action with the rapidity of movement and the size of the animal which forms the subject of experiment.

Fig. 3.

As we explained not long ago (NATURE, vol. x. p. 39), according to the work before us, the action of the horse in walking, we need not discuss that step on the present occasion. It is by far the most complicated of the movements. The trot is much more simple, being a double instead of a quadruple action ; the opposite fore and hind feet striking the ground simultaneously. There is also an "irregular trot," which is frequently met with, and depends on a lag in the action of the hind limbs.

"Several different paces, the common character of which is that irregular impacts return at regular intervals, are comprehended under the gallop." There is the gallop in *two*, *three*, and *four* times, so called according to the number of sounds heard in each completed pace Fig. 5 gives the notation of the gallop in three-time, which is the most common ; *A* indicating the time, and *B* indicating the number of feet which support the body at each instant of the step. From it the left hind-foot is

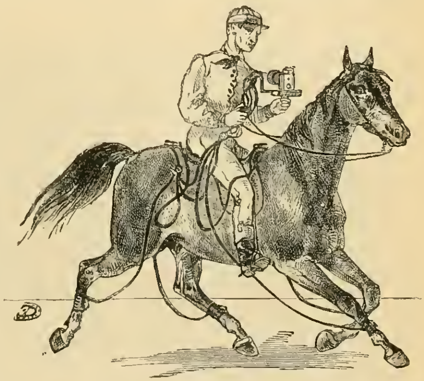


Fig 4.

seen to reach the ground before any of the others, and to produce the first sound : the second is caused by the simultaneous impact of the right hind and left fore feet ; and the third by the right fore-foot, which the animal always

Fig 5.

places forward to commence with. The similarity between this pace and that of children "playing at horses" can be readily seen by comparing this figure with Fig. 2. The gallop in four-time differs from that just described, in that the impacts of the hind legs are slightly delayed, which causes the two feet, which in three-time strike the ground simultaneously, to do so one after the other, the right hind one after the left fore, so that the single sound is duplicated.

The full gallop is so violent an action that the delicate instruments employed in analysing the previous movements have to be dispensed with, and a more substantial apparatus employed. The rider, instead of carrying it in his hand, has it tied, as a knapsack, on his back, and he sets the recording watchwork in motion with his teeth. Notwithstanding the difficulties of the experiment, very successful tracings have been obtained, which show that the full gallop is really a gallop in four-time, in which, although the fore-feet hit the ground with a fair interval, the hind feet hit it nearly simultaneously. The time of complete suspension is extremely short.

Besides the actual and relative durations of the different paces, Prof. Marey's instruments are so constructed as to record also the rise and fall of the body of the horse during each. This point is of particular interest, as it explains the varying degrees of comfort to the rider in

the trot, gallop, &c. The rise in the trot is sudden and simultaneous with the time the animal's feet are on the ground, and the fall with the time of suspension. In the gallop the same is the case, though the rises and falls are less sudden; they are, "therefore, less jarring to the rider, though they may, in fact, present a greater amplitude."

(*To be continued.*)

OUR BOOK SHELF

1.—*Les Roches; Descriptions de leurs Éléments: Methode de Détermination, etc.* Par Edouard Jannetaz, Docteur ès Sciences, etc. (Paris: J. Rothschild, 1874.)

2.—*Les Minéraux: Guide Pratique pour leur Détermination, etc.* Par F. de Kobell. Avant-propos et Additions, par F. Pisani, Professeur de Chimie et de Minéralogie. (Same publisher.)

3.—*Le Monde Microscopique des Eaux.* Par Jules Girard. (Same publisher.)

THESE three works form part of a series of popular scientific treatises issued by the enterprising Paris publisher, M. Rothschild. They are small volumes neatly printed and got up, and Nos. 1 and 3 are fully illustrated with well-executed cuts.

No. 1 is intended as a practical guide for the use of engineers, geologists, mineralogists, agriculturists, and pupils of Government schools. It is illustrated with thirty-nine woodcuts, contains a great deal of valuable information in small space, and seems well calculated to form a useful little handbook for the classes mentioned.

No. 2, which is a translation from the tenth German edition of Kobell's work by Count L. de la Tour-du-Pin, with a preface and additions by Prof. Pisani, is intended for the use of chemists, engineers, manufacturers, &c., and, like the above, seems well calculated to serve its purpose, of helping those who have a moderate knowledge of chemistry to analyse speedily and exactly the principal minerals.

No. 3 is of a much more popular kind than the two previously mentioned works; its author, M. Girard, is well known as a successful populariser of scientific results. It contains sixty-eight beautiul and useful cuts. It is intended as a handbook to those who wish to derive amusement and instruction from the use of the microscope, and takes up successively some of the principal points in the animal, vegetable (existing and fossil), and mineral kingdoms.

Nos. 1 and 2 have very full indexes appended.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Periodicity of Auroras

ON my return to Newcastle-on-Tyne I take the opportunity of being able to recur to books of reference to reply to a question put by Mr. Procter, in NATURE (vol. x. p. 355), whether any complete catalogues of auroras have been constructed, and if they show indications of periodicity in its displays. Kæmtz's "Meteorology," in which almost every feature of the weather capable of being chronicled has been fully catalogued, probably contains a list more or less complete, up to its author's time, of all then known descriptions of auroras. If this be so, it has probably served for the groundwork upon which later and more complete catalogues have been compiled, extended, and completed in his own and other countries. Dr. Heis, the director of the Prussian Observatory at Münster, in Westphalia, is especially active in collecting information of the slightest appearances of aurora in any quarters of the globe, from whence published or private descriptions of them can be obtained. Every successive number of such works as Mr. G. J. Symons's *Monthly Meteorological Magazine* and the *Quarterly Journal of the Scottish Meteorological Society* contains, in a few pages of "meteorological notes" on the weather peculiarities of each month from their numerous observers, a list of scattered aurora-observations, which is probably as complete for the British Isles during the years in which these publications have been carried on, as the perfect or partial clearness of the sky over this country, and indeed over some adjacent continental stations, enables such a list to be made by observations. But this collection, invaluable as it is for our own immediate field of registry, is not assorted, nor suited, without extension by the help of similar collections made in surrounding foreign countries, to be regarded as a sufficiently extensive list of auroras for dealing generally with the question of their periodicity. The present state of progress of our knowledge, with regard to auroral frequency, we owe largely, if not almost entirely, to the researches of Prof. E. Loomis, of Yale College, U.S., the results of whose discussion of the collateral views and considerations involved in them will be found in numbers of the *American Journal of Science* for July 1860, Sept. 1870, and April 1873. In the first of these papers, a map of lines of equal auroral frequency for the northern hemisphere is presented, dividing the northern area of the globe into zones encircling the arctic regions. It appears, for example, from this map, that auroral displays are not very much more frequently visible in St. Petersburg than they are in London, and that even Boston and Edinburgh are as frequently visited by them as the great northern capital itself. An oval belt of

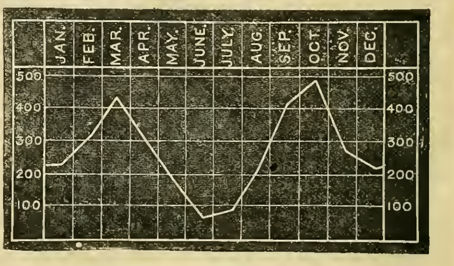


FIG. 1.—Number of auroras observed in each month of the year (Kæmtz).

greatest auroral frequency encloses together the north geographica and north magnetic poles, covering all the European, Asiatic, and American coast lines of the Arctic Ocean, and passing onwards from the latter across Hudson's Bay, the mouth of Baffin's Bay, and Iceland, back to the North Cape. For a short distance within this ample belt auroras continue to be tolerably frequent, and grow comparatively more scarce in Smith's Sound and the northern parts of Baffin's Bay, and indeed apparently in proportion as the geographical north polar regions are approached.* It is with the outer and not with the inner margin, however, of this ring-maximum of auroras that observers in ordinary latitudes are concerned, and it is pointed out in his most recent paper by Prof. Loomis, that in constructing general catalogues for deciding questions of auroral periodicity, a line, or at least a restricted zone, bordered northwards and southwards by lines of equal auroral frequency, should be chosen as the localities from which observations may be gathered. To place this line or belt in the zone itself of almost constant auroral activity, where auroras can only vary periodically in brightness rather than in

* It will be remembered that in Capt. Kane's description of a winter-detention of his vessel in Smith's Sound (the northernmost passage from Baffin's Bay, about eight and-a-half degrees from the north pole), it is related that the feeling of prolonged darkness at length became so oppressive that even the Esquimaux dogs were affected by it, and when excluded from the luxury whined piteously for light. A darkness so deep and enduring as this description suggests can scarcely have been broken, as it occurs in the more favoured belt twenty degrees south of this high latitude, at the mouth of Davis Strait, by the illumination of bright rays and flashing beams of constantly appearing fine auroras. The position occupied by Capt. Kane was not more than two or three degrees from the general centre of the region of fast-diminishing auroral frequency, embracing the whole Arctic Ocean, which is shown on Prof. Loomis's auroral map as merging insensibly on all sides into the broad or narrow belt of greatest auroral activity surrounding it. The latter seems to follow very nearly along its whole extent, with a corresponding strong depression and expansion of its width towards Hudson's Bay, the general direction of the arctic coast line.

frequency, would be of no avail for enumerations; the zone selected must be one of occasional auroras, arising only from the southward spreading of the strongest disturbances of the ever-beaming and sometimes forth-sallying illuminations of the north.

It is also for such other obvious reasons, as that years of arctic exploration tend to appear in general catalogues as years of extraordinary auroral frequency, and that observations in Asia, Western America, and in the whole of the southern hemisphere have for the most part been made but recently or at very irregular intervals, that the use of general auroral catalogues in questions of periodicity calls for much selection and reduction of the miscellaneous mass of observations. A most extensive general auroral catalogue appears to have been published early last year, or at the end of the previous year,* by Prof. Lovering, of the United States, of which Prof. Loomis has employed the materials, and of which he acknowledges the completeness in terms of commendation. It extends from the year 500 B.C. to the year 1864, and includes with its supplements upwards of 12,000 cases of observed auroras. For the following years, from 1864 to the end of 1872, Prof. Loomis has continued the catalogue for a restricted area suited to the question of periodicity, partly from American sources, and partly (in Europe) from the periodical journal published by Dr. Heis, *Wochenschrift für Astronomie und Meteorologie*. The selected region of observation is limited on the north by an iso-auroral line skirting the northern boundary of the State of Massachusetts and crossing the Atlantic from near Boston to the north of Ireland, passing thence between England and Scotland, and through the northern part of Jutland, a little south of Stockholm, to a little north of St. Petersburg, where it continues its course in Russia as far as long. 40° E from Greenwich. The meridian of this longitude (nearly that of the eastern ends of the Black Sea and Red Sea) limits the area on the east. It is similarly limited westwards by the meridian of 80° W. from Greenwich, including Washington, and the eastern, but none of the western States of North America. A lengthy general catalogue for this region was extracted by Prof. Loomis from Lovering's list, including all the auroras recorded in it in the years between the beginning of the year 1776 and the end of the year 1872, with their mouth and dates. The whole of this long list, supplemented in great measure by his own inquiries, is given at full length at the end of the last paper (*sup. cit.*) by Prof. Loomis. The number of auroras in each year, or their annual frequency, is then obtained and laid down in a curve for the whole interval of ninety-six years of the observations. On the same plate is projected the mean daily range of magnetic declination, and the relative extent of black spots on the sun's disc for the same

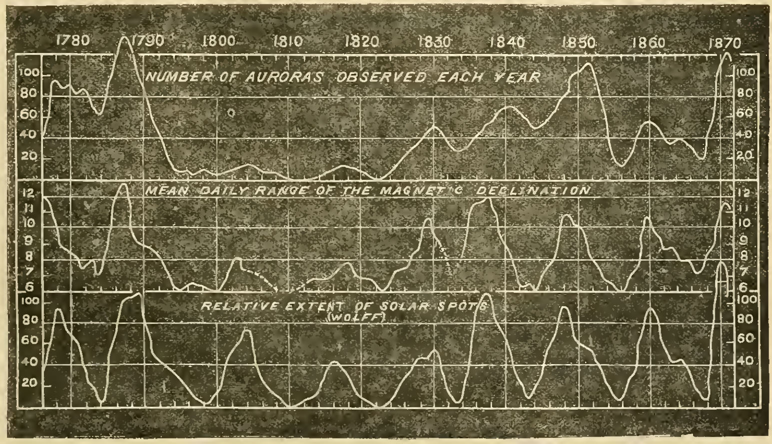


FIG. 2

series of years of observation; the latter from Wolff's numbers, and the former from the average of magnetic observations made at Prague from the year 1777 to the year 1871 inclusive. Very uncouth in appearance are all these curves: and the curve of annual auroral frequency is far the most shapeless in outline of them all; but the leading crests and troughs of the ruling eleven-year period of the sun-spot curve are conspicuously reproduced in each of the other two curves, so that it is difficult to say whether the auroral curve or the curve of magnetic declination is the stricter in its adherence to the times of maxima prescribed to it by the solar spots. In two cases, however, the auroral maximum took place some three years, and in another case about a year, too late (1840, 1851, 1871). The maximum of the magnetic disturbance curve also took place on one of these occasions (1838) a year later than the sun-spot maximum, while in the year 1787 both the auroral frequency and magnetic disturbance curves attained their maxima together between one and two years earlier than the sun-spot curve.

Prof. Loomis concludes that the times of auroral minimum and maximum frequency happen on an average from half a year to a year later than the same critical times of magnetic disturbance and of the sun's relative obscuration by black spots; that they are more nearly related to the same times for the magnetic daily range than for the sun-spot curve, and that the time of greatest auroral frequency lasts longer than that of the sun's obscuration by spots or of the magnetic needle's greatest daily disturbances. A period of very moderate activity in all the curves is embraced between the maxima of 1788 and 1830, which is particularly noticeable in the scarcity of auroras and in the smallness of the magnetic oscillations in that period. More than 4,000 auroras are included even in the limited selection from Prof. Lovering's catalogue used by Prof. Loomis to establish these results, and yet the interval of ninety-six years (during which the magnetic declination had been continuously observed) to which it is confined proves to be too short to determine certainly the long cycle of activity and repose that seems to govern the times of greatest auroral frequency for years together, in long recurring periods of between half a century and a century. In a previous paper (the second in the *American Journal of Science* above quoted), Prof. Loomis had arrived at all the conclusions of the paper just described from an auroral catalogue of his own construction, of observations in not very northerly latitudes of Europe and in the United States; extending, however, only to the year 1850, the closing year of the magnetical observations at Prague then accessible to him. A period of about sixty years, from the

* "Memoirs of the American Academy," vol. x.

maximum of the year 1790 to that of 1850, was thence concluded, perhaps too confidently, as the real length of this long cycle of auroral frequency.

On turning to Kæmtz's "Meteorology" (translation by C. V. Walker, 1848, p. 458), I find that the author, with his usual exhaustive completeness, has constructed a general list of auroras observed up to his time (about the year 1820), and has established from it certain laws of their periodicity. The list itself, although not given for brevity in the translation, is in all probability contained in the original, and it must embrace upwards of 3,000 cases of auroral occurrences, since a table of about that total sum showing the numbers recorded in each of the several months of the year is given as the most important scientific result of the compilation. The numbers seen in March, September, and October are about half as great again as those recorded in any of the adjacent months, and about twice as great as have been recorded in either of the two mid-winter months of December and January, when the length of the nights is yet most favourable for their registry. That the numbers of auroral displays noted in June and July are relatively very small is easily explained by the length of the twilight in those months in European latitudes, rendering many, that would be conspicuous exhibitions in darker nights, invisible.

The times of greatest annual activity of the auroræ are thus about the seasons of the equinoxes, when the seat of the most direct action of the sun's rays upon the earth's surface is undergoing its most rapid changes during the sun's yearly course; and when nearly the same parts of the earth's surface continue to be heated directly by the sun's rays at the seasons of the winter and summer solstices, there are times of comparative repose and tranquillity among the exhibitions of auroral outbreaks.

Regarding a secular period, Kæmtz's Catalogue appears to have shown nothing positive. "A period of this kind," he writes, "occurred between the years 1707 and 1790, attaining its maximum about the year 1752; since the year 1820 they have again continued to become more numerous." This maximum in the year 1752, and those shown on Prof. Loomis' auroral curve about the years 1780–90, 1850, and 1870–72, agree very ill with each other, or with the return of a constant cycle of long period connecting them together; the succession more nearly resembles that of periods of hot summers, or of cold winters, governed by fixed laws that have not yet been discovered in their returns and durations: and seems to point to causes influencing the production of auroras very similar to those which determine some of the obscurest features of our seasons. Thus, since the commencement of the earliest continuous temperature records at the Royal Observatory, Greenwich, in the year 1771, the commencement of winter or the arrival of a mean daily temperature of 40° has fluctuated between the months of November and December, apparently from different degrees of prevalence in those months of an annual tide of south-west wind then reaching a maximum in the British Isles. Assuming changes in the strength of this wind to be the cause of the observed fluctuations and of a gradually increasing retardation of winter and secular rise of mean temperature in the months of November, December, and January, noticed by Mr. Glaisher during the first half of the present century, the average course of this phenomenon, when submitted to examination, resembles very closely the general course of the curve of auroral frequency. There was a sensible retardation of the winter season from about the year 1775 to about the year 1790, followed by a marked acceleration from the latter year onwards through nearly the first quarter of the present century, indicating apparently a considerable abatement of south-west, anti-trade, or equatorial currents, on an average, for that lengthened period. The acting cause however returned, and its strength may be gathered from the fact that the mean temperature of the month of December at Greenwich during the twenty-five years from 1825 to 1850 was higher in eight years than that of the month of November, an anomaly which had only taken place thrice in the first quarter of the century. The last occurrences of the same kind, with which I am acquainted, happened in the years 1858, 1861, and 1862; but the strong retardations of winter, noticeable towards the year 1850, were then rapidly disappearing, and it is not improbable that in the further fluctuations that have since followed, a new correspondence between the secular rise of temperature of the months of November, December, and January at Greenwich, and the considerable maximum of auroral intensity reached during the years 1870–1873, may be found to bear out an analogy which is only hazarded here, in the absence of a better working hypothesis, as an apparently real and perhaps not altogether unnatural connection.

With regard to the relative proportion between eastward and westward movements of auroral rays, I know of no observations that have been made that can offer Mr. Procter any additional information. The possibility that auroral streamers may be uprushes of positive or negative electricity to a point of saturation in the highest regions of the atmosphere, followed by downrushes of the same electricity when the exciting cause in the interior or on the surface of the globe subsides, might be well proved by such observations. The existence of the motion shows that the auroral rays diverge sensibly from the earth's lines of magnetic force, probably in the endeavour (whether effectual or not is indifferent to the explanation) of the Aurora Borealis and Aurora Australis to combine and to neutralise each other (perhaps a rare occurrence) across the equator. The strength of the motion of the beams may be some measure of this tendency, and its absence a sign that the aurora is local and of comparatively little generality and extent. It may here be remarked that the annual periodicity of auroras differs entirely from that observed in the average frequency of sporadic shooting stars, which reaches a maximum in August and September, but has a well-marked minimum in March, resembling the single cold of winter and the single heat of summer produced three months earlier, in each year, by the tropical motion of the sun. A marked frequency of auroras on the dates of January 1–3, April 19–21, August 9–11, October 18–21, November 14 and 27, and December 10–12, when meteor-showers of various degrees of brightness are of almost annual occurrence, has not, as far as I am aware, been definitely traced and established; but the large auroral catalogues recently published by Prof. Loomis and Prof. Lovering will, it is evident, supply very valuable materials by which any such connection between auroras and periodical meteor-showers, if it exists, can be more thoroughly investigated and determined.

A. S. HERSCHEL

Automatism of Animals

YOUR correspondent, Mr. Wetterhan, has, I think, misunderstood Prof. Huxley's argument; which is, not that the adjusted motions he refers to never were the result of conscious and voluntary motion, but that they are not so now. His letter has, however, induced me to call attention to what has always seemed to me a real difficulty. As I understand automatic or reflex actions, they are those which have been so constantly repeated and which are so essential to the well-being of the individual, that the various nerves implicated have become so perfectly co-ordinated that the appropriate stimulus sets the whole machinery in motion without any conscious or voluntary action on the part of the individual. Thus we can quite understand how a paralysed limb would be drawn up when the sole of the foot is tickled or the toe pricked. If, however, any such irritation continues to be felt in the normal state, a man would stoop down and remove the irritating substance with his hand, or would place his foot upon the opposite knee, and, stooping down, endeavour to *see* the object which caused the irritation. But these are *conscious*, not *reflex*, acts. They are not repeated often enough, and are not sufficiently identical in form, to become automatic; and we are not told that a wholly paralysed human body does actually go through these various motions, as it certainly would do if not paralysed.

Now, in the case of the frog I can quite understand the jumping, swallowing, swimming, and even the balancing; for all these are actions so essential to the animal's existence, and so often repeated during life, as to have become automatic. So, also, I can understand the drawing up of the foot to remove an irritation on the side of the body, for with the short-necked frog this too is an essential, and must have been an oft-repeated action. But we are further told that "if you hold down the limb so that the frog cannot use it, he will, by and by, take the limb of the other side and turn it across the body, and use it for the same rubbing process." Now, this seems to me not to be explicable by automatic or reflex action, because it cannot have been an action frequently if ever performed during the life of every frog. It is true that from the co-ordination of the movements of the opposite limbs, we might expect, if the irritation were continued, and the leg on the same side kept for some time in motion, that the other leg would begin to move *in the same way*. But what causes it to move in a quite different and unusual way, *across* the body to the opposite side; and this, as related, at once and without first trying its own side? The most usual motion of both legs is directly up and down, each on its own side. What is it that causes one of these legs, when it

begins to move, not to move in the usual way (that which *is* automatic during life), but in an unusual manner, which must have been very rarely, if at all, used during life, and when used must have been purely conscious and voluntary? I think I cannot be mistaken in considering this to require some explanation. It may be that the frog is constantly, during life, crossing one foot over to rub the opposite side of the body; but we cannot accept this as an explanation unless it has been observed to be a fact. What puzzles me is, that Prof. Huxley, Dr. Carpenter, and Mr. Darwin, all refer to this case as an example of reflex action, and none of them see any difficulty in it, or seem to think that it requires any more explanation than the remaining quite intelligible cases. As others may, like myself, feel the difficulty I have endeavoured to point out, I hope some of your physiological correspondents will enlighten us if they can.

ALFRED R. WALLACE

Supernumerary Rainbow

IN Mr. Backhouse's letter (NATURE, vol. x. p. 437) he remarks that the supernumerary rainbow is commonly seen only in the upper part of the arch. Dr. Thomas Young, in his Bakerian Lecture ("Works," vol. i. p. 185, or Phil. Trans. 1804), after explaining the supernumerary bow by interferences, quotes a paper in vol. xxxii. of the Phil. Trans., in which Dr. Langwith describes his observation of a supernumerary bow on August 21, 1722; then remarks: "I have never observed these inner orders of colours in the lower parts of the rainbow. I have taken notice of this so often that I can hardly look upon it as accidental; and if it should prove true in general, it will bring the disquisition into a narrow compass; for it will show that this effect depends upon some property which the drops retain whilst they are in the upper part of the air, but lose as they come lower and are more mixed with one another." But I am not aware that anyone has ever remarked an appearance which struck me on seeing a few days ago a very complete primary and secondary bow with a portion of two supernumerary bows within the primary and about the highest part of the arch. To my eye the supernumerary bows were *not concentric* with the primary. My son agreed with me as to this appearance when I pointed it out to him; yet I thought it was probably an illusion till the following explanation occurred to me.

The rain-drops may be presumed to be smaller high in the air, and to increase as they descend.

Now, the smaller drops produce wider interference fringes than the larger drops do. Hence the supernumerary bow is widest and therefore farthest from the primary at the top of the arch, and gets narrower and nearer to the primary as it descends the arch on each side, and "in the lower parts" ultimately fines away to nothing. According to this theory the supernumerary bow is not always concentric with the primary, nor indeed circular.

It should be observed that another reason for the interference bow being seen most frequently at the highest part of the bow is that the small drops high in the air are probably more uniform in size than the larger drops lower down.

Oct. 8 JOSEPH BLACKBURN

Colour in Flowers not due to Insects

THE doctrine that the conspicuous colours of flowers are entirely due to the necessity for cross-fertilisation by the agency of insects seems to be taking the world by storm. It is supported by Mr. Darwin and Sir John Lubbock. It could scarcely be put forward on better authority. Yet there are several facts with which it does not harmonise. For instance—

1. *Cultivation* increases the size and colour of flowers quite independently of the existence or non-existence of insects.
2. *Double flowers* in which the doubling arises from metamorphosis of stamens or pistils are more showy than the single forms, yet insects can be of little use to them, since they are either partially or entirely barren. The double-blossomed cherry is brilliantly conspicuous, but it bears no fruit.
3. Such *abortive flowers* as the cultivated Guelder Rose and Hydrangea depend for their beauty upon the destruction of the reproductive organs. If their increased splendour is meant only as a lure to insects, it is surely an absurd failure.
4. The *autumn colours* of leaves and fruits can serve no such purpose, yet these are often as bright and conspicuous as the flowers of summer.
5. *Fungi* and *lichens* exhibit brilliant colours, which can have nothing to do with insect-fertilisation.

Do not these facts indicate that though insects may be attracted by conspicuous colours, and may have some influence in the maintenance of coloured species, there is yet a deeper and more permanent cause for the colour itself?

Leicester, Oct. 11. F. T. MOTT

Habits of Squirrels

WOULD you permit me to ask of your readers a question or two upon the habits of squirrels? I have had one in my possession, from the age of three weeks, for more than two years. I have noticed that whenever it cleans itself, after licking, it *sneezes* violently three or four times into its forepaws, then rubs them thus damped over its fur. It seems to have the power of sneezing at volition.

Now, is this habit of sneezing, for the purpose of cleaning itself, a habit peculiar to squirrels; or is it shared by other animals?

I notice also that frequently when it is going thoroughly to clean itself it jerks its forepaws over its ears, bringing them back over its eyes, and always causing a milky liquid to suffuse the eyes. This liquid swims over the eye, and then is absorbed. I have thought that it may use this secretion also for the purpose of moisture. The animal is in perfect health and splendid condition.

A squirrel I had three years ago also had this habit, though in a slighter degree. D. T.

THE NEW VINE-DISEASE IN THE SOUTH-EAST OF FRANCE

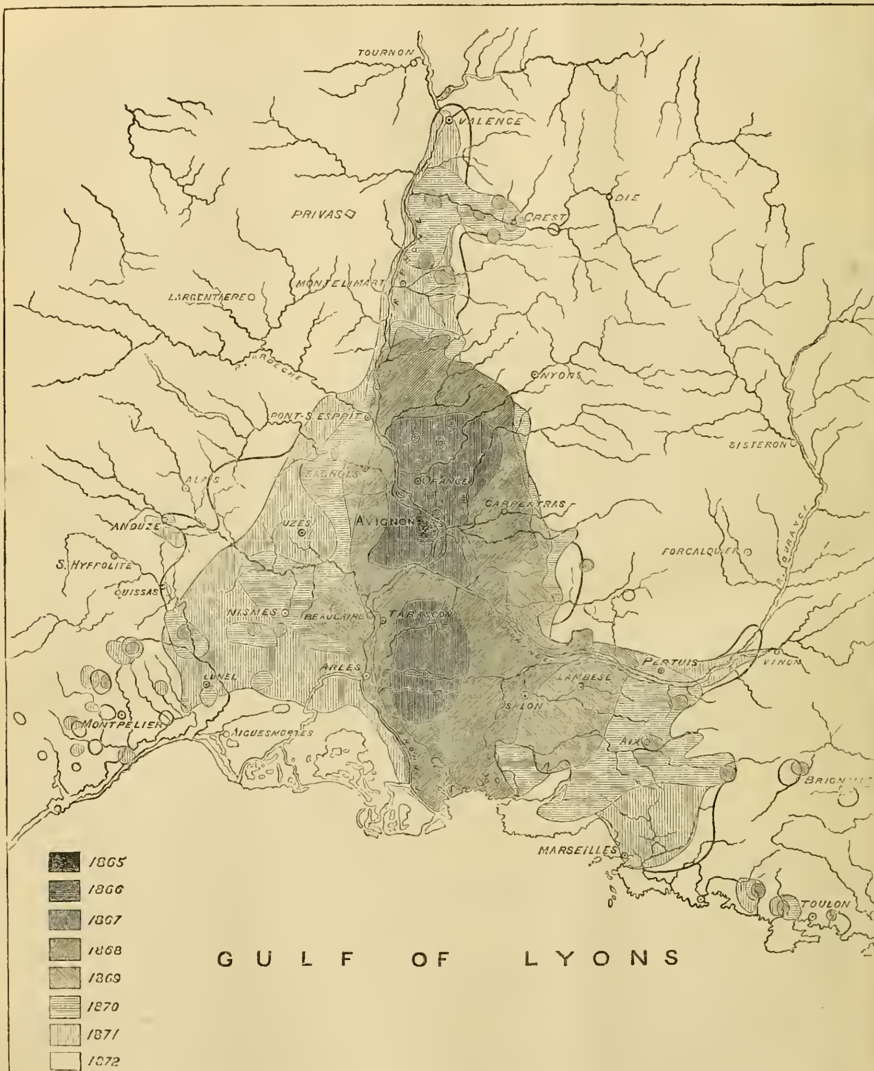
I.

WE have before us the Reports presented to the French Academy of Sciences by the delegates of the Commission appointed by that body to investigate the phenomena of the new and terrible disease of the vine in the south-east of France—a disease which is fraught with the most serious consequences to the material prosperity of that country, which depends on its wine as a source of national wealth not less important than are our coal and iron to us.

It was in the autumn of the year 1871 that the Academy of Sciences directed special attention to the communications which poured in upon it from all quarters relative to the ravages of the new parasite of the vine in the South of France; and at the sitting on the 25th September in that year, it charged a Commission, consisting of M. Dumas as president, MM. Milne-Edwards, Duchartre, and Blanchard, to investigate the means of coping with the disease. The Commission examined with the greatest care all the manuscripts and printed monographs which were brought under its notice, and paid particular attention to the scrutiny of the leaves and the roots attacked by the *Phylloxera vastatrix* (for such is the name which has been given to the new insect), which had been sent to it from different places in France; and, with the object of giving to its labours the active direction necessary in such circumstances, it decided to confide the execution of them to three delegates, viz. MM. Balbiani, Max Cornu, and Duclaux, whose learned researches in zoology, botany, and chemistry, suggested recourse to them, and they were accordingly charged with the pursuit of all the observations which the subject would allow of, on the actually affected territory.

It is worth our while, at the outset, to observe the thorough and methodical manner in which an attempt has been made to wrestle with this new enemy of the material welfare of France, and the application of the resources of science to unravel as exhaustively as possible the causes and manner of extension of the invasion of the parasite from its first appearance till the present time. We in England are too apt in similar crises to neglect the practical employment of scientific means, to depend on private and individual exertions for the investigation and treatment of the different causes which threaten the national wealth or

prosperity; and though in the long run perhaps we come out of the difficulty in a manner not altogether unsatisfactory, still such result can only be obtained at the xpense of interests to which speedy action and promp methodical treatment are the only means of preservation. But in France and in most of the continental countries of



Map showing the spread of *Phylloxera* from 1865 to 1872.

Europe, the State, or at least important corporate bodies, come quickly to the aid of science, which, thus subsidised and encouraged, can penetrate far deeper and can have a freer play for its researches. As a result, in the present case we have the studies of men of science on this subject of altogether national importance, studies which, if we mistake not, should go far to direct the efforts of the nation into the right course of treatment for the extirpa-

tion of this alarming scourge, which has destroyed the produce of so many of the fairest vineyards of the south-east of France.

It is a matter of no difficulty to master the history of the new disease produced by the *Phylloxera*, and to trace its growth from the earliest beginnings. The first definite signs of the invasion of the parasite were observed in the year 1865, at a spot (plainly marked in the maps annexed to the report of M. Duclaux, and now copied for our readers) on the plateau of Pujaut, near Roquemaure, in the neighbourhood of Avignon, and in the department of the Gard, on the west bank of the river Rhône. Though in this year it attracted but little attention, in 1866 it descended rapidly from the plateau to the outskirts of the village of Roquemaure, and also appeared in several spots in the departments of Vaucluse and the Bouches du Rhône, both lying on the east side of the river-valley. It was the owner of a vineyard in this latter department, a M. Delorme, of Arles, who was the first to recognise the disease, while still in the birth, as a new disease, and to have the presentiment of the disasters which would follow in its train. At a later period a commission of the Society of Agriculture of the Hérault visited by request the vineyards around Saint-Rémy, and a member of that commission, M. Planchon, discovered that the cause of the vine-disease was an insect "destined to be the subject of so much discussion, and to become the source of so much misery." It was he who afterwards gave the parasite the name which it has since borne everywhere—*Phylloxera vastatrix*.

Before proceeding to describe the ravages of the insect and the manner in which it ultimately causes the death of the vine, it will be well to show the progressive extension of the disease itself over the country adjacent to the Rhône valley and lying inland to the north of the Gulf of Lyons. M. Duclaux has shown us, in his series of maps annexed to his report, the progress of the disease between the years 1865 and 1872, and marks it as gradually extending from the little spot first attacked in the neighbourhood of Avignon till in the last of those years it included the whole country between Valence on the north and Marseilles on the south, while westwards and eastwards it extended to Montpellier and Aix respectively, thus covering, roughly speaking, nearly four departments, viz., the Gard, the Drome, Vaucluse, and Bouches du Rhône. We are told in the memoir of M. Louis Faucon, also presented to the Academy of Sciences, and embracing a later period than that of M. Duclaux, that the disease extended to an alarming degree in the year 1873, at the same or a greater progressive rate, and had established itself in that year in no less than twelve departments of South-east France, having spread into the Ardèche, the Basses-Alpes, Var, Isère, Hérault, and even reaching so far as the Gironde and the two Charentes.

We may gain a more precise idea than can be afforded by a mere observation of the geographical extension of the disease, of the disastrous nature of the ravages of the *Phylloxera*, by the examination of some of the statistics of the grape-crop in successive years in some of the departments attacked. Thus, in the department of Vaucluse, where the disease showed itself in 1866, there were in 1869, according to the results obtained by the departmental commission instituted at Avignon to observe on the new vine-disease, 6,000 hectares absolutely dead or dying, and a much larger number already attacked, which have since succumbed to the parasite. Out of the 30,000 hectares of vineyard comprised in this department, 25,000, or five-sixths of the total area, have been destroyed. In the Gard, where the vine flourishes better than in the above-mentioned department, the ravages of the disease are yet most terrible, for in 1871, in the arrondissement of Uzès, but one-half of the average crop was produced, and in the arrondissement of Nismes, a tenth part of the crop was destroyed. These proportions, moreover, have increased since that year.

If we examine the mischief done in the less extended areas of the communes, we shall obtain a still clearer idea of the rapid spread of the disease :—

COMMUNE OF GRAVESON.

1865-66-67	mean crop	10,000	hectolitres
1868	"	5,500	"
1869	"	2,200	"
1870	"	400	"
1871	"	250	"
1872	"	100	"
1873	"	50	"

In the commune of Maillanne the crop in 1868 was only 40 per cent. of the average of the three preceding years, while in 1869 it was only 10 per cent. In the commune of Eyragues the crop in 1868 was about 33 per cent. of the average of the three preceding years, and in 1869 there was a further falling off of about 10 per cent. In 1870 the crop in the three above-named communes was almost entirely destroyed. From instances such as these, fairly selected from many others equally tragic in their stern figures, we may form some idea of the magnitude of the disaster. Indeed, it is difficult to see, so rapid is the extension of the disease, how, unless some potent and effective remedy can be soon applied, any vine-bearing district in France can escape the visitation of the *Phylloxera*.

Though there can be no doubt that the *Phylloxera* is the cause of the new vine-disease, this conviction was by no means arrived at at once, nor without considerable doubts being thrown upon it by those whose better judgment was obscured by the confusion of concomitant phenomena such as drought, cold, and impoverishment of the soil with the real source of malady of which they were the companions. Others, even now, hold that the *Phylloxera* is the effect and not the cause of the disease; this idea M. Faucon dissipates satisfactorily in his treatise by the following reasoning :—A vine is watched which is in a perfect state of health and vigour; not a single parasite is discovered in the ramifications of its roots. A day comes when the destructive insect invades it—it resists for some time; the *Phylloxera* lays its eggs, multiplies its numbers, and with them its attacks. The stem of the vine begins to show signs of the disease, and if the roots are laid bare, they may be observed to have deteriorated in some degree from their normal state. The multiplication of the insect continues, and assumes such proportions as to form yellow spots of no small size, the result of the close collection of a large number of the insects, whose puncturings are so numerous and so incessant that the roots can no longer perform their proper function, the nutrition of the plant, which, in consequence, falls into a most evident state of sickliness, lingers on for some time, and eventually dies. The *Phylloxera* takes its first food where it can get it with the least difficulty. After it has exhausted the surface rootlets, tender and succulent as they are, it attacks others deeper down; then it spreads over the hardier roots, till at last the prodigious increase of its family causes it to overrun the whole radical system of the plant, and even the part of the stock of the vine which is underground. It abandons the exhausted plant when it is of no more use to it, and its instinct turns its steps towards a new vine, where it can find fresh food. The work of destruction in a vine, especially if it be vigorous and the soil nutritious, is not completed in a few days. A year may pass without the vine exhibiting any marked sign of sickness. The store of vigour which it contains in itself, added to that which it imbibes for some time after it is attacked in the soil, will permit it during one or even two seasons to perform the double functions of nourishing both itself and the parasite which eventually destroys it. M.

Faucon's observations, confirmed by those of all the other persons who have made positive investigations for themselves, have established that—

1. The number of insects on a plant is in direct and constant accordance with the state of the roots.

2. According as the state of the roots is healthier, is the number of insects greater.

3. The number diminishes in proportion to the exhaustion and consequent death of the roots.

4. On an absolutely dead plant it is impossible to discover a single insect. Surely, therefore, the *Phylloxera* is the cause, and the only cause, of the vine-disease, since its appearance invariably precedes the rotting of the roots, and never follows on their decay.

We postpone till next week the description of the *Phylloxera* itself and the manner in which it attacks and ultimately kills the vine, together with the mention of the various means which have been proposed for the extirpation of the disease.

(*To be continued.*)

*PHYSICS AT THE UNIVERSITY OF LONDON**

AT the present time, when the bulk of the educated population of many countries may be divided into the three classes of *Examinandi*, *Examinati*, and *Examinatores*, a large part of any discussion of what is called the higher education must inevitably be devoted to the question of examinations. Usually, if the matter is discussed from the point of view of those whose business it is to teach, the result is the condemnation of examinations in general as unfavourable to all thorough study; and, from whatever quarter the discussion proceeds, it seems to be taken for granted that the functions of the teacher and those of the examiner are naturally opposed to each other. And indeed no one who has given any attention to the question can doubt but that such an opposition really does exist in very many cases. Originally employed by teachers themselves to consolidate and test the results of their instruction, examinations were at first a natural part of the educational system; but of late years they have rapidly developed into an independent species, which has separated off from the parent organism and now too often tyrannises over it. As of other developments, so of this, we are bound to believe that it is an adaptation to co-existing conditions, and therefore fulfils some useful purposes; but, from the teacher's point of view, as soon as examinations become detached from instruction, and come to be the end of learning instead of a means of teaching, the evils they produce are much more apparent than these benefits. When they have no worse result, they are apt to be viewed by students as affording them an authoritative standard, independent of the judgment of their professors, by which to decide what subjects of study and what parts of these subjects are of sufficient importance to be worthy of their attention. It is therefore not to be wondered at that such examinations should be looked upon by teachers with dislike, as being hindrances and not helps to their work, or that we should hear frequent protests against their excessive multiplication.

While, however, I in general heartily sympathise with such protests, and feel strongly that the difficulty of honest and thorough teaching in my own subject is greatly increased by the regulations for those examinations which, in fairness to the students attending my lectures, I am bound not to lose sight of, it does not seem to me that the remedy for the evils complained of is to be looked for in the abolition of the present examination system. This system is no doubt defective in many ways, and we may perhaps hope that some day it will be replaced by one more accordant with sound educational principles; for the present, however, it exists, and must be recognised as one of the conditions under which our work has to be done. Practical wisdom therefore teaches that instead of trying to get rid of it, we should strive as far as possible to improve it, to lessen its faults, and to develop whatever good it may be susceptible of.

It is admitted on all hands that examinations carried on in direct connection with teaching are of great educational value, of so much value indeed that no careful teacher ever thinks of doing without them. What, therefore, in the interests of sound education, we ought to strive for, in relation to those examinations which are not connected with any system of instruction, is that they should be made, as nearly as possible, what they would be if they did form part of such a system. It is perhaps too much to expect that this should be taken as the leading principle in the case of examinations such as those, now so common in connection with various branches of the public service, which exist for the primary object, not of promoting education, but of preventing dolts and dunces from being supported at the public expense; but, besides these, there are many examinations nowadays, which, though unconnected with teaching, are professedly intended for the advancement of education. Among such examinations, those of the University of London are on many accounts the most important, and the intimate relation between them and much of our work in this College seems to me to be a sufficient reason for considering how far the influence which, through this relation, they exert upon our teaching, is beneficial or otherwise.

If any further justification be needed for discussing the educational tendency of the examinations of the University of London, beyond the general one arising from the paramount importance of the improvement of education, it may be found in the history of the University. It is doubtless known to many of my audience that the University of London was constituted, in most essential respects as it now exists, by a Royal Charter dated December 5, 1837, in order, "for the advancement of religion and morality, and the promotion of useful knowledge, to hold forth to all classes and denominations of [her Majesty's] faithful subjects, without any distinction whatsoever, an encouragement for pursuing a regular and liberal course of education." The form which this encouragement was to take was that of "ascertaining, by means of examination, the persons who have acquired proficiency in Literature, Science, and Art, by the pursuit of such course of education, and of rewarding them by Academical Degrees, as evidence of their respective attainments, and marks of honour proportioned thereto;" and it was directed that all persons should be admitted as candidates for degrees in Arts and Laws, who should produce certificates of having completed the course of instruction prescribed by the University either in *this* College or in King's College, London, or in any other such institution as might be authorised by the Crown to issue such certificates. But in 1858, the Senate of the University obtained a new charter by which they were empowered to admit candidates to the examinations for degrees in Arts, Laws, Science, and Music without requiring them to have previously pursued any prescribed course of study, or to have attended any particular place of instruction; and since that time no other qualification has been demanded of graduates of the University of London (with the exception of those who have taken degrees in Medicine) than the ability to pass the appointed examinations. I do not now propose to discuss the question whether the passing of an examination only affords as good ground for conferring academical distinction as the passing of the same examination combined with studentship at some recognised college or other educational institution; my object at present is

* Introductory Lecture delivered at the opening of the Session of the Faculties of Arts and Laws and of Science, in University College, London, on Monday, Oct. 5, 1874, by G. Carey Foster, F.R.S., Professor of Physics.

simply to draw attention to the fact that the University of London, created in order to encourage the pursuit of "a regular and liberal course of education," no longer requires candidates for degrees in Arts or in Science to pass through any collegiate course, but considers that she sufficiently fulfils her mission by devising and carrying out into practice a system of examinations. It appears to me that this fact justifies all who are interested in the progress of sound education in demanding that these examinations should be so arranged as to encourage to the utmost possible extent thorough study and conscientious teaching.

The present Regulations of the University do not in all cases seem to me to fulfil this condition as completely as they might do, and I therefore think that I may suitably make use of this opportunity for trying to point out their defects as definitely as I can, and for attempting, if possible, to suggest improvements. I need hardly say, however, that whatever criticisms or suggestions I may venture to make will refer almost exclusively to the Regulations affecting that branch of science, namely Physics, with which I am specially connected. I believe, nevertheless, that the general principles which it is of greatest importance to keep in view in framing an examination in any department of knowledge are very nearly the same, and therefore I venture to hope that if the reflections which my experience of the London University examinations, both as an Examiner and as a Teacher, has suggested to me, are of any value in relation to my own subject, they may not be quite worthless in relation to others.

In order to apply to the case of Physics the general principle that examinations and direct teaching ought to be only different ways of attaining the same object, it is needful to consider first of all what reasons there may be for including the study of Physics in "a regular and liberal course of education," and what ought therefore to be the aim of teacher and examiner alike. With regard to this point, it will probably be admitted that the educational value of the study of Physics depends upon the mental discipline which it ensures, and not upon the individual facts, or even on the general laws, with which it stores the memory. It follows from the nature of the phenomena with which this science deals, that, to a much greater extent than has hitherto been the case with the phenomena of any other branch of science, the exact conditions of their occurrence have been ascertained, and the relations which they bear to one another have been expressed by definite numerical laws. In consequence of the precision which it is hence possible to give not only to statements respecting individual physical phenomena, but also to statements involving general laws, the reasoning by which the conclusions of Physics are established assumes a stricter character than can be attained in any other branch of natural science. It may be confidently asserted that, for training the mind in habits of accurate thinking, no other study can be compared with that of Physics if properly pursued; for, while it affords abundant practice in deductive reasoning of mathematical strictness, it obliges us to give no less attention to the converse process of inferring general laws from particular concrete phenomena and the direct impressions which they make on our senses. It is this combination of deductive with inductive reasoning which constitutes the special value of the study of Physics for the purposes of mental discipline. It is quite true that the deductive processes of Physics are borrowed from Mathematics, and that it shares the inductive method with all the other branches of natural science; but the greater definiteness of physical phenomena, as compared with those of other sciences, not only, as I have already said, leads to a greater definiteness in our general conclusions respecting them, but, as a further consequence, makes it easier to test the truth or falsehood of their conclusions by comparing the results deductively derived from them with the results of new experiments or observations. It may even, indeed, be thought that the comparative definiteness and precision of the problems with which the science of Physics is concerned render the study of it less serviceable, as a preparation for dealing with the complex questions which arise in the common experience of life, than the study of sciences in which the uncertainty and indefiniteness of the data leave a greater scope for the exercise of a judicious tact in the estimation of probabilities; but to maintain such an opinion would be very much like saying that in order to become familiar with the laws of chemical action and the nature of chemical combination, we ought to study the transformations of albumen and chlorophyll rather than the properties of such things as potassium, oxygen, or sulphuric acid. It is of course because physical phenomena are simpler and more accessible to investigation than those of Chemistry or Biology, that greater progress has been made in the study of them, and that the explanations that have been reached are of a higher degree of certainty and generality; but it is precisely the relatively advanced stage which has been reached by it that gives to the study of Physics its high value as an element in general education, and is the reason why it furnishes us with fuller and more instructive examples of scientific reasoning than other sciences.

The nature of the intellectual benefits that have been pointed out as resulting from this study, suggests at once the conditions that must be fulfilled in order to obtain them. If in studying Physics we really undergo, as I have said, a process of training to think correctly, this can only be through the exercise of our minds in following the demonstrably correct trains of thought whereby the general conclusions of Physics have been derived from the observed facts, and through our becoming so familiar with them that, consciously or unconsciously, we take them for our models, whatever may be the subjects to which we require to direct our minds. It follows from this that these benefits do not depend upon the direct results of experiment or observation with which the study makes us acquainted, nor upon the general laws of nature which it reveals to us, but upon the reasoning processes whereby facts and laws are connected together and both are made part of the living body of science. And from this again we see that the kind of teaching and study to be aimed at is that which enables us to trace these processes step by step and to understand their validity; while the kind to be anxiously avoided is that which stores the memory with detached pieces of information, either in the form of facts whose mutual relations are not perceived, or in the form of theoretical conclusions hung up between heaven and earth, and supported neither by revelation from above nor by demonstration from below. This latter, however, is the kind of teaching so much in demand and so frequently offered, which is known by the name of "cramming."

By way of guarding against misconception, it may be well to point out—what, however, is exceedingly obvious—that there can be no reasoning about Physics until the facts of Physics are known, and therefore that the teaching of these facts must always occupy an important place as the indispensable groundwork of all that is to follow. But still it must be remembered that, so long as we are considering the study of Physics merely as a part of general education, the facts of the science are of importance only in relation to the reasoning that is based upon them. Taken by itself, one bit of information is of about as little use in developing the mental powers as any other; it does us about as much good to be told that "heat is a mode of motion" as that "the Government of England is a limited monarchy," and to know the difference between a thermometer and a barometer enlarges the mind to about the same extent as to know how to distinguish a pitchfork from a Dutch hoe.

We may now return to consider the effect of the examinations of the University of London upon the teaching of Physics. These examinations, as we have seen, exist for the express purpose of encouraging the pursuit of "a regular and liberal course of education," or, as it may be otherwise expressed, in order to encourage good teaching and to discourage bad; and in the foregoing remarks I have tried to show as definitely as I can what meaning is to be attached to the words "good" and "bad" in relation to the teaching of Physics. The obvious conclusion, applicable to the particular point to which I now wish to ask your attention, is that examinations are to be regarded as *good* if they induce candidates to *think* about the mutual relations of individual facts and their connection with general principles; while examinations are *bad* in proportion as they lead to the loading of the memory with unconnected scraps of knowledge.

There are two ways in which the examinations of the University of London tend to affect the quality of teaching for good or for evil: first, by the general Regulations drawn up by the Senate in reference to the various examinations, including the list of subjects to be taken up and the specifications of the requirements in each subject; and secondly, the questions set by the Examiners, which form as it were a detailed commentary, authorised by the Senate, on the meaning of their own Regulations. For various reasons, the lowest examinations, or those which come earliest in the University scheme, produce the greatest effect on methods of teaching and learning; for one thing, they affect the greatest number of candidates, and they come at a part of the candidates' career when they are most dependent on external authority or advice as to the course of their studies.

THE BIBLIOGRAPHY OF SCIENCE

THERE can be no surer indication of the universal spread of science during the last few years than the large and annually increasing number of works relating to its various branches that are advertised for publication during each successive season. The considerable element which science now forms in education, in the arts and manufactures, in commerce and agriculture, and in the social economy of life, renders the knowledge of at least its rudiments absolutely necessary in almost every sphere of existence. The particulars given below will show that publishers are fully alive to the importance and value of good works in this department of literature.

Although even now we have a large quantity of educational books of varying degrees of mediocrity and excellence in almost all the commoner branches of science, and the number of works is ever increasing, yet the advance made by science makes it imperative that fresh manuals and class-books and new editions should be continually published, in order that students and workers should be enabled to keep pace with its rapid strides. The works we notice beneath range from the smallest general primer to the most elaborated and matured works in particular and specific branches of science; and among them will be found books by men of the highest reputation in their special provinces. We have endeavoured to notice every work of importance which is to be published during the next few months; but our list is necessarily incomplete; we shall, however, in future numbers note any deficiencies, omissions, or fresh announcements.

In ASTRONOMY we observe the following books:—*The Moon*, and the Condition and Configuration of its Surface, by Edmund Neison, Fellow of the Royal Astronomical Society, &c., illustrated by maps and plates. (Longmans.)—*A Primer of Astronomy*, by J. Norman Lockyer, F.R.S., with illustrations. (Macmillan.)—A new edition of *Navigation and Nautical Astronomy*, in theory and practice, by Prof. J. R. Young. (Lockwood.)—*The Transits of Venus*, a Popular Account of Past and Coming Transits, from the first observed by Horrocks, A.D. 1639, to the Transit of A.D. 2112, by Richard Anthony Proctor, B.A. Cantab., Hon. Fell. King's Coll. Lond., with twenty plates and numerous woodcut illustrations. (Longmans.)

In CHEMISTRY we are promised a new edition of *Dr. Normandy's Commercial Handbook of Chemical Analysis*, enlarged and almost re-written by Dr. H. M. Noad, Ph.D., F.R.S. &c., with numerous illustrations. (Lockwood).—A second edition of *Plattner's Manual of Qualitative and Quantitative Analysis with the Blowpipe*, from the last German edition, revised and enlarged by Prof. Th. Richter, of the Royal Saxon Mining Academy, translated by Prof. H. B. Cornwall, Assistant in the Columbia School of Mines, New York; this work is illustrated with eighty-seven woodcuts and one lithographic plate. (Sampson Low.)—*Industrial Chemistry*, a Manual for Manufacturers and for use in Colleges or Technical Schools, being a translation by Dr. J. D. Barry, of Professors Stohmann and Engler's German edition of Payen's "Précis de Chimie Industrielle;" edited throughout and supplemented with chapters on the Chemistry of the Metals, by B. H. Paul, Ph.D., with very numerous plates and woodcuts. (Longmans.)—A third enlarged edition of *A Systematic Handbook of Volumetric Analysis*, or the Quantitative Estimation of Chemical Substances by Measure, applied to Liquids, Solids, and Gases, with numerous engravings, by Francis Sutton, F.C.S., Norwich. (Churchill.)—*The Chemical Effects of Light and Photography, in their Application to Art, Science, and Industry*, by Dr. Hermann Vogel. (King and Co.)—A new edition, revised and enlarged, of *Practical Metallurgy*, by John Percy, M.D., F.R.S., Lecturer on Metallurgy at the Government School of Mines. Vol. I., Part 1. Introduction; Fuel, wood, peat, coal, charcoal, coke, refractory materials, fire-clays, &c. Vol. I., Part 2. Copper, zinc, brass. (John Murray.)

In PHYSICS and MECHANICS, Messrs. Longmans will publish the three following books:—*The Elements of Physics*, by Neil Arnott, M.D., F.R.S., the seventh edition, revised from the author's notes and other sources, and edited by Alexander Bain, LL.D., Professor of Logic in the University of Aberdeen, and by Alfred Swaine Taylor, M.D., F.R.S., Professor of Medical Jurisprudence, Guy's Hospital.—*Introduction to Experimental Physics, Theoretical and Practical*, including directions for constructing physical apparatus and for making experiments, by Adolf F. Weinhold, Professor in the Royal Technical School at Chemnitz, translated and edited (with the author's sanction) by Benjamin Loewy, F.R.A.S, with a preface by G. C. Foster, F.R.S., Professor of Physics in University College, London, with numerous wood engravings.—*Lessons in Elementary Mechanics*, introductory to the Study of Physical Science, by Philip Magnus, B.Sc., B.A. This book is adapted to the requirements of the London Matriculation, Preliminary, Scientific, First M.B., and other Examinations.

Messrs. Charles Griffin will issue *A Mechanical Text-Book*, a Practical and Simple Introduction to the Study of Mechanics, by William John Macquorn Rankine, C.E., LL.D., F.R.SS., &c., late Regius Professor of Civil Engineering in the University of Glasgow; and Edward Fisher Bamber, C.E.

In BIOLOGY we have a large number of new books and new editions, of which the following are the most noteworthy:—*The History of Creation*, by Prof. Ernst Haeckel, the translation revised by E. Ray Lankester, M.A. (King and Co.)—*Elements of Human Physiology*, by Dr. L. Hermann, Professor of Physiology in the University of Zurich, translated and edited from the sixth (yet unpublished) German edition, at the author's request, by Arthur Gamgee, M.D., F.R.S., Brackenbury

Professor of Practical Physiology and Histology in the Owens College, Manchester. (Smith, Elder, and Co.)—*Outlines of Animal Physiology*, with engravings on wood, by W. H. Allchin, M.B., M.R.C.P., Assistant Physician to the Westminster Hospital and Lecturer on Practical Physiology, Histology, and Pathology in its Medical School. (Churchill.)—*Notes of Demonstrations on Physiological Chemistry*, by S. W. Moore, F.C.S., Joint Demonstrator of Practical Physiology at St. George's Medical School. (Smith, Elder, and Co.) This work is nearly ready for publication.—The same publishers announce *The Pathological Anatomy of the Nervous Centres*, by Edward Long Fox, M.D., F.R.C.P., Physician to the Bristol Royal Infirmary, with illustrations; and a *Text-Book of Pathological Anatomy*, by John Wyllie, M.D., F.R.C.P.E., Lecturer on General Pathology at the School of Medicine, Surgeons' Hall, Edinburgh, &c.

We are glad to see that Messrs. Churchill have in the press a fifth and revised edition of Holden's well-known work on *Human Osteology*, comprising a Description of the Bones, with Delineations of the Attachments of the Muscles, &c.—The three following new works also belong to the same publishers:—*Frey's Manual of the Histology and Histo-Chemistry of Man*, a Treatise on the Elements of Structure and Composition of the Human Body, for the use of Practitioners and Students, largely illustrated with engravings on wood, translated by Arthur E. J. Barker, L.R.C.S.I., and revised by the author.—*The Student's Guide to Human Osteology*, with numerous lithographic plates, by William Warwick Wagstaffe, F.R.C.S., Assistant Surgeon and Lecturer on Anatomy at St. Thomas's Hospital.—*The Student's Guide to Practical Histology, Histo-Chemistry, and Embryology*, with engravings on wood; by H. A. Reeves, F.R.C.S. Edin., Assistant Surgeon and Demonstrator of Anatomy at the London Hospital.

The only other book we notice in this branch of science is a new edition of *Demonstrations of Anatomy*, being a Guide to the Knowledge of the Human Body by Dissection, by George Viner Ellis, Professor of Anatomy in University College, London, with 248 engravings on wood. The number of illustrations has been largely added to in this edition, and many of the new woodcuts are reduced copies of the plates in the author's work, "Illustrations of Dissections." (Smith, Elder, and Co.)

In GEOGRAPHY and TRAVELS, probably the works most looked for are *The Last Journals of Dr. Livingstone, in Eastern Africa, from* 1865 *to his Death*, continued by a narrative of his last moments and sufferings, taken down from the mouth of his faithful servants Chuma and Susi, edited by Rev. Horace Waller, F.R.G.S., Rector of Twywell, Northampton, with a map prepared on the spot by the author, and illustrations from his sketches. (Murray); and Sir Samuel Baker's new book, which is entitled *Ismailia*, a Narrative of the Expedition to Central Africa for the Suppression of the Slave Trade, organised by Ismail, Khedive of Egypt, with maps, portraits, and upwards of fifty full-page illustrations by Zwecker and Durand (Macmillan.)

Messrs. Sampson Low, as usual, are to the fore in books of travels. We give the titles and some particulars of seven of them:—*Turkistan*, Notes of a Journey in the Russian Provinces of Central Asia and the Khanates of Bokhara and Kokand, by Eugene Schuyler, Secretary of American Legation, St. Petersburg. This book will be profusely illustrated.—*The Straits of Malacca, Indo-China, and China*, or Ten Years' Travels, Adventures, and Residence Abroad, with upwards of sixty woodcuts from the author's own photographs and sketches, by J. Thompson, F.R.G.S., author of "Illustrations of China and its People." This work contains a narrative of the writer's personal experience and adventures in the Straits of Malacca, Siam, Cambodia, Cochin-china, and China, illustrated with over sixty wood engravings from the author's sketches and photographs. A long residence in the Straits of Malacca enabled the author to visit some of the native states, and to give an account of our important colonial possessions in that quarter of the globe, as also of his personal intercourse with the native Malay rulers, and his estimate of the value of the Chinaman and of Chinese labour in a tropical region.—*The Second North German Polar Expedition in the years* 1869—70, of the ships *Germania* and *Hansa*, under command of Capt. Koldeway, edited and condensed by H. W. Bates, Esq., of the Royal Geographical Society, and translated by Louis Mercier, M.A. (Oxon.) The narrative portion of this important work will be full of interest and adventure in the ice-fields; and, in addition to much matter of great scientific value, will give a graphic account of the hardships and sufferings of the crew of the *Hansa* after the crushing of that ship in the ice.—*Warburton's Journey across Australia*, an account of the Exploring Expedition sent out by Messrs. Elder and Hughes, under the command of Colonel Egerton Warburton, giving a full account of his perilous journey from the centre to Roebourne, Western Australia, with illustrations and a map, edited, with an Introductory Chapter, by H. W. Bates, Esq., of the Royal Geographical Society.—*Captain Tyson's Arctic Adventures;* Arctic Experiences, containing Captain George E. Tyson's Wonderful Drift on the Ice-Floe, a history of the *Polaris* Expedition, the cruise of the *Tigress*, and Rescue of the *Polaris* Survivors, to which is added a General Arctic Chronology, edited by E. Vale Blake, with a map and numerous illustrations.—*The Marvellous Country*, or Three Years in Arizona and New Mexico, by Samuel W. Cozzens, illustrated.—*The Earth as Modified by Human Action*, by George P. Marsh, being a new edition of "Man and Nature."

Mr. Murray announces *Six Months among the Palm Groves, Coral Reefs, and Volcanoes of the Sandwich Islands*, by Isabella Bird, author of "The Englishwoman in America," with illustrations.

Messrs. Trübner have nearly ready *A Peep at Mexico*, Narrative of a Journey across the Republic from the Pacific to the Gulf, in December 1873, and January 1874, by J. L. Geiger, F.R.G.S, with four maps and forty-five original photographs.

In MEDICINE, &c., the announcements are very numerous; we give the more important. Messrs. Longmans have in the press *A Dictionary of Medicine*, edited by Richard Quain, M.D., F.R.S., assisted by numerous eminent writers.

Messrs. Charles Griffin will publish very shortly *Outlines of the Science and Practice of Medicine*, a Handbook for Students, by William Aitken, M.D., F.R.S.

From Messrs. Churchill we receive notice of the following forthcoming books among a long list of others, viz.:—*Air, Water, and Sewage*, a Manual of Analysis for Medical Officers of Health, &c., by Francis Sutton, F.G.S., and William Thorp, B.Sc., F.C.S.—*A Handy-Book of Forensic Medicine and Toxicology*, with numerous wood engravings, by W. Bathurst Woodman, M.D. St. And., Assistant Physician and Lecturer on Physiology at the London Hospital, &c., and C. Meymott Tidy, M.A., M.B., Medical Officer of Health and Food Analyst for Islington.—*Experimental Investigation of the Action of Medicines*, a Handbook of Practical Pharmacology, with engravings, by T. Lauder Brunton, M.D., D.Sc., Lecturer on Materia Medica in the Medical College of St. Bartholomew's Hospital.—*The Diseases of Tropical Climates and their Treatment*, with Hints for the Preservation of Health in the Tropics, by J. A. B. Horton, M.D. Edin., F.R.G.S., Staff-Assistant-Surgeon of the Army Medical Department.—*The Face, Mouth, and Throat*, the Surgical Treatment of their Diseases, Injuries, and Deformities, with engravings on wood, by Francis Mason, F.R.C.S., Senior Assistant Sur-

geon and Lecturer on Anatomy at St. Thomas's Hospital.—*The Student's Guide to the Diseases of the Eye*, with engravings, by Henry Power, M.B., F.R.C.S., Senior Ophthalmic Surgeon to St. Bartholomew's Hospital.—*Report on the Issue of a Spirit Ration during the March to Coomassie*, by E. A. Parkes, M.D., F.R.S., Member of the General Medical Council.—*The Student's Guide to the Practice of Midwifery*, with engravings, by D. Lloyd Roberts, M.D., Vice-President of the Obstetrical Society of London, Physician to St. Mary's Hospital, Manchester.—*Clinical Studies of Disease in Children*, by Eustace Smith, M.D., F.R.C.P., Physician to the King of the Belgians, Physician to the East London Hospital for Children.

Messrs. Charles Griffin have nearly ready *A Dictionary of Hygiene and Public Health* (with illustrations), comprising Sanitary Chemistry, Engineering, and Legislation, the Dietetic Value of Foods, and the Detection of Adulterations, based on the "Dictionnaire d'Hygiène Publique" of Prof. Ambroise Tardieu, by Alexander Wynter Blyth, M.R.C.S., L.S.A., A.R.C., Medical Officer of Health, and Analyst to the County of Devon.

Messrs. Smith, Elder, and Co. also promise us a work *On the Curative Effects of Baths and Waters*, being a Handbook to the Spas of Europe, by Dr. J. Braun, with a Sketch on the Balneotherapeutic and Climatic Treatment of Pulmonary Consumption, by Dr. L. Rohden, an abridged translation from the third German edition, with Notes, by Hermann Weber, M.D., F.R.C.P., London Physician to the German Hospital.

The following BOTANICAL BOOKS are advertised as coming out this season:—*Medicinal Plants*, by Robert Bentley, F.L.S., Professor of Botany in King's College, London, and Henry Trimen, M.B., F.L.S., of the British Museum, and Lecturer on Botany at St. Mary's Hospital Medical School. This work will include full botanical descriptions and an account of the properties and uses of the principal plants employed in medicine, especial attention being paid to those which are officinal in the British and United States Pharmacopœias. The plants which supply food and substances required by the sick and convalescent will be also included. Each species will be illustrated by a coloured plate drawn from nature. This will be published in monthly parts, and Part I. will be ready very soon (Churchill.)—*Pharmacographia*, a History of the Principal Drugs of Vegetable Origin found in Commerce in Great Britain and British India, by F. A. Flückiger and D. Hanbury, F.R.S. (Macmillan.)—*The Primæval World of Switzerland*, by Prof. Oswald Heer, of the University of Zurich, translated by W. S. Dallas, F.L.S., and edited by James Heywood, M.A, F.R.S., with numerous illustrations. (Longmans.)

In the Sciences of GEOLOGY and MINERALOGY, &c., we are promised *Geology, for Students and General Readers*, embodying the most Recent Theories and Discoveries, by A. H. Green, M.A., Professor of Geology and Mining in the Yorkshire College of Science. Part I. The Elements of Physical Geology, with upwards of 100 illustrations by the author. Part II. The Elements of Stratigraphical Geology, with upwards of 100 illustrations by the author. (Daldy, Isbister, & Co.) The same publishers also have *Geological Climate and Time*, a Theory of Secular Changes of the Earth's Climate, by James Croll, of H.M. Geological Survey; *A Treatise on Mining*, by Lottner and Serlo, of the Berlin Academy of Mining, translated from the German by Prof. Le Neve Foster and Mr. Galloway, with 268 illustrations and diagrams; and *The Creation*, or Dynamical System of the Earth's Formation, in accordance with the Mosaic Record and the latest Discoveries of Science, by Archibald T. Ritchie.—*The Origin of Creation*, or the Science of Matter and Force, a New System of Natural Philosophy, by Thomas Roderick Fraser, M.D., and Andrew Dewar. (Longmans.)—*The Dawn of Life upon the Earth*, by J. W. Dawson, LL.D., F.R.S., F.G.S., Principal and Vice-Chancellor of McGill University, Montreal, with illustrations. (Hodder and Stoughton.)

Finally, among MISCELLANEOUS BOOKS the following will probably interest the majority of our readers:—A new edition is nearly ready of *The Origin of Civilisation and the Primitive Condition of Man*, Mental and Social Condition of Savages, by Sir John Lubbock, Bart., M.P., F.R.S. (Longmans.)—*Outlines of Cosmic Philosophy, based on the Doctrine of Evolution, with Criticisms on the Positive Philosophy*, by John Fiske, M.A., LL.B., formerly Lecturer on Philosophy at Harvard University. (Macmillan.)—*On the Sensations of Tone*, as a Physiological Basis for the Theory of Music, by Prof. H. Helmholtz, translated (with the author's sanction) from the third German edition by Alexander J. Ellis, F.R.S., F.S.A. (Longmans.)—*Out of Doors*, a selection of original articles on Practical Natural History, by the Rev. J. G. Wood, M.A., F.L.S., author of "Homes without Hands," &c., with six illustrations, from original designs engraved on wood by G. Pearson. (Longmans.)—*Insects Abroad*, being a popular account of foreign insects, their structure, habits, and transformations, by the Rev. J. G. Wood, M.A., F.L.S., illustrated with 600 figures by E. A. Smith and J. B. Zwecker. (Longmans.)—*The Aërial World*, by Dr. George Hartwig. (Longmans.)—*Memoir of Sir Roderick Murchison*, including extracts from his journals and letters, with notices of his scientific contemporaries, and a sketch of the rise and progress, for half a century, of Palæozoic Geology in Britain, by Archibald Geikie, LL.D., F.R.S., Murchison Professor of Geology and Mineralogy in the University of Edinburgh, and Director of the Geological Survey of Scotland. (Murray.)—*The Physics and Philosophy of the Senses*, or the Mental and the Physical in their Mutual Relations, by R. S. Wyld, F.R.S.E., illustrated. (King and Co.)—*The Elements of the Psychology of Cognition*, by Robert Jardine, B.D., D.Sc., Principal of the General Assembly College, Calcutta. (Macmillan.)—*On Parasites in the Animal Kingdom*, by M. Van Beneden. (King and Co.)—*The Doctrine of Descent and Darwinism*, by Prof. Oscar Schmidt. (King and Co.)—*Optics*, by Prof. Lommel, profusely illustrated. (King and Co.)—*Fungi*, their Nature, Influences, and Uses, by the Rev. M. J. Berkeley and Dr. M. Cooke, profusely illustrated. (King and Co.)—*Scientific London*, an account of the History and present scope of the principal Scientific Societies and Institutions of London, by Bernard H. Becker. (King and Co.)

THE NEW REPTILE-HOUSE IN THE JARDIN DES PLANTES

THE new house for Reptiles and Batrachians in the Jardin des Plantes at Paris was opened to the public last week. It contains four divisions: two larger central, and two smaller end compartments, all connected by folding doors. The front larger compartment is fitted up in the middle with large shallow tanks for the Crocodilia, of which there are five examples of *Crocodilus vulgaris*, *C. frontatus*, *Alligator mississippiensis*, and two species of *Jacare*. In front is a row of glass cages for Snakes—Boas, Pythons, and various Colubrines. The second larger compartment is devoted chiefly to Batrachians, and contains various Salamanders (*Triton*, &c.), and a large number of Axolotls (*Siredon*). In one tank are the two celebrated specimens of this most abnormal of creatures which have got rid of their external gills and converted themselves into the Salamandroid form, *Amblystoma*. In one of the end compartments are the venomous snakes; in the other, Lacertilia of various kinds.

The cages for the Snakes are fitted up with moss, earth,

and stones, which are certainly prettier and more natural than the gravel and blankets used for the same purpose in our Zoological Gardens. But the difficulty seems to be that the animals conceal themselves and are not easily extracted from their hiding-places, whereas a blanket is readily unfolded when the occasion requires, and is more easily kept clean and tidy.

There can be no question of the great improvement of this house as compared with its predecessor, nor of its superiority to the Reptile-house in our Zoological Society's Gardens, so far as concerns space and arrangement. But as regards the extent of the collection, we believe the London Society still holds its own.

NOTES

SEVENTY-FIVE cases of specimens taken by the *Challenger* expedition have been received at the Admiralty from Prof. Wyville Thomson.

THE vessel bearing the French Transit Expedition, under charge of M. Janssen, was caught in the typhoon which swept over Hong Kong on Sept. 23; although the ship appears to have suffered, the *personnel* and apparatus are happily safe. We may state that M. Janssen's wife accompanies him.

FROM the list of the lectures to be delivered during the present term at Oxford, on subjects connected with Natural Science, the want of organisation among the teachers of its different branches is but too apparent. The four biological courses—by Prof. Rolleston (1), Mr. Lankester at Exeter College (2), Mr. Barclay Thompson at Christ Church (3), and Mr. Chapman at Magdalen (4)—are to be on (1) The Comparative Anatomy of Vertebrata, (2) The Structure and Genealogy of Vertebrata, (3) Ichthyic Anatomy, (4) The Anatomy of Vertebrata; so that no provision is made for those who are studying Human Anatomy, nor the Invertebrata. Histology fares hardly any better, for its rapid progress during the last few years has quite overthrown the practical microscopy of ten years ago. The Professor of Experimental Philosophy and Dr. Lee's Reader in Physics are also both to lecture on Electricity.

SIGNOR L. M. D'ALBERTIS, the Italian naturalist, who recently ascended the Arfak Mountains in New Guinea and made so many important discoveries, is now at Genoa preparing for a fresh expedition into the same country, and will leave Europe in about a month's time. On this occasion the traveller will endeavour to penetrate into the southern part of that *terra incognita*, that is into the district adjacent to Torres Straits, where mountain-ranges of considerable altitude are known to exist. Should he succeed in his arduous enterprise, there can be no doubt that he will reap an abundant harvest, as the zoology of this part of New Guinea is absolutely unexplored.

SIGNOR D'ALBERTIS' former companion, the distinguished botanist, Dr. Beccari, is still in the East. His last letters, dated at Macassar in August last, announce his recent return there from an excursion into the south-eastern districts of Celebes. We believe that Dr. Beccari also is preparing for a fresh expedition to New Guinea.

UNDER the sanction of the trustees of the British Museum, the course of twelve lectures on Geology, which the liberal endowment of Dr. Swiney makes *free to the public*, will this year be delivered by Dr. Carpenter, at the Birkbeck Literary and Scientific Institution, Southampton Buildings, Chancery Lane, on Saturday evenings, at half-past seven o'clock, commencing Saturday next. We understand that the main purpose of the course will be to elucidate the past history of the earth by the study of the changes at present in progress; and that the course will include an account of the lecturer's own researches in the deep sea. It will be illustrated by an extensive series of photographs and paintings, exhibited by the oxy-hydrogen lantern.

THE South African correspondent who sent us the Natural History Notes which appeared in NATURE, vol. x. p. 486, is Mr. J. P. Mansell Weale.

IT has been decided to publish, as a yearly volume, a Record of Works on Geology, Mineralogy, and Palæontology, British and Foreign. The first volume will be printed by the middle of 1875, and will contain short abstracts or notices of papers, books, maps, &c., published during the year 1874. It is estimated that this volume will contain from 200 to 300 pages, and that its price will be 10*s*. 6*d*. The gentlemen named below have volunteered to assist in the work, which has already been begun. Those marked * have taken charge of various sections (as sub-editors), and the last has undertaken the post of general editor:—* W. Carruthers, F.R.S. (British Museum); C. E. De Rance, F.G.S. (Geological Survey); R. Etheridge, jun., F.G.S. (Geological Survey of Scotland); D. Forbes, F.R.S.; Prof. Geikie, F.R.S. (director of the Geological Survey of Scotland); * Prof. A. H. Green, F.G.S.; Prof. T. R. Jones, F.R.S.; A. J. Jukes-Browne, F.G.S. (Geological Survey); * G. A. Lebour, F.G.S.; * L. C. Miall (Leeds Museum); E. T. Newton, F.G.S. (Jermyn Street Museum); Dr. H. A. Nicholson, F.G.S.; * F. W. Rudler, F.G.S. (Jermyn Street Museum); E. B. Tawney, F.G.S. (Bristol Museum); * W. Topley, F.G.S. (Geological Survey); Henry Woodward, F.R.S. (British Museum); H. B. Woodward, F.G.S. (Geological Survey); W. Whitaker, F.G.S. (Geological Survey). The work will be greatly helped if Provincial Societies and Field Clubs will forward copies of their publications to the editor. It is hoped, from the low price, that the number of subscribers will be enough to cover the expenses of printing; but should this not be the case, a number of eminent scientific gentlemen have kindly consented to act as guarantors. Names of intending subscribers, and of societies and institutions that will purchase the Record for 1874, will be gladly received by the editor.

MR. WILLIAM DITTMAR, F.R.S.E., Lecturer on Chemistry at Owens College, Manchester, has been appointed Professor of Chemistry at Anderson's University, Glasgow, in the place of Dr. Thorpe, who has been elected Professor of Chemistry at the Yorkshire College of Science.

DR. WILLIAM STIRLING has been appointed assistant to Dr. Rutherford, the newly elected Professor of Physiology in the University of Edinburgh.

DR. JAMES APJOHN has resigned his appointment of Professor of Chemistry in the Medical School of Trinity College, Dublin.

MR. BRYCE M. WRIGHT, the well-known collector of fossils, who for some time past had been far from well, died last week.

A NEW wing has been quite recently added to King's College, London, by means of which considerable improvements have been made in the Physiological Laboratory and the Dissecting Room.

TWO scholarships in Science, of the value of 100*l*. each, have this year been awarded at St. Bartholomew's Hospital; one to Mr. Coates, of Balliol College, Oxford, the other to Mr. Saunders, of Downing College, Cambridge, these gentlemen having been coupled as of equal merit for the first place in the competition.

THE following gentlemen have been elected to the vacant Natural Science Postmasterships in Merton College:—Mr. J. Larden, of Rugby School, and Mr. A. Macdonell, of Aberdeen University. The Delegates of Unattached Students of Oxford University give notice that the Master and Court

of Assistants of the Clothworkers' Company have offered three exhibitions of 50*l*. a year each, tenable for three years, for the encouragement of the study of natural science; the first examination to be held at the beginning of the Hilary Term 1875, at which time one exhibition will be awarded. Gentlemen who shall have matriculated in the present term, or who have not yet matriculated, are eligible for this exhibition.

THE following sonnet on the late Dr. Jeffries Wyman appears in the New York *Nation*, with the initials "J. R. L.":—

"The wisest man could ask no more of Fate
Than to be simple, modest, manly, true,
Safe from the Many, honoured by the Few;
Nothing to court in World, or Church, or State,
But inwardly in secret to be great;
To feel mysterious Nature ever new,
To touch, if not to grasp, her endless clew,
And learn by each discovery how to wait;
To widen knowledge and escape the praise;
Wisely to teach, because more wise to learn;
To toil for Science, not to draw men's gaze,
But for her lore of self-denial stern;
That such a man could spring from our decays
Fans the soul's nobler faith until it burn."

A TELEGRAM from Berlin states that Major von Mechow will shortly start by sailing vessel from Rotterdam to succeed Dr. Lohde, who is in ill health, in the military command of the scientific expedition which left Europe in June 1873, under the leadership of Dr. Gussfeldt, for the exploration of Central Africa. The Berlin African Society will also send out a second expedition under the leadership of Captain von Homeyer, which will leave at the end of December. It will first proceed to Canandge, on the frontier of Angola, and will endeavour to reach the capital of Muata-Jamvo.

THE Austro-Hungarian explorers of the North Pole are preparing a popular edition of their adventures, as well as a scientific narrative.

WE learn from *Iron* that a scheme has been recently devised for supplying London with an inflammable mixture of gases to replace coal. The new gas, termed "pyrogen," consists of a mixture of nitrogen and carbonic oxide, three-fourths by weight consisting of the latter gas. The temperature of combustion of the mixture is stated to be 2,700° C.; and for heating purposes the flame of the burning gas is to be allowed to raise some good radiating substance to incandescence in an ordinary grate. It is justly pointed out that with our present arrangements three-fifths of the available heat of coal are wasted, but, on the other hand, it must not be forgotten that on the proposed plan the force evolved in the oxidation of the carbon (in whatever form it is made use of) to carbonic oxide is likewise wasted. We should prefer, on the whole, to see some feasible plan for utilising the waste heat of coal, as the highly poisonous nature of carbonic oxide would, in the absence of all other objections, be a serious obstacle to its introduction into our dwelling-houses.

AT an influential meeting held at Manchester on Monday, to take measures to secure some permanent memorial of the late Sir William Fairbairn, it was resolved to raise funds for the purpose by public subscription, and "that the permanent memorial of Sir William Fairbairn be in the form of a statue of such a character and to be placed in such a position as may be hereafter determined, and also for a scholarship or some other suitable endowment inconnection with the Owens College." It was understood that the scholarship or endowment should have special reference to the teaching of engineering or pure mechanics.

MR. JOHN HORNE, of the Botanic Garden, Mauritius, who is now on a botanical expedition in the Seychelles, writing to Dr. Hooker, says that he has visited the islands of Silhouette, Praslin, and Félicité, searching them from the sea-shore to the tops of the highest hills, in Silhouette up to 2,200 ft., at which elevation Pitcher-plants abound, hanging in immense clusters over every stone, bush, and tree. Flowers of these Nepenthes were obtained, and arrangements made for procuring a good supply of plants. When these materials come to hand it will be seen whether the Nepenthes of Silhouette is different from the *N. wardii* which grows in Mahè. The tops of these mountains where the Pitchers grow have a perpetual moisture hanging over them, being almost constantly enveloped by mist and rain.

WE have received an excellent little Italian work—price only two francs, notwithstanding its many illustrations. It is entitled "Parasiti Interni degli Animali Domestici," and is a translation of the well-known little English work on the subject, by Dr. Spencer Cobbold, F.R.S. The Italians are very anxious to make themselves acquainted with English scientific works, and this translation by Dr. Tommasi, as well as the admirable translation of Huxley's "Vertebrate Anatomy" by Prof. Giglioli, show their earnestness.

THE fifth volume of the "Annali del Museo Civico di Storia Naturale" of Genoa, just issued, is occupied with an excellent memoir on the Ornithology of Borneo, prepared by Count Tommaso Salvadori, of Turin. The memoir is based on the collections made in Sarawak in 1865 and subsequent years, by the Marquis Giacamo Doria and Dr. Odoardo Beccari, which contained about 800 specimens. All previous authorities on the birds of Borneo have been consulted, and the result is a complete *résumé* of all that is yet known upon the ornithology of this most interesting country, which will be highly acceptable to naturalists.

AT two o'clock P.M. on the 18th inst. a severe shock of earthquake was felt at Malta. There was a heaving motion, accompanied by an explosive noise resembling the bursting of a shell. Eight slight shocks followed later. Several buildings are injured, but no casualties are reported.

A TELEGRAM, dated Bombay, Oct. 17, states that a cyclone in Bengal has caused a total interruption of telegraphic communication with Calcutta. Fifty miles of the line are reported to have been blown down, and a passenger train has been thrown off the rails. No further details of the damage done have yet been received.

THE Council of the Labour Representation League have drawn up a Report founded upon the resolutions adopted by the members at a meeting held some weeks since touching the endowed schools in their relation to technical education. The Report, which deals very fully with the question, and which will shortly be published *in extenso*, recommends a scheme of technical training under four heads, viz.—1. In our elementary board schools. 2. The secondary industrial schools. 3. The higher endowed schools, such as Eton, Harrow, &c. 4. The Science and Art Department at South Kensington. The scheme will be submitted to a general meeting of workmen and others interested in the question, for discussion and approval. The Council of the League express themselves very sanguine as to the beneficial results that would follow the adoption of the scheme. In connection with the subject of technical education we may state that the opening meeting of the members of the Artisans' Institute was held on the 14th inst., in the premises of the institution, Castle Street, St. Martin's Lane. The meeting was addressed by the Rev. H. Solly, Mr. Samuel Morley, M.P., Dr. Carpenter, and others, and the promoters are sanguine of its success in educating and elevating skilled workmen.

ON Monday evening a public meeting was held in the hall of Clanricarde College, Pembridge Square, Bayswater, Dr. J. H. Gladstone, F.R.S., presiding, to establish a popular society in

West London for the advancement of natural history and physical science. There was a very good attendance, chiefly of members of the various London field clubs. A number of ladies have been received as members, and working men are represented on the committee.

According to the *Belgique Horticole*, Dr. Candèzi has invented a small photographic apparatus, which he calls a "scenograph," which consists simply of a stick and of a camera the size of an opera glass. To photograph a plant or other object, it is sufficient to place it in the focus of the scenograph for a minute or two. The negatives, it appears, can be purchased ready prepared.

The opening of the School of Horticulture at Versailles, which was to have taken place on Oct. 1, is postponed till Dec. 1.

Dr. A. Corlieu states, in *La France Médicale* for Sept. 30, that he had occasion to search the registers of the parish of Saint Antoine, preserved in the National Library. It was in the cemetery of the Innocents, in that parish, that the dead bodies from the Hôtel-Dieu were interred; and Dr. Corlieu has ascertained that during the first six months of 1694 the deaths in the hospital amounted to 11,696. In 1873, during the same space of time, the mortality amounted to 770 for 925 beds.

The additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Cynocephalus porcarius*) from South Africa, presented by Mr. J. D. Lloyd; a Ducorps' Cockatoo (*Cacatua ducorpsi*) from the Solomon Islands, presented by Mr. F. J. Dean; two Lions (*Felis leo*) from South Africa; a Malbrouck Monkey (*Cercophithecus cynosurus*) from West Africa; a Sun Bittern (*Eurypyga helias*) from South America, deposited; two European Rollers (*Coracias garrula*), European; a Naked-throated Bell-bird (*Chasmorhynchus nudicollis*) from Bahia; a solitary Tinamou (*Tinamus solitarius*) from Rio de Janeiro, purchased.

SCIENTIFIC SERIALS

The *Quarterly Journal of Microscopic Science* for this month commences with two articles which are of special interest to embryologists, and therefore to biologists generally. The former of these is by Mr. F. M. Balfour, entitled "A Preliminary Account of the Development of the Elasmobranch Fishes;" it occupies about forty pages, and is fully illustrated. The investigations were conducted at the Zoological Station at Naples, which illustrates the value of that institution, and the justifiableness of Dr. Dohrn's enthusiasm. The earliest stages of development are those most minutely described. The points of greatest interest made out are the following:—(1) The epiblast of the blastoderm in that part which corresponds to the caudal extremity of the future embryo, folds round inwards and becomes continuous with the deeper layers; which leads the author to conclude that, as the hypoblastic origin of the alimentary canal is connected with the presence of a food-yolk, and in origin its those animals which develop an "anus of Rusconi" is not so, the former is but an adaptation. (2) The notochord is shown to be developed from the hypoblast, the mesoblast forming a mass on each side of it. This may depend upon the mesoblast, whose lateral columns just referred to, are "split off, so to speak, from the hypoblast," also developing a median independent sheet; or it may be, which unbiassed observation undoubtedly supports, that the notochord is a true hypoblastic structure. The former of these views, as the author remarks, "proves too much," since it is clear that by the same method of reasoning we could prove the mesoblastic origin of any organ derived from the hypoblast and budded off into the mesoblast. If Mr. Balfour's fundamental fact is verified, it will much modify the argument as to the homology of organs as based upon their embryonic origin. (3) The medullary groove is quite flattened out in the cephalic region at the time that the canal is fully formed in the caudal. This paper is well worthy of careful study.—Mr. Ray Lankester writes on the development of the pond snail (*Lymnæus stagnalis*), and on the early stages of other mollusca. He begins by describing the shell-gland, which is situated below the developing shell; he shows its presence in Lamellibranchs, Gasteropods, Pteropods, also in the Brachiopoda and *Loxosoma*. From this the question is asked whether it in any way corresponds to the pen of the Dibranchiate Cephalopoda and the internal shell of *Limax*. Reasons are given in favour of the plug, which is always found to occupy the shell-gland, being developed into the latter; but with regard to the former, the author, from originally holding the opinion that it has a similar origin, now thinks differently for the following reasons:—The pen of *Loligo* must correspond to the guard of the Belemnite, in which the phragmacone is aborted. This guard is only a sheath to the phragmacone, which again corresponds to the whole shell of *Spirula*. The shell of *Spirula* must have been preceded by the shell-gland, therefore the plug of the latter cannot have been the direct origin of the *Loligo* pen. The latter part of the paper discusses the development of the pond-snail in detail.—Mr. E. A. Schäfer describes an ingenious and much-improved microscope warm-stage, in which a mercury valve regulates the gas supply to a small circulating boiler. He remarks that much of the cooling is produced by the proximity of the objective, and suggests that this may be warmed by coiling a tube round it. It has always occurred to us to ask whether the heating of objectives does not injure, for the time being, their optical powers; as they are constructed so as to be achromatic, &c., at the average temperature of the air, and very slight differences must produce material changes in the distance between the lenses and their shape.

Bulletins de la Société d'Anthropologie de Paris, fascicule v. tome 8, 1874.—M. Topinard concludes his paper on the anthropology of Algiers, by drawing attention to the five periods which characterise the anthropological history of the colony, and which are those of the brown-skinned Kabyles; the light-skinned Kabyles; the Numidians, to whom we must refer the greater number of the Berber inscriptions hitherto found; the Romans, Arabs, and Turks; and lastly, the Aryans. M. Topinard is of opinion that in the fair and dark skinned Berbers we have a kindred race with our oldest West-European races, and that therefore, with due regard to locality, we have evidence that European colonies could be made, like those tribes, to flourish in various parts of Algiers. In the meanwhile, however, as General Faidherbe has remarked, it becomes a question of political as well as ethnological importance to investigate and, if possible, arrest the causes which are diminishing the numbers of the native population, whose existence is the more important from their being the best able to bear the climate and cultivate the soil. M. Topinard considers that the mortality among the native races is not to be referred with any special prominence to diseases introduced by Europeans, but is due very much more to a natural scrofulous diathesis antecedent among them, to any imported constitutional taint, while famine, war, and many other causes depending upon political conditions are probably the most important agents in the process.—M. de Mortillet has recalled the attention of the Society to M. l'Abbé Bourgeois' assumed evidence of the existence of man at the base of the Miocene or mean Tertiary, while he presented to them one of the latest of the Abbé's finds of flint implements from the Miocene beds at Thenay, and which in its longitudinal lines showed unmistakable traces of cutting. The speaker pointed out that since the foundation of the calcareous beds at Beauce, and the deposit of the flints at Thenay, the mammalian fauna has been renewed at least three times, while the differences between the extinct and living fauna are sufficient to justify the acceptance of the supervention of specific genera. The question of the existence of man in the mean Tertiary period rests, however, for the present, open, and must await further discoveries of a less questionable nature before it can obtain an unassailable solution.—M. Onimus, in a paper on language, has considered at length the importance of reflex action generally on all phenomena of the nervous system and on the intellectual functions, illustrating his point by reference to the changes in the faculty of speech which give rise to aphasia, and considering the manner in which the latter lesion is modified by the previous and normal mental condition of the patient. This number also contains a suggestive paper, by Madame C. Royer, on the mathematical laws of reversion through atavism; notes by M. Bataillard on the Gipsies of Algiers; and a report of the hairy dog-man of Kostroma, in whom an abnormal development of the hair of the head and the down on the face and neck, combined with considerable prognathism, has similated the characters of the canine head.

THE *Bulletin de la Société d'Acclimatation de Paris* for July devotes a considerable portion of its space to the description of an ostrich farm at the Cape of Good Hope. This industry is largely extending in that colony, and yields excellent results.—M. Maumenet gives a valuable contribution in the shape of a paper on the various plants acclimatised by him at Nîmes, in the province of the Gard. Bamboos, Eucalyptus, palms, and several new and useful Chinese plants and vegetables, are among his successful attempts at acclimatisation.—M. Martinet gives details of the mode of cultivating the *Erythroxylon coca* in Peru, a vegetable which the French are desirous of introducing into Algeria and French Guiana.—M. Collenot suggests, as a means of staying the ravages of the Phylloxera, that instead of introducing American vines, the wild vines abundant in many parts of France should be carefully cultivated; they produce, in a wild state, excellent fruit, and as they are very hardy, he thinks that they would withstand the attacks of this pest.—A Japanese tree, the Sophora (*Styphnolobium japonicum*), is recommended for cultivation as rivalling the Eucalyptus in many respects. The wood is very hard, and a tree planted in France thirty-five years ago is now 21 ft. in circumference. It resists cold and drought with equal facility.—The silkworm is being acclimatised in the Baltic provinces, and some species of this caterpillar seem able to withstand the cold with ease.

SOCIETIES AND ACADEMIES

LONDON

Royal Microscopical Society, Oct. 7.—Charles Brooke, F.R.S., president, in the chair.—A paper, by Mr. Alfred Sanders, entitled "Supplementary Remarks on the Appendicularia," was read to the meeting by the secretary, in which the author corrected several observations made in the course of a previous paper, and gave an exhaustive description of a species which he believed to be different from any hitherto described, although he refrained at present from naming it as new.—A paper by Mr. Kitton, of Norwich, was also read by the secretary, upon some new species of diatoms found in deposits sent from New Zealand by Mr. H. R. Webb and by Capt. Perry from Colon.—Mr. Slack made some observations on silica films prepared from a solution containing four parts glycerine to one part water, and pointed out the difficulty of obtaining clear definition of the forms presented when high-power objectives of large angle were employed, whereas those with small angular aperture gave good results.—Mr. Stewart drew the attention of the Fellows to a remarkable living organism exhibited in the room by Mr. J. Badcock, of the nature of which very considerable doubt was entertained, the prevailing opinion being that it was either an entozoon or the larval form of some unrecognised animal.

LEEDS

Naturalists' Field Club and Scientific Association, Oct. 13.—Mr. Edwd. Thompson, vice-president, in the chair.—A lecture was delivered by Mr. Samuel Jefferson, F.C.S., upon "Volcanic Phenomena." After giving the more familiar facts with regard to the shape and formation of volcanic cones, the nature of the ejected materials, the periods and frequency of eruptions, and the distribution of volcanic energy, and after an exposition of the chief hypotheses which have been framed with regard to the internal condition of our earth, Mr. Jefferson pointed out a coincidence which had not to his knowledge been previously noticed, that the equatorial diameter between the two centres of intensity of volcanic energy, Java and Quito, is shorter by two miles than that drawn at right angles through Africa. Mr. Jefferson explained his views at some length.

PHILADELPHIA

Academy of Natural Sciences, June 2.—Dr. Ruschenberger, president, in the chair.—"Poisonous character of the flowers of *Wistaria sinensis*."—Mr. Meehan remarked that there was a popular belief that the flowers of the *Wistaria sinensis* were destructive to bees. He had himself seen hundreds of dead bees under large flowering plants. He was struck with the fact this season that none were dead under similar circumstances. The flowers were continually visited by the honey bee and others, without, so far as he could see, any fatal results following. It was clear, therefore, that whatever might be the cause of the death of these insects under some circumstances, it could not be from the honey alone.—"Growth of the *Cnicus arvensis*, Hoff." In regard to the rapidity with which plants sometimes grew, Mr. Thomas Meehan observed that, though it was well known that the Canada thistle spread surprisingly, there had been no figures giving its exact growth placed on record. From experiments he found that it spread at an average rate of about three-fourths of an inch of growth per day, equal to maize or other rapid-growing vegetation above ground.

June 16.—Dr. Ruschenberger, president, in the chair.—Prof. Leidy made remarks on the revivification of *Rotifer vulgaris*, showing that when the animals are actually dried they are incapable of being revivified.—Prof. Cope mentioned the capture of a young *Balæna cisarctica*, of forty-eight feet in length, in the Raritan River, near South Amboy. He was informed that the whale was entirely black, and the dorsal line without irregularities.—Prof. Cope explained the distinctive features of the genus Symborodon, one of the gigantic horned mammalia of Colorado, as compared with Titanotherium, exhibiting typical specimens of the latter from the Academy's museum, showing four inferior incisor teeth, while the lower jaw of Symborodon does not possess any.

PARIS

Academy of Sciences, Oct. 12.—M. Bertrand in the chair.—The following papers were read:—The enunciation of the principle of the theory of *timbre* is due to Monge, by M. H. Resal.—Letter from M. Langley, director of the Alleghany Observatory, United States, on cyclonic movements, by M. Faye. This paper was an extension of the author's theory of sun-spots. The laws of fluids in rotatory motion round a vertical axis are shown to apply to these phenomena.—M. Daubrée made some remarks in connection with the foregoing paper concerning the indications of circular motion traced in the diluvian deposits of the neighbourhood of Paris.—Critical observations on the employment of the tincture or powder of guiacum for testing the purity of "*kirschenwasser*," by M. Boussingault.—M. C. Sédillot communicated a surgical paper on the subject of preventive trepanning.—Presence of the genus Lepisosteus among the fossils of the Paris basin, by M. P. Gervais.—External linear extraction, simple and combined, of cataract; a surgical memoir, by M. R. Castorani.—Proportion of real to sulphated ashes in the products of the sugar industry, by M. Ch. Violette.—Communications relating to the destruction of Phylloxera were received from MM. Maurice Girard, Mouillefert, Balbiani, &c., upon which remarks were offered by M. Dumas.—New experiments with alkaline sulphocarbonates for the destruction of Phylloxera; method of employing them, by M. Mouillefert.—Researches on the action of coal-tar in the treatment of phylloxerised vines, by M. Balbiani.—On the employment of electro-diapasons of variable periods as tonometers and electric contact breakers, by M. E. Mercadier.—Attempted theory of the formation of the secondary facets of crystals, by M. Lecoq de Boisbaudran.—Microscopic study and proximate analysis of a pumice from Vesuvius, by M. F. Fouqué. Under the microscope this stone was seen to be composed of a multitude of crystals of amphigene united by an amorphous vitreous substance; of crystals of hornblende, pyroxene, peridote, oxide of iron, feldspath, and brown mica irregularly distributed through the mass. An analysis of the amphigenetic crystals proved this mineral to be rich in sodium and calcium; the amphigene from the tufa of Somma is generally potassic.

CONTENTS

THURSDAY, OCTOBER 29, 1874

METEOROLOGY IN FRANCE

WE hail with much satisfaction the movement which has just been made by the French Government in the direction of a more effective organisation than has hitherto existed for the investigation of the meteorology of France. The best results may be expected from the step just taken, which is detailed in the printed documents quoted below,* and when we consider the great contributions made to practical meteorology by Le Verrier, the distinguished head of the Paris Observatory, in the *Bulletin International*, the *Atlas des Mouvements Généraux de l'Atmosphère*, and the *Atlas des Orages* originated under his direction, we may rest assured that these hopes will be fully realised.

In the decree of February 13, 1873, in which the basis of the reorganisation relative to the meteorology of France was laid down, occurred the following resolutions :—

"1. The investigation of the great movements of the atmosphere and meteorological warnings for the seaports and for agriculture are remitted to the Observatory of Paris.

"2. The working out of the meteorology of the various river-basins of France, and cognate inquiries, is handed over to Commissions representing the different regions and departments of the country, the organising of which the Council of the Observatory is commissioned to prosecute."

In carrying out these resolutions, the meteorological warnings to the seaports were re-established by the Observatory on May 17 of the same year. The duty of issuing meteorological announcements to all departments for the benefit of agriculture, especially in time of harvest, was recognised, and it was at the same time suggested that an inquiry be set on foot with the view of organising a system by which this could be effectually done.

As regards the second resolution, a systematic inquiry into the climate of France had been organised in 1865 by the appointment of Departmental Commissions, and the establishment of a system of observations chiefly by the primary normal schools. At first, when the Departmental Commissions were yet imperfectly organised, it was found necessary to concentrate the observations made over the country in the Observatory of Paris, which undertook their discussion and publication ; but this system, which was forced on the Observatory at the time, could not be indefinitely continued with advantage. The grounds for this opinion are stated in these words :—

"From 1869 the Observatory continued to point out that the discussion of the climatic conditions of the different river-basins of France could not be concentrated in Paris with advantage. It seemed necessary that the large body of skilled meteorologists that had been formed during the four years which had elapsed should boldly take the observations into their own hands, in order to discuss them and deduce from them the scientific truths they may be shown to teach. It was not merely from the advantages which would accrue to meteorology itself by adopting this line of action that the effort towards decentralisation was put forth, but from the intimate bearing which the partition of the work of meteorological inquiry over the whole breadth of the country had on the scientific movement of France, in favouring the spirit of original inquiry and research without which no nation can take a high position in science."

The circumstances which followed hindered the carrying out of these proposals. Subsequently, however, the matter has been resumed and dealt with successfully in several parts of the country, particularly in the basin of the Meuse and over the western sea-board of the Mediterranean, by concerted action on the part of the five departments of Hérault, Gard, Aude, Pyrénées-Orientales, and Lozère. The Astronomical Commission nominated for the purpose of proposing the best measures to be taken in reorganising the astronomical department entered into the same view, and recommended further that inquiries referring to the climate of France be remitted to Regional Committees appointed by departments grouped together according to the river-basins.

"But it must be observed that the proposed institution of Regional Committees will in no way interfere with the Departmental Organisation, but is intended, on the contrary, to give greater weight and vigour to the operations of the Departmental Commissions, in that united action in certain lines of inquiry is thereby facilitated ; it being evident that the area embraced by a single department is too small for the proper study of many of the widespread meteorological phenomena which pass across it. The local Commissions have repeatedly drawn attention to this great disadvantage ; the organisation by regions will, however, henceforth give to the departments the means of publishing the results of their inquiries in a more complete form. In correcting the system of centralisation which had been carried to so great an excess, it is not intended to leave the Commissions to themselves, with no connecting link between them and the Central Administration. On the contrary, the Observatory of Paris is specially instructed to be in active and fruitful correspondence with the Departmental Commissions, and to give assistance, as far as the Commissions may desire, in organising them by regions."

The programme, thus briefly sketched, has been only imperfectly followed out, solely on account of the pecuniary difficulties. But these difficulties the National Assembly has now removed by authorising the necessary funds. What then is now required, and what is now asked by the Minister of Public Instruction, is that the Prefects enter in the departmental budgets such a sum as may in each case be required by the Commission, and we are glad to learn that there is no doubt that the request will be generally acceded to. M. de Cumont concludes his letter with the remark : "I shall act in concert with my colleague, the Minister of the Interior, in carrying out the propositions of the decree of Feb. 13, 1873, to secure the regular despatch of the meteorological warnings to those departments whose scientific Commissions are put in possession of the requisite funds to enable them to take advantage of the warnings in the interest of agriculture."

In the meantime, the Observatory has hastened the resumption of the publication of the "Atlas Météorologiques de la France," which has been stopped for some years. To make up for lost time, the first issue, which is ready for delivery, embraces the three years 1869, 1870, and 1871, and consists of four parts, viz. :—

* "Letter from M. A. de Cumont, Minister of Public Instruction to the Préfets of the Departments, Paris, October 9, 1874." "Letter from M. Le Verrier, Director of the Paris Observatory, to the Presidents of the Meteorological Commissions of the Departments, Paris, October 9, 1874."

(1) Discussion of the thunderstorms (*orages*) of these years, illustrated with forty-six maps. (2) Hailstorms, with three maps. This part of the work, which is of so much importance to agriculture, has been unfortunately neglected for some time, but is now to be vigorously prosecuted. (3) Report on the climatic observations made in France, and particularly on the distribution of rain, with four maps. (4) Meteorological memoirs and documents (thirteen in all), contributed by different meteorologists of France and other countries, a section of the work which is expected to receive a fuller development in future issues.*

A noteworthy feature of the publication consists in the fact that the materials which make it up have been collected under the auspices of the Departmental Commissions, and in great part discussed by them. This is, particularly for such a country as France, an admirable arrangement, since there is no European country the working out of the meteorology of which presents a more complex problem, owing to the great diversity of the climates of its different regions; and further, the agricultural interests of no other country would benefit more than those of France, were a correct knowledge of its climate generally disseminated among the people. Now, this feature of the publication gives the local colouring to the reports which is fitted to arrest general attention and secure the putting forth of those local efforts by which alone the meteorology of France can be satisfactorily worked out.

It may be here pointed out that the French meteorological organisation is based on the Commissions which have been appointed in each of the departments; it being to them that the Government, in the decree of Feb. 13, 1873, has remitted the working out of the meteorology of the different river-basins, and inquiries connected therewith. They are invited to unite together for certain objects into Regional Commissions, for the purpose of imparting to their investigations greater breadth and exactness. They are not put under the Central Administration at Paris in the sense of being controlled by it, but are connected with it in order that they may be aided by it in cases where aid is needed. The Departmental Commissions have free automatic action in working out the problem of the local climates of the respective districts which have been entrusted to them.

The programme assigned to the Central Observatory of Paris, consisting of the investigation of the great movements of the atmosphere, and meteorological warnings for the seaports and for agriculture, is too limited in its scope; and we cannot suppose that its illustrious head will be satisfied till he has succeeded in including in the regular work of the Observatory those physical researches we have already strongly advocated in NATURE (vol. x. p. 99) as an indispensable part of the work to be undertaken by the Central Meteorological Office of each country, and which have been more recently and ably stated by Prof. Balfour Stewart and Col. Strange (pp. 476 and 490).

In the same article we urged the necessity of the State and the country working together; indeed, in no other way is it possible successfully to work out the great national questions of storms and of local climates in their bearings on the health, productions, and commerce of the country. In France we see that this essential requisite, of the State and the country working together, has been effected, and it may not be irrelevant to add that the French Government has clearly recognised the position that unaided voluntary efforts are insufficient of themselves to cope with the subject, and that if the undertaking is to be conducted in a manner worthy of the nation and of the ends to be subserved by it, it must be supported with aid from the public funds.

* The price of the volume, post-free to England, is, we understand, 10s. (12 fr.)

MAREY'S "ANIMAL MECHANISM"*

Animal Mechanism. By E. J. Marey. "The International Scientific Series." (London: Henry S. King and Co., 1874.)

II.

In his treatment of aërial locomotion, Prof. Marey has been even more successful than in his investigations with regard to progression on land. Nearly two centuries ago the general principles of this subject were very ably worked out by Borelli, who, after having shown that in the wing the anterior margin is rigid whilst the posterior portions are more and more flexible as they go backwards, inferred, as will be self-evident to all, that in the downward stroke of the flying bird the plane of the wing becomes directed downwards and backwards on account of the hinder margin yielding slightly to the resisting air. It not having struck him that the wing was elastic in its horizontal as well as its vertical direction, Borelli assumed that the stroke was strictly vertical.

By a series of experiments, the logical sequence and convincing power of which are perhaps unequalled in any other extant biological problem, Prof. Marey has been able to demonstrate the effects of the horizontal yieldingness of the wing, and to prove that in insects the stroke, instead of being, as Borelli assumed, a simple vertical line, is a vertical figure of 8. In proof of this original and, at first sight, unexpected observation, he shows that if the tip of the wing of a wasp be gilt, and the insect allowed to buzz n a beam of sunlight, a very elongated vertical figure of 8 image is seen, as in Fig. 1, to be produced by the reflecting tip of the rapidly moving wing; "sometimes, indeed, the wing seems to move entirely in one plane, and the instant afterwards the terminal loops which form the 8 are seen to open more and more. When the opening is very large, one of the loops usually predominates over the other; it is generally the lower one which increases, while the upper diminishes. Indeed, by a still greater opening, the figure is occasionally transformed into an irregular ellipse, at the extremity of which we can recognise a vestige of the second loop."

There is still more to be learnt from this simple experiment. By carefully gilding one surface of the wing alone, the buzzing wing, when intensely illuminated, exhibits the figure of 8 of unequal intensity in its two moieties, as seen in Fig. 1; so that it resembles the figure printed thus, **8**, if its thick part be considered to represent that which is most illuminated, and its thin part the darker half. This result can only be produced by the plane of the

* Continued from p. 500.

wing being different in the up and down strokes ; and, as is found to be the case, the thick limb is reversed by turning the insect round so that it presents its other side to the observer. The same conclusion is arrived at by the employment of the method to be now described.

Without sensibly interfering with the movement of the wing, its tip may be made to come in contact with a revolving cylinder, in which the surface is covered with smoked paper. "Although the figures thus produced are for the most part incomplete, we are able, by means of their scattered elements, to reconstruct the figure which has been shown by the optical method." Fig. 2 is one

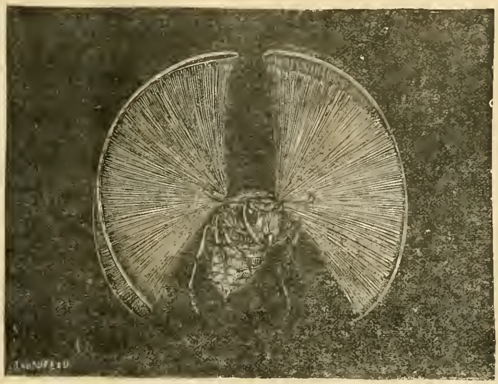


FIG. 1.

of the results obtained, in which several of the loops are distinctly seen, as is generally the case when, as here, the insect is so held as to rub the cylinder with the hinder edge of the tip of the wing. That a figure of 8 movement of a point, when made to record on a revolving drum, produces a similar curve, is seen from Fig. 3, which is a tracing of a Wheatstone's kaleidophone rod, tuned to the octave, or, in other words, vibrating twice transversely for each longitudinal vibration.

Still we are not able to say in which direction the wing is moving in the different branches of the 8 figure ; the following simple experiment determines this completely.

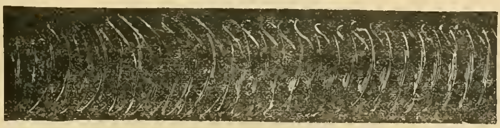


FIG. 2.

A slender glass rod is smoked at the tip in the flame of a candle, and held at right angles to the direction in which the wing moves, in the different parts of the wing-tip tract, as in Fig. 4. It is evident that if the wing hits the rod whilst it is descending, it will rub off the smoke film from its upper, and whilst ascending, from its lower surface. Supposing that, in the figure, the head of the insect is directed to the right: when the glass rod enters the loops at b' and a it is found to strike the upper surface; when at b and a', the lower; consequently the arrows indicate the true direction of the wing's motion.

The foregoing facts, when taken in connection with

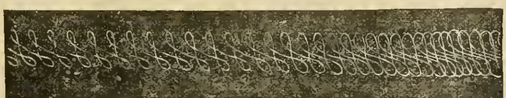


FIG. 3.

their known anatomical arrangements, place us in a position to discuss the mechanism of the flight of insects. These animals possess muscles, &c., which produce direct downward and upward movements of the wings, and these movements only ; therefore the expansion of this vertical line into a figure of 8 must be caused by forces acting external to the thoracic or wing-moving mechanism ; in other words, by peculiarities in the structure of the wings themselves. Simple inspection of the wing of a fly shows it to be formed of a rigid, or comparatively rigid, anterior nervure, which supports a thin more yielding membrane behind it. In its descent, the resistance of the air retards the movement of the more yielding posterior portion of the wing sufficiently to cause the lower surface of its

otherwise horizontal plane to become directed slightly backwards, and in its ascent the same cause directs it somewhat forward. But an inclined plane striking the air has a tendency to move in the direction of its own inclination; consequently, both in the down and up stroke of the wing, it tends to move forward at the same

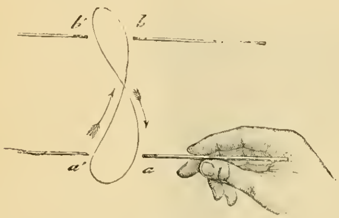


Fig. 4.

time. "But this deviation cannot be effected without the nervure being slightly bent. The force which causes the wing to deviate in a forward direction necessarily varies in intensity according to the rapidity with which the organ is depressed. Thus, when the wing towards the end of its descending course moves more slowly, we shall see the nervure, as it is bent with less force, bring the wing backwards in a curvilinear direction. Thus we explain naturally the formation of the descending branch of the 8 passed through by the wing;" and the same theory applies to the ascending branch of the figure.

Acting upon the suggestions of his theory, Prof. Marey has constructed artificial wings, which are planned and move upon the same principle as those of insects. He has not succeeded in making a flying machine, it is true; this, however, is not from any fault in the wings, but because it is impossible to obtain an engine sufficiently light to drive them. He has, however, contrived an apparatus which, when the motor power is supported, is capable of moving horizontally with rapidity, of rising and of falling, just like an insect; and, what is more, when propelled by a simple up and down movement, the tips of the wings describe a figure of 8 of their own accord, as they ought to do upon the theory which led to their construction.

The mechanism of the flight of birds is a problem far more difficult to master than that of insects. The size of the subjects of experiment, and the comparative slowness of the movements of their wings, remove them beyond the reach of the optical and direct graphic method previously employed. Each stroke of the wing has to be

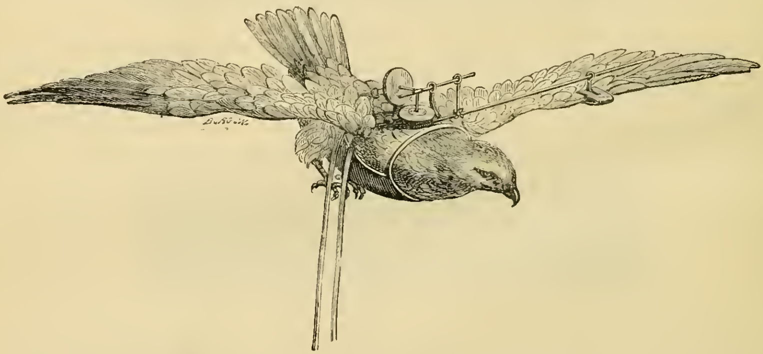


Fig. 5.

recorded through the intervention of a complicated system of tubes and levers, as fragile as they are delicate, and as expensive, as they are liable to be broken. Movements in a single plane are capable of being transferred to paper with comparative ease, but when they are not so limited, and may be in any direction, the necessary complication of the recording machinery becomes immense. The number of little details which have to be continually remembered, and the oft-repeated futile attempts which have to be allowed for, makes Prof. Marey's success in his investigations a matter of more than ordinary surprise. He has mastered the whole subject, having by separate and by combined check methods demonstrated what is the rapidity, direction, and inclination of the wing of the bird in every part of its course. Further than this, he has shown what effects the stroke has on the movements of the body of the bird, and this by a very ingenious new method. The way in which the author invents means for reproducing and originating any quality of movement he may want to develop, must be a source of admiration and almost astonishment to all readers of his work.

Fig. 5 shows a buzzard saddled with the machinery which, by means of the two tubes running downwards from it, transmits the vertical and horizontal movements of its wing to the recording apparatus, which is not represented. In the study of the more intricate points the necessary instruments are so heavy that the whole bird has to be partially supported. This is done by attaching it to the extremity of a long lever which revolves, with scarcely any friction, on a pivot. This is found not seriously to interfere with the normal flight of the bird.

Most of the facts made out by the employment of this apparatus are shown in Fig. 6, which is constructed to illustrate the inclination of the plane of the wing with reference to the axis (Av) of the body of the bird during flight. The direction of the movement of the wing is from H to Av. It shows "that the wing during its ascent assumes an inclined position, which allows it

to cut the air so as to meet with the minimum of resistance; while in its descent, on the contrary, the position of its plane is reversed, so that its lower surface turns downwards and slightly backwards." During the descent

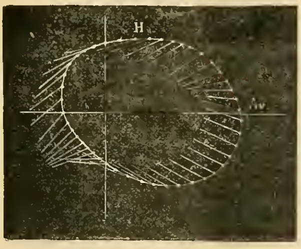


Fig. 6.

of the wing the body of the bird is carried forwards as well as upwards. The resistance of the air explains the elliptical form of the figure.

We hope that in the short glance which we have taken of some of the most important points discussed in the work before us, we have succeeded in interesting our readers sufficiently in its contents to make them curious to learn more of its subject matter. We cordially recommend it to their attention. To the student of art it gives rules and general principles which will be found invaluable in all attempts to portray the various attitudes of man and his faithful companion, the horse; and these, when understood, will direct attention to the most salient points in the locomotion of other animals.

To the student of physiology it is useful in at least two ways. It shows how invaluable is a knowledge of manipulatory details and the principles of mechanics. Prof. Marey, in the period of his studentship, must have learnt more than the simple routine facts of a medical education. The mechanical Cardan universal joint and Wheatstone's kaleidophone rod are as familiar to him as is the valvular mechanism of the heart; it is his control of method which is one of his most marked characteristics. It shows how elaborate are some of the phenomena which at first sight seem so simple, and how much the science of physiology is within the domain of physics.

The translation, as far as we have had the opportunity of judging, seems a good one, except in one or two cases, where improvement would not be impossible.

OUR BOOK SHELF

The Protoplasmic Theory of Life. By John Drysdale, M.D. (Baillière, Tyndall, and Cox, 1874.)

The author of this small book is one of the editors of a work on Pathology, by Dr. John Fletcher, of Edinburgh, whose "Rudiments of Physiology" contains much speculative biology of no mean quality. As a disciple he enters into an analysis of the philosophy of his master, discussing its details in connection with the light thrown upon it by modern research, especially the bioplasm theory of Beale. Fletcher argued thus:—The peculiar property, vitality, does not reside in the tissues of the living body indiscriminately, but in one anatomical element alone; because, as the various tissues differ extremely in their physical properties, and these latter are almost exactly the same after as before death, it is hardly to be expected that the living matter can rearrange itself on death, in a short time, into a number of different forms, which shall possess exactly the same physical properties in the vital as in the ordinary state of combination. The concordance of this idea with the theory of Dr. Beale, which divides all tissues into a living forming material (bioplasm), and a dead formed material, the composition of the latter of which alone varies to any extent, must be evident to all; and the working out of its minutiæ occupies several chapters of the work before us. The author also enters fully into the muscle and nerve theory of Dr. Beale in a manner which we do not think will throw much light on either subject. He remarks that the insulating power of the medullary sheath of the nerve-fibre is not demonstrable, therefore "the nerves are not fitted for simple conduction of electric currents; and these have no reason to choose the nerves as their channels, so they spread through the moist tissues almost uniformly." With this opinion we think there are few or no physiologists who will agree, as there is not the least doubt that it is through nerve-fibres that electric stimulation will most readily and most powerfully affect muscular fibres at a distance; otherwise, what is the peculiar value of the "nerve-muscle preparation" of the physiological laboratory? In his remark that Dr. Sanderson is premature in arguing with regard to the Dionæa "that because the contraction of the plant-leaf depends on changes, apparently in the contents of the cells, the muscular contraction of the higher animals is of the same nature," the author is, we think, more fortunate; we have never been able to see that the two phenomena have anything in common. From the consideration of the less speculative protoplasmic theory of the origin of tissues, such points as the nature of life, the connection of force with life and mind, consciousness, and materialism, subjects beyond the pale of precise knowledge, are treated of in a manner which will quite repay perusal by those who are fond of speculating on those precarious topics.

Out of Doors: a Selection of Original Articles on Practical Natural History. By the Rev. J. G. Wood, M.A., F.L.S. (London: Longmans and Co., 1874.)

Mr. Wood is well known as one of the most successful popularisers of natural history. He has himself an extensive and thorough knowledge of his subject, as well as a genuine love of it, and his genial enthusiasm cannot fail to infect the minds of the fortunate boys and girls into whose hands his books may fall. The present volume consists of a number of thoroughly readable papers which have already appeared in various periodicals. They are written in an easy, graceful, chatty style; and while apparently trying only to amuse his readers, he manages to convey a great deal of valuable information about animals and plants, especially about such as anyone who likes to take the trouble may observe for himself. Some of the papers are concerned with exotic animals, as in that describing "A January Day at Regent's Park," in which are contained many facts concerning the inhabitants of the Zoological Gardens. Most of them are, however, about the "common objects of the country," as is indicated by such titles as "A Sand Quarry in Winter," "Under the Bark," "My Toads," "The Children of the New Forest," "The Repose of Nature," the last concerned with hybernating animals. In "Medusa and her Locks," and "Life on the Ocean Wave" (describing a visit to the Crystal Palace Aquarium), "The Green Crab," &c., we are introduced to the denizens of the ocean. The book is an excellent one to give to a boy or a girl, who, we are sure, would enjoy it, as indeed would many whose boyhood or girlhood is only a sad memory.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

Automatism of Animals and Men

I WAS surprised to see by Mr. Wallace's letter of last week that he and I had understood Prof. Huxley's address in senses entirely different. I understood Prof. Huxley to mean that not only the reflex action of animals, but also all the conscious, so-called voluntary actions of men—those, for example, that we perform for the first time and, as we say, with a conscious end in view—are purely automatic; that is, that consciousness, while it accompanies the workings of the animal machine, never stands in a causal relation to any movement whatever; that no movement ever was the result of a state of consciousness, that every movement is the result of physical antecedents which, being present, the movement must of necessity follow, and that in this physical chain there is no break whatever. Years ago I saw no escape from this conclusion, and I have repeatedly made explicit statements of it in the pages of this journal and elsewhere. I was therefore gratified to find Prof. Huxley agreeing with the doctrine; and that the British public should be so little startled by his announcement of an opinion which has seemed absurd to almost everyone to whom I have attempted to expound it, struck me as rather curious. But the explanation is easy, if a man of such fine and cultured intellect as Mr. Wallace could so completely miss the meaning of Prof. Huxley's discourse.

DOUGLAS A. SPALDING

The Edible Frog

YOUR correspondent Mr. Miller (vol. x. p. 483), will find, in Cooke's "British Reptiles," p. 103, accounts of other endeavours to naturalise *Rana esculenta*. About ten years ago I imported a basket full from the Parisian fish-market, where they can easily be obtained, and turned them out into a pond at Woburn Abbey, in Bedfordshire. They thrived and multiplied there; but our summers are seldom hot enough to enable the tadpole to attain his full development before the cold autumnal nights set in. Last week, for example, I forwarded to Prof. Huxley a living tadpole of *R. esculenta*, born in Bedfordshire, who will scarcely complete his evolution before the winter, though his hind legs are fully developed. I have several summers, however, observed a plentiful supply of young *esculentæ*, and I believe that in our climate the young will pass the winter as tadpoles, and complete their transformation in the following spring. But this would require more accurate observation before I can affirm it with certainty. During the past summer I imported from Berlin a fresh supply of 200 exceedingly fine specimens, as my French frogs had been reduced in numbers after the frequent visits of a heron. *R. esculenta* is easily imported in the spring, and will travel many days packed in damp moss. These frogs are easily preserved, being more aquatic in their habits than our *R. temporariæ*, who roam through the woods and meadows in search of food when the breeding season is over, while the edible frog remains on the banks of his native pond, into which he plunges, describing a graceful curve, at the slightest approach of danger. They have been introduced into Ireland quite lately, from France, by the Earl of Granard, at Castle Forbes; with what success I am unable yet to say. In the spring any number can be easily obtained from the Parisian market, or the aquarium shop of M. Carbonier, 20, Quai du Louvre, Paris; or from the keeper of the reptiles in the Jardin des Plantes, who always has a plentiful supply to feed his snakes.

The laboratories of our lecturers on physiology are supplied from Leipzig, annually, with living *R. esculentæ*, and Mr. Miller can easily obtain the address of the dealers who export them.

Oct. 26 ARTHUR RUSSELL

Colour in Flowers not due to Insects

FROM Mr. F. T. Mott's letter, in your last issue (p. 503), I can hardly imagine him to be acquainted with the literature of the subject on which he writes. The difficulties he suggests, though great, are, I think, not unanswerable.

1. Cultivation seldom greatly affects the size or colour of the first cultivated individual. In the cases in which it does so, Mr. Darwin considers the origin of the variation to be due, as suggested by Knight, to change, or excess in food ("Origin of Species," chap. i.) Where the variation is at first slight and slowly intensified, this is the result of artificial selection.

2. When we consider the exhausting character of the reproductive process, we may perhaps think that the abortion of the sexual organs by the multiplication of phyllæ is the result of weakness; but a high state of cultivation, or any excess of food, predisposes to the degradation of organs, the excessive growth of parenchyma, rapid growth, and disease. Organs are also absorbed by heat or by frost. As to the perpetuation of such forms, Mr. Darwin instances ("Origin of Species," chap. viii.) some varieties of the annual stock which produce both double sterile and single fertile seedlings, justly comparable to the fertile and neuter forms of social insects.

3. The "abortive flowers" of such umbellate and capitulate inflorescences as the Guelder Rose, Hydrangea, and Centaurea, where not effected by artificial selection, act as a lure to the central fertile florets, as shown by Dr. Ogle (*Popular Science Review*, April 1870), originated according to the law of balance of growth.

4. The beauty of fruits "serves merely as a guide to birds and beasts, in order that the fruit may be devoured and the manured seeds disseminated" ("Origin of Species,"chap. vi.)

5. "We meet very commonly with gaily-coloured chemical products, essentially connected with the normal processes of development, and originating from venomous infection by insects, or from decomposition. These colours appear to be merely an accidental quality of the chemical products . . . natural selection is without any influence as to colours, unless animals are attracted or repelled by them" (Hermann Müller: NATURE, vol. ix., p. 460). Mimicry has been recorded in fungi (NATURE, vol. vii. p. 55). Mr. Mott's letter indicates the fallacious opinions that mere beauty or variety are objects in nature, and that the Darwinian hypothesis deals with the origin of variations.

G. S. BOULGER

Harrow Road, W., Oct. 26

ABLER pens than mine will probably reply to Mr. Mott's letter in NATURE, vol. x. p. 503; but if not, may I be permitted to point out that the facts therein adduced, as not harmonising with the theory that colour in flowers has been assumed for the purpose of attracting insects, are capable of explanation.

1. *Cultivated flowers.*—The greater size and brilliancy of colour attained by these is not due to cultivation alone, but to selection practised by the cultivator. He chooses his seeds from the plants that bear the largest and best coloured flowers, and thus, directly and intentionally, performs the very work that in a state of nature is carried out, indirectly and unconsciously, by the insect fertiliser.

2. *Double flowers* are only accidental, and not permanent, in a state of nature. The cultivator has succeeded in producing and preserving them by giving a preference to, and propagating from, those plants which bear flowers with a tendency to become double. Here also intentional selection by the gardener has taken the place of natural selection by the insect.

3. The *abortive flowers* of the Guelder Rose and Hydrangea, as they grow naturally, are confined to the outer part of the corymbs, and serve the same purpose as the ray of Compositæ (which in some species consists of neuter florets) and the highly coloured floral bracts of some plants, viz., to attract insects to the fertile flowers they surround. The garden forms of Viburnum and Hydrangea, the corymbs of which are composed entirely or nearly so of sterile flowers, are, like double flowers, the result of intentional selection by the cultivator.

4. The brilliant colours of many succulent fruits have resulted from their superior attractiveness, not indeed to insects for the purpose of fertilisation, but to birds and other fruit-eating animals for the purpose of dissemination, as has been well described by Prof. Hildebrand. The occurrence of brilliant colours in the vegetable kingdom, independently of the agency of insects, as on fruits, galls, fungi, and lichens, is no more irreconcileable with the theory that the colour of *flowers* has been brought about by that agency, than is the occurrence of bright colours on insects themselves and other members of the animal kingdom, or the vivid colour of many mineral substances.

Newton-le-Willows, Oct. 26 THOMAS COMBER

Migration of Birds

I HAVE waited for some time to see if anyone would ask Prof. Newton or Mr. Tegetmeier, on what evidence the latter gentle-

man has been led to "declare that knowledge of landmarks obtained by sight, and sight only, is the sense which directs these birds," viz., carrier-pigeons. (See NATURE, vol. x. p. 416.) As no one has asked this question, I am obliged to do so myself; but at the same time I should like to say that it is only because the subject is one of great importance that I think we should not here be satisfied with an authoritative statement of opinion, without some indication of the kind and degree of evidence on which such opinion is based. Moreover, it seems to me particularly desirable, that if a man of Mr. Tegetmeier's immense experience in this matter has any conclusive reasons for his decision, the public should have the benefit of their recital; so that the vexed question as to the "homing" of pigeons may once for all be settled.

The importance of settling this question I deem almost impossible to overrate; for, with all deference to Prof. Newton, I do not see why "sight alone cannot be regarded as of much aid to birds which at one stretch transport themselves across the breadth of Europe," if it is once satisfactorily proved that "sight, and sight alone, is the sense which directs" carrier-pigeons, say, from Paris to London. For it must be remembered that carrier-pigeons are descended from a non-migratory species of bird, and may therefore well be supposed not to have the faculty of remembering landmarks so fully developed as is the case in migratory species, where this faculty has doubtless been deeply impressed by means of natural selection. Further, we must not forget that in the case of all migratory birds, the younger generations fly in company with the older ones; so that the former must make several journeys before it devolves upon them to lead the way.

When the instinct question was last discussed in NATURE, I published a summary of the evidence which had been adduced by the correspondence. As at that time I thought with Prof. Newton that the supposition of sight being the faculty to which the return of carriers is due was a very improbable one, I argued that to account for the facts of migration by a similar supposition would be unwarranted. But when so great an authority has found cause to alter his opinion regarding the supposition on which my previous argument was founded, I think the fact bids fair, not only to destroy that argument, but, as just shown, to reverse it. Now I call attention to this in order to show how much depends upon a final determination of the instinct question so far as carrier-pigeons are concerned. In no other case of "homing" (and migration is nothing more) are we able to subject the birds to experiment; so that if this has been done in the case of pigeons with unequivocally positive results, we are at any rate in possession of a valid analogy from which to establish a probability as to the nature of the migratory instinct in general. And the value of this probability would be more definite if Mr. Tegetmeier would tell us what he thinks, or knows, to be the utmost limit of a pigeon's memory for landmarks.

GEORGE J. ROMANES

The Aboriginal "Murri" Race of Australia

(Communicated by Sir J. Lubbock, F.R.S.)

HAVING lately had an opportunity of reading your work on "The Origin of Civilisation," it has occurred to me that some information which has come to my knowledge during missionary tours among the aborigines known as the race of Murri, and during a journey afterwards undertaken at the instance of the Government of this Colony to the Namoi and Barwun Rivers, may be acceptable to you. Through Prof. Max-Müller my journal and my grammar of "Kamilaroi, Dippil, and Turrubul" were transmitted to the Anthropological Society; and I suppose all I have written is accessible for the purposes of philosophical investigation among the records of that society. I now confine my statements to points touched upon in those parts of "The Origin of Civilisation" which treat of the Australian aborigines.

Page 11. In the north-western part of this colony, about the tributaries of the Darling, a man will not look at his mother-in-law. If they meet accidentally they turn back to back, and take no further notice one of another.

P. 34. My experience differs entirely from that of Mr. Oldfield. Having shown many drawings and paintings of animals and men—including their own likenesses—to the aborigines, I always found them quick at perceiving the design. They themselves trace on the trees, with their tomahawks, fair representations of snakes and other animals.

P. 109. It is true no man may marry a woman of the same names as his sisters. But it is by no means true, as Dr. Long stated, on imperfect information, that no one can marry a woman "of the same clan," taking the word "clan" in the common sense of the term as equivalent to "gens." The rule that restricts marriage is founded on an exact law of pedigree and class names. It is as follows among the aborigines of the Namoi; and other tribes have rules similar in the main, though the names differ widely.

The men are all divided into four classes—Murrī, Kumbo, Ippai, and Kubbi. The Murrī (whose name differs from that designating the race, "Murrĭ," only in the quantity of the last syllable) are regarded as the most important; the Kubbi are the lowest in esteem. The sisters of these four are respectively Mātā (or Matha), Būtha, Ippatā, and Kubbotha (the vowels are pronounced as in French). So that in one family every son bears the name Murrī, every daughter the name Mata; in another family every son is Kumbo, every daughter Butha. There is also another classification marked by "totems," in which a second name is given to everyone according to birth. Thus there are the *bundar* (kangaroo), *meité* (opossum), *dūlī* (iguana), *nūrai* (black snake), *dīnoŭn* (emu), and others. On these classifications are based laws of marriage and descent. A Murri may marry Butha of the same totem, and of any other totem he may take a Mata, though she bears the name of his own sisters, who are all Mata. So Ippai dīnoŭn may marry Ippata nurai, but not Ippata dīnoŭn. But Ippai dīnoŭn may marry Kubbotha dīnoŭn.

Children always bear the second name (or totem) of their mother; and the first name of the child depends on the mother's. Thus the sons and daughters of Mata are always Kubbi and Kubbotha; those of Butha are Ippai and Ippatha; those of Ippatha are Kumbo and Butha; those of Kubbotha are Murri and Mata. As Ippai generally marries Butha, Ippai's son is generally Murri, but not always. When Ippai's wife is other than Kubbotha, his son is other than Murri. At first it seemed to me that the father's name determined that of the son; but afterwards I found that it is by the mother's name that those of the children are fixed. It is remarkable that while the second name of a child is the same as the mother's, the first, though dependent on the mother's, is always different. Mata's daughter cannot be a Mata, but is always Kubbotha. The Rev. Lorimer Fison, who had been in communication with Prof. Goldwin Smith and others on the "Tamil" system, and had found that system in Fiji, on seeing the rules of marriage and descent which I had noted down as prevailing among the Kamilaroi of Australia, said the principles of the "Tamil" were observed here also.

They have no words meaning simply brother and sister, but use terms signifying elder brother and younger brother. Thus "daiadī" is elder brother, "gullami" younger brother; and in a family of six brothers the eldest has no daiadī, but five gullami; the youngest has no gullami, but five daiadī; the third has two daiadī and three gullami. "Boādi" is elder sister, "burandi" younger sister. "Gunī" (γυνή) is the child's word for "mother dear."

P. 205. The Kamilaroi and Wiradhuri tribes, who formerly occupied a large territory on the Darling and its tributaries, have a traditional faith in "Baiame" or "Baiamai," literally "the Maker," from *baia*, to make or build. They say that Baiame made everything. Some say that he once lived as a man upon earth; and near the Narran River is a hole in a rock, somewhat in the shape of a man, where they say Baiame used to rest. He makes the grass to grow, and provides all creatures with food. Baiame gave them a sacred wand, which they exhibited at their "bora," the initiatory rite of admission to manhood, and the sight of this wand is essential to make a man. Baiame once showed the black fellows how to get rid of "Mullion," a demon in the form of an eagle, who lived in a tree and devoured many people. Baiame is also the Supreme Judge who awards to men their future lot. When people die, the good ascend to Baiame, and he appoints them a place on the great *warrambool* (watercourse, with groves, fruits, and animals, for the enjoyment of the blessed), in the sky—the Milky Way; the bad perish at death.

The Rev. James Gunther, of Mudgee, who was many years engaged in the instruction of the Wiradhuri tribes, has recorded the fact that these people ascribe to Baiame "three of the attributes of the God of the Bible"—supreme power, immortality, and goodness. There are among them men who make light of these traditions; but even when first spoken with by Christian instructors, some were evidently devout in their thoughts of Baiame and their hopes of a future life; and as to a future

state, they generally have a lively expectation. A squatter, M. De Becker, who lived many years at a remote station, where the blacks were in frequent communication with him, told me he had seen many of them die with a cheerful anticipation of being soon in a "better country." WILLIAM RIDLEY

Paddington, Sydney, Australia, July 11

Reported Discovery of Gold in Samoa

FROM a note in NATURE (vol. ix. p. 273) I am surprised to learn that Mr. Williams, H.M.'s Consul in these islands, has stated, in an official despatch to the Foreign Secretary, that gold in quartz has been found on Upolu, in a valley about three miles from the Port of Apia. The samples assayed are said to have yielded at the rate of 3,000 ozs. to the ton.

No geologist who knows Samoa will believe that gold in paying quantities has been found in this island. Still, I think it right to give the following explanation of what gave rise to the above report.

A few months ago gold was said to have been found, as reported by Mr. Williams. Most people here, however, disbelieved it, thinking the report had been raised by unprincipled men for the purpose of attracting settlers and promoting the sale of land. Some believed the pretended specimens of Samoan gold had not been found in Samoa, and felt quite certain they had not been procured in the particular valley specified.

The facts of the case have been lately disclosed, since Mr. Williams left the islands in ill health; he was therefore in ignorance of them when he wrote his despatch from Sydney in October 1873.

The specimens of gold assayed were brought from the Thames gold diggings in New Zealand, and two or three foreign settlers here, who own land in the valley where the gold is said to have been found, raised the report in order to sell their land at a high price. They appear to have imposed upon the credulity of the Consul, who took the specimens to Sydney and had them assayed there. S. J. WHITMEE

Upolu, Samoa, June 2

Photographic Irradiation

I SHALL be obliged if you will allow me space to state more specifically why I am not able to concur in the irradiation theory of Mr. Aitken (vol. x. p. 439). I understand from his last letter that he fully agrees with Lord Lindsay and myself as to the cause of the outer irradiation, and our only difference of opinion now lies in the amount of the inner irradiation that can be traced as due to what he has termed *molecular reflection* within the thickness of the collodion film. Mr. Aitken and Capt. Abney both appear to consider this as the chief cause of the inner irradiation fringe, while I am disposed to rank the irradiation arising from the optical imperfections of the instrument with which the photograph is taken; together with any irradiation that may arise in the wet plate processes from circulation in the film of fluid covering the plate—before—or as very much greater in amount than the irradiation due to dispersion within the collodion film.

We should expect that light dispersed within the thickness of the collodion film would produce its photographic effect in all directions round the illuminated point—and that the area of action would not be affected, or certainly would not be decreased, by covering the front surface of the portions of the collodion film adjacent to the directly illuminated area with an opaque object. Indeed, if the opaque object were a good reflector, such as a bright piece of platinum foil, we might expect slightly to increase the area of photographic action due to dispersion within the film; for the light dispersed towards the front surface of the film would be in great measure reflected back into the thickness of the collodion. But, as I have shown in former letters, placing a piece of platinum foil in immediate contact with the collodion film causes the photographic image of a bright image to be sharply cut off, and no perceptible irradiation can be traced under the edge of the foil.

Again, we should expect the action of dispersed light to extend further within a thick film of collodion than within a thin film; for there would be a greater thickness of illuminated collodion, and the angle through which light could be radiated directly upon the adjacent area without suffering reflection at either surface would be increased, but I have not been able to detect any perceptible difference in the amount of irradiation of similarly exposed plates coated with four thicknesses of collodion and in those coated with but one film.

I have felt myself therefore driven to look for the cause of irradiation either in some circulation taking place within the film of liquid covering the collodion at the time of exposure, which film would be interrupted and its tension greatly altered by the contact of a solid body; or else to seek its explanation in the optical imperfections of the photographic instrument. Possibly, in the wet-plate processes, circulation within the fluid film may produce a very sensible effect. Indeed, there are phenomena which make this more than probable. When a wet-plate picture of a strong light projected upon a dark background is taken with a decided over-exposure of say ten minutes or a quarter of an hour, the inner irradiation fringe is seen to be most opaque on its outer edge; and the phenomenon is so marked that it cannot be held to be an effect of contrast. This, of course, should not be the case if the irradiation edge were due merely to the optical imperfections of the instrument. Again, in the small negatives of the eclipse of December 1871, taken at Dodabetta and Baikul, there is a decided structure in the irradiation under the prominences: under the brightest of them it can be distinctly seen that the opacity of the irradiation fringe is greatest along lines radiating from the prominences—while along the outside, that is, furthest from the prominences, there is an arc of slightly greater intensity. The same structure is traceable in all the negatives, but it is most marked in the Baikul series, and especially in those negatives in which the prominences are most exposed, viz., on the east and west limbs, at the beginning and at the end of totality. This, of course, cannot be accounted for merely by the optical imperfection theory. Again, the little brushes mentioned in a former letter as extending under the edge of the platinum foil, cannot be accounted for without supposing that there is circulation within the liquid film. I hope on my return to England to carry out some further experiments for determining the amount of the inner irradiation which in the wet-plate processes may be due to such circulation. A. COWPER RANYARD

Florence

Curious Rainbow

THE unusual phenomena described by Mr. Swettenham as having been observed by him in a rainbow in the Kyles of Bute (NATURE, vol. x. p. 398), are due, I think, to interference. If I remember rightly, he will find an explanation of the matter in "Deschanel's Natural Philosophy," by Prof. Everett.

Clifton, Bristol, Oct. 19 G. J. THOMSON

Aurora

A BRIGHT display of aurora was seen here on Friday, Oct. 16, between eight and eleven o'clock. At ten o'clock, when I first saw it, the arch of the aurora stretched from Pollux to Arcturus, then both near the horizon, the apex of the arch being under Ursa Major. Deep fringes of light hung from the inner side of the arch and moved with a curtain-like motion to the north. The light was white. On Saturday night numerous streamers were seen darting upwards from the horizon; and many falling stars, two of them leaving trains of light for about a second.

JAMES S. ANDERSON

Castletown, Caithness, N.B.

Sneezing in Animals

I HAVE a rough-coated terrier dog which will sneeze when told to do so. I taught him this trick by repeatedly imitating sneezing in his presence.

When about to perform, he shakes his head obliquely once or twice, just as many people do, and then ends with a good sharp sneeze. J. F. M. H. S.

THE RECENT ERUPTION OF ETNA

PROF. ORAZIO SILVESTRI has published* his observations on the eruption of Etna which occurred on the 29th of August, and reminds us that two months previously he predicted not only the formation of the fissure on the Mongibello side, but likewise the eruption by which it was accompanied.

After an uninterrupted period of eruptive phenomena by which the central crater was considerably modified, at

* "Notizie sulla eruzione dell' Etna del 29 Agosto 1874." Catania, 1874.

4 A.M. August 29, subterranean rumblings were followed by two shocks, when a formidable column of black smoke and flaming materials rushed up into the air, and, carried by the wind, fell at great distances, in the form of small scoriæ and sand. Numerous other columns succeeded, with roaring, rumbling noises, lasting for seven hours with great intensity, dying away towards night. The noises ceased on the 30th of August, and vapour and smoke alone rose from the crater and along the line of disturbance.

When the volcanic tremors were most intense, at 4 A.M. 29th August, a fissure appeared on the north side of the great central crater, extending for five kilometers, with an axis running E. by 8° N. The centre of the impellant force was at an elevation of 2,450 metres, between two mountains of lava known as *Fratella Pii* and *Monte Grigio*, where the rent widened to its maximum width of fifty to sixty metres, whence it narrows very steadily towards the base, terminating after a course of three kilometres. And at this altitude, where the greatest thrust was manifested, may be noticed the formation of a new mountain, or crater, with an elliptical contour, coinciding with the fissure in the direction of the axis. It has a diameter of about 100 metres, and covers a superficial area of about 117,734 square metres. This crater, now appearing as a new mountain, is formed of doleritic lava and a pre-historic grey Labradorite, torn from the surface by the black lava of this eruption, in which they are enveloped. There are thus mingled two lavas of the most distant epochs in the history of Etna, the older forming the framework of the mountain. The crater shows internally the usual funnel shape; and near its base, over a width of fifty to sixty metres, there are ten eruptive mouths, open wide, which succeed each other like button-holes;—those nearest the crater are abysses twenty-five to thirty metres in diameter along the line of the fissure. There are also two other groups of small cones, in which the diameter of the mouths is not more than from one to three metres—eight in the second group, and four in the third; so that within a distance of half a kilometre from the crater there are twenty-two minor cones in linear extension. The crack is now continued down a declivity formed by the lava current of 1614, which slopes to the north at an angle of 13° or 14°. Although the rent traverses this lava, there are no more small cones for a distance of 600 metres, when a fourth group of five mouths, each two to three metres wide, is found at an altitude of 2,170 metres; these latter have poured out a torrent of lava descending in a stream 150 metres long, 60 metres wide, and two metres thick. A little lower, at a height of 2,150 metres, is a fifth group of three mouths, more active than the others, but situated like the last group on the great lava stream of 1614. The torrent of lava hurled from these mouths is 400 metres long, 80 wide, and two metres thick, and forms two short bifurcations. Finally, near the end of the crack, at an altitude of 2,030 metres, a sixth and last group of five mouths is formed, which have ejected large quantities of cinder and scoriæ. They are situated about twelve kilometres from the old crater of Mojo, towards which this great crack runs down the side of Etna from its central crater. Besides this principal rent there are an infinite number of smaller clefts, breaking up the soil and radiating from the centres, of great dynamic activity. In a few hours the new mountain and its system of about thirty-five subordinate cones were thrown up, and thus there was brought to the surface a total quantity of about 1,351,000 cubic metres of volcanic materials.

The mingling of the old and new lavas will form the subject of a subsequent memoir. The recent lava, like all modern lavas, is augitic, black, magnetic, and has a metallic lustre. Its specific gravity is 2·3636 at a temperature of 25° Cent. The superficial temperature of the lava was 70°, while at a depth of half a metre it was 90°, and a still higher temperature was recorded where fumeroles were active.

From the remarkably short duration of the eruption, Prof. Silvestri anticipates a more powerful outburst to come, which will be manifested along the rent in making which the present internal explosion has spent its force.

Concurrently with this disturbance the whole of volcanic Italy has been affected. The island of Volcano, after a century of quiescence, discharged cinders and flaming materials from its vast crater for nine months previous to the eruptive phenomena of Etna in the autumn of 1873. The eruption of Volcano continued decreasing in intensity through July 1874, and traces of it are still continually seen. Stromboli last June made a rare eruption, sending out small stones with great energy in place of its characteristic feeble incessant explosions.

Vesuvius has not been unsympathetic, and discharged an unusual volume of dense vapour at the end of August contemporaneously with the eruption of Etna.

THE SECOND AUSTRO-HUNGARIAN EXPEDITION TO THE NORTH POLE, UNDER WEYPRECHT AND PAYER, 1872–74.

ON the return of the Austrian North Polar Expedition we gave in NATURE, vol. x. p. 439, an outline of the discoveries made. From the original memoirs on the achievements of the voyage, by Dr. A. Petermann, Dr. Joseph Chavanne, and Dr. v. Littrow, which have been kindly forwarded to us by the first-named, along with the map, we are able to give still further details.

No general with his victorious army returning from battle could have been welcomed with greater enthusiasm and cordiality than this little band of twenty-two men. For though they only come home from a North Polar expedition, people instinctively feel that the accomplishment of the *Tegetthof's* voyage is a heroic deed. To gain a battle, hetacombs of precious human lives must be sacrificed; here all came safely back. A battle does not demand greater endurance and courage, for the battle of the *Tegetthof* lasted two years. We think of the times of Columbus and Vasco da Gama, of their discoveries and return to Palos and Lisbon. It is true the Austrian expedition did not find an America or an India; but Columbus, and other great discoverers, did not really discover more than Weyprecht and Payer. Before Columbus traversed it, men believed that the western ocean was not navigable, and similar ideas prevailed with more reason concerning the sea just explored. One of the first describers of polar regions, Scoresby, had, in the year 1820, in his famous work, drawn a line over the whole sea from Bear Island, in 74½° N. lat., to Novaya Zemlya, and said, with confidence, "Here is the icy barrier where navigation must end;" and the unknown regions beyond this line were regarded by mariners with pious dread. The Austrian expedition has torn away the veil up to 83° N. lat., and has narrowed the undiscovered parts of the earth by a space of 8° to the north.

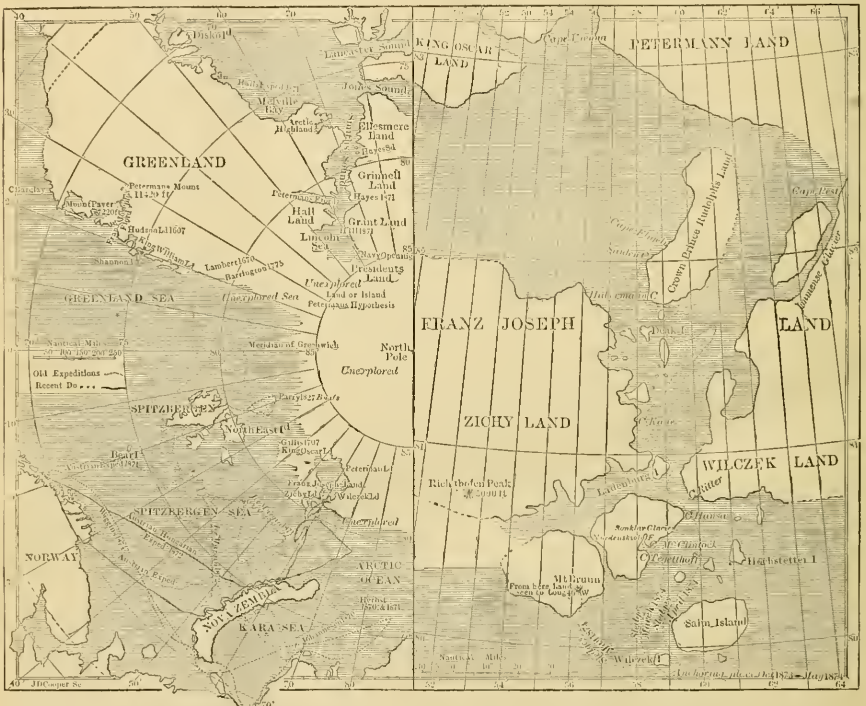
They had to stay at Novaya Zemlya for four weeks, and work their way out of thick ice for at least 240 geographical miles before reaching Cape Nassau, which was the starting-point of the expedition. They then encountered the most terrific dangers which can befall a polar expedition, for they were hemmed in by an ice floe, and shut up for fourteen months in pack ice, and driven about in the Siberian icy ocean. Eventually a tolerably safe place in the open ice was found for the second wintering, when the crew heroically divided themselves, the better to explore the land they had discovered.

The comrades of the *Tegetthof* have shown themselves worthy to take rank with their prototypes, Ross, Parry,

M'Clintock, Kane, Hayes, and Hall, for they have made a breach in a place where no one since Barents, during all the 300 years of arctic discovery, had attempted an attack. The explorations are here shown on a map constructed from the original preliminary sketch by Payer, with the geographical constants drawn by Dr. Petermann.

The nature of the North Pole is not so fully known but that the learned world is still fighting as to whether it is land or water, or an everlasting ice-cap, stretching like our home glaciers, or obeying other laws, or dissolving and opening under the influence of the warm sun, air, or water, like our own seas. And since any expedition can only discover a proportionally small part of the great unknown arctic world, there will always be some people ready with ape-like wisdom to pronounce against any endeavour to unfold the laws of nature within the inner polar regions. Dr. Petermann has for ten years urged that Germany should send out a polar expedition far into the great European polar sea, and is particularly anxious to get the whole breadth of the European North Sea explored from East Greenland to Novaya Zemlya, north of Bear Island.

The results of this expedition have marked an epoch in various ways. First by the drift for fourteen months in



The map on the left shows the state of polar exploration up to the end of September 1874; that on the right is the newly-discovered land.

the ice-floe. Such driftings have occurred before on a larger scale, as in the case of De Haven, M'Clintock, the *Hansa* people, and the *Polaris* people; but all these expeditions drifted south—the *Polaris* crew from 80° N. lat. to 53°. But entirely new and full of significance for physical geography, is the circumstance that the path of the Austrian expedition was uninterruptedly towards the north.

The following instances also show that the icy sea is navigable. Hall's expedition north from Smith's Sound proved that from Tessiusak in 73° 20′ N. lat., through the ill-famed Melville Bay, Smith's Sound, Kennedy Channel, Robeson Channel, to 82° 11′, was reached with ease in eleven days, the distance being more than 700 miles; and the best officers of this expedition declare their united conviction that they could easily have reached further north. The Karis Sea, formerly called the Ice-cellar of the North Pole, has proved to be completely navigable. Admiral Sir E. Parry, after Sir James Clark Ross perhaps the most experienced of all polar travellers, going north from Spitzbergen, came to the conclusion that a ship might sail to 82° N. lat. without encountering a piece of ice. Admiral Beechey, one of the most excellent and perhaps the most scientific sea captain who has ever lived, said in 1831 that he considered the navigation of the coast of the arctic region as practicable.

Dr. Petermann then asks: Is the experience of the Austrian expedition a measure of the resistance offered by the ice in the icy sea just explored? Are all the results which are opposed to it, from the former expedi-

tion of Weyprecht and Payer, not worthless? Is it worth nothing that numerous Norwegian fishermen in sailing boats have been able to sail round Novaya Zemlya since 1869 and penetrate far into the Siberian ice sea, always finding it navigable and quite free from ice? Is it not worth remembering that at the time Payer and Weyprecht found the unwonted accumulation of ice by Novaya Zemlya, the western half of the great sea, *quite against the rule*, was free from ice, so that the Norwegian fishermen were able for the first time to reach the mystic Gillisland, which is King Charles Land? Under certain unfavourable conditions of wintering, the north side of Novaya Zemlya is, without doubt, as difficult and impossible for navigation as the north side of Spitzbergen, or Cape Horn, or the Cape of Good Hope, or the English Channel, or the mouth of the Weser.

The *Tegetthof* is a small steamer of 220 tons, and though her supply of coal was necessarily small, it proved ample, for steam could only be got up three times in the first three weeks of the voyage. And thus, as in all recent voyages, rowing boats proved themselves better fitted than steam launches for exploring work. In the summer of 1872, the journey from Cape Nassau could not be made in a straight course, but Count Wilczek's journey in the sailing vessel *Isbjörn* demonstrated that it was practicable by following a tortuous course.

The best and first account of the results of the Austrian expedition, in relation to their bearing on the present state of knowledge of arctic geography, and of the current setting into the icy sea from the south, is given by Dr. Joseph Chavanne, and is as follows:—

"The rising polar sun of 1874 lighted up and discovered a new land, now named Franz Joseph Land, and the expedition set off to explore it in sledges. They found the country to be a narrow, far-extending foreland, divided from Greenland by a wide arm of the sea now named Austria Sound. It is mountainous, approaching to a plateau, with steep conical mountains 5,000 feet high, covered with enormous glaciers. This newly discovered land stretches for more than 15° of longitude, and bounds the horizon with mountains as far as the eye can carry to the north and west. In 83° N. lat. they sighted Cape Vienna, the most northern point visible, and Cape Pesth, one degree further south, and finding the great glaciers impassable in this latitude, they returned to their icebound ship. Imperative necessity compelled them to abandon their vessel upon its icy platform, and they set out to return to Europe with four sledges. They travelled on for sixty-nine days, and then fell in with the Russian schooner *Nikolai*, who landed them at Vardoe, in the north of Norway. Austria Sound, and other fjords, were filled with icebergs. They met with no trace of human inhabitants, and remark that animal and plant life is scarce and small in the south."

Twenty-two years ago Dr. Petermann indicated on a map of the arctic regions the polar extension of the Gulf Stream. Though generally regarded at the time merely as the hypothesis of a German philosopher, the unwilling drifting of the *Tegetthof* in the ice has proved that the principal northern branch of the Gulf Stream washes the west and northern coast of Novaya Zemlya. Between the west coast of Novaya Zemlya and the east coast of Spitzbergen, enormous masses of ice press westward with the polar current flowing from New Siberia Island and the Siberian rivers, and penetrate wedge-like into the Gulf Stream. The temperature of Franz Joseph Land in the winter of 1872-73 was 40° Réaumur.

The remarkable correspondence between the coasts on the two sides of Greenland supports the conjecture that the polar land, if not subdivided into a number of islands by ramifying arms of the sea, is at least deeply indented by fjords, as is demonstrated by Hall's discovery of Petermann's Fjord on the west coast of Greenland and Franz Joseph's Fjord on the east.

*PHYSICS AT THE UNIVERSITY OF LONDON**

II.

TURNING then first of all to the Regulations for Matriculation in the University of London, we find that the knowledge of Physics that is required is specified under four heads: namely, *Mechanics; Hydrostatics, Hydraulics*, and *Pneumatics; Optics;* and *Heat*, which last, until quite recently, was included in the examination in Chemistry; and the whole is accompanied by a general qualifying note to the effect that "the questions in Natural Philosophy will be of a strictly elementary character." The particulars, which are given under each of the above general heads, read as if they might have been copied, as they stand, from the table of contents of an elementary treatise on Natural Philosophy published about a hundred years ago. I have examined them often and carefully, and have never found a tittle of internal evidence to show that they were drawn up within the present century; and yet we know that they are the work of a University, not yet forty years old, which owes its very existence to the demand for educational progress, and began its career—without indeed the wealth or the prestige of its older compeers—but also without the trammels of tradition and ecclesiasticism, which render it so difficult for them to advance with the times. It is not a sufficient defence of the antiquated character of these Regulations to say that the very nature of the examination to which they refer would make the introduction of new discoveries entirely out of place, and that, in point of fact, the fundamental doctrines relating to the subjects in question were as fully established a hundred years ago as they are now. This is so nearly true (except in the case of *Heat*), that it would not be worth while to dispute it; but my objection is not to the want of novelty in the subjects enumerated, but to the want of perception, which the manner of the enumeration indicates, of the possibility of progress or improvement in the ways of teaching long-known truths. Instead of giving prominence to general principles in such a way as to suggest to teachers the use of easy and comprehensive methods, these Regulations cut up the subjects to which they relate into a number of detached propositions, of greater or less generality, which teachers and students, who accept these Regulations as their guide, generally treat as independent units of knowledge each of which is to be put into a separate hole of the memory. It would be wearisome, but not difficult, to illustrate my meaning by particular examples; the substance of it is that this examination does not encourage good teaching of the elementary parts of Physics, but induces candidates to trust to memory almost to the total exclusion of any attempt at thinking. My opinions on this subject have not been formed *à priori*, but have been forced upon me by reading examination papers and by trying to teach in what I believed to be the best way. It is in general nearly hopeless to try to get students, who have the fear of the London Matriculation Examination before their eyes, to make any serious attempt to understand the principles of Mechanics; but they often show a lamentable willingness to learn statements of them by heart, and when they go up for examination they know a great deal and understand next to nothing. They know that in a lever of the first kind, whose weight is neglected, the power is to the weight as the weight's arm to the power's arm; that when a heavy body falls from rest, the spaces described in successive seconds are as the natural series of odd numbers; and they are ready at the shortest notice to write down the formula for calculating the specific gravity of a solid body heavier than water; but it is only in the rarest possible

* Introductory Lecture delivered at the opening of the Session of the Faculties of Arts and Laws and of Science, in University College, London, on Monday, Oct. 5, 1874, by G. Carey Foster, F.R.S., Professor of Physics. Continued from p. 508.

cases that they can be got to reproduce the reasoning by which these results are connected with general physical principles. The industry displayed in acquiring separate fragments of information about Physics is often extremely creditable; but it is impossible not to regret that the same method should be employed in learning what is called Science, as in learning the dates of accession of the Kings of England.

A still more curious instance of the antiquarian tendencies of the University of London is afforded by the Regulations for the Degrees in Science, which were instituted as recently as 1860. It might have been supposed that when the Senate had once determined to make so great an innovation in the traditional usages of English Universities as to grant Degrees in Science, they would have been impelled by the spirit of their own act to frame such regulations for the examinations as should be in full agreement with the present state of science. I recognise as fully as anyone the impropriety of introducing anything that can fairly be called a new discovery into examinations such as those for the London degree of Bachelor of Science, but between such a course and that adopted by the University there is a very broad *via media*. In order to obtain the degree of Bachelor of Science, a candidate requires, after Matriculation, to pass two further examinations, called respectively the First and Second B.Sc. Examination. At the former, a paper is set in what is called "Mechanical Philosophy," and another in "Natural Philosophy," the Mechanical Philosophy being a repetition of the subjects called Natural Philosophy at Matriculation, with a few additions, chiefly under the head of Optics, while the Natural Philosophy includes *Heat*, *Electricity*, and *Magnetism*. At the Second B.Sc. Examination there are two papers in "Mechanical and Natural Philosophy," which are explained by the Regulations to mean nearly the same parts of Statics, Dynamics, Hydrostatics, Pneumatics, and Geometrical Optics as those prescribed for the First B.Sc. Examination, but treated a little more fully, and with the addition of a very little Acoustics, a little Physical Optics, and a smattering of Astronomy. The details given in the Regulations under each of these general heads are open to the same general criticisms as those which I have already ventured to make upon the mode in which the requirements in Natural Philosophy are stated in the Regulations for Matriculation; in fact, those parts of the subject which are common to the three examinations are specified in very nearly the same words in each case, the difference being that a slightly more mathematical treatment of them is expected at the higher examinations. In each case there is the same failure to suggest general and comprehensive points of view, and the same enumeration of particular examples, as though they were of equal importance with the general principles which they illustrate. It is just as if, in an examination in Latin or Greek, instead of its being stated that candidates would be required to answer questions in grammar, lists of particular nouns and verbs were given with the announcement that candidates might be required to give the declensions or principal parts of any of these. But these Regulations are defective not only in form but in substance—not only in spirit but in matter. Without going into further details in order to justify this statement, I may mention, by way of illustration, that at the First B.Sc. Examination, under the head *Electricity*, there is no distinct reference to any of the quantitative laws of the science, and it is only by a laxity of interpretation quite unsuited to the subject that an obscure allusion to Ohm's Law can be discovered—the great law expressing the connection between the strength of an electric current and the nature of the circuit which it traverses; while, under *Heat*, no liberality of interpretation could detect the smallest trace of the Dynamical Theory of Heat. This last omission, however, ceases to be surprising when we find the steam-engine classed with the common pump and forcing-pump; the hydrostatic press, the barometer, and the air-pump, under *Hydrostatics*, *Hydraulics*, and *Pneumatics*. It might have been natural a hundred years ago to look for Newcomen's atmospheric engine among such company; but, even then, James Watt had nearly converted the old atmospheric engine into the modern steam-engine.

But there is no need to enter upon any minute investigation of the Regulations for these examinations, in order to be convinced that their effect upon the study of Physics must be unfavourable. The small amount of encouragement which they hold out to pursue this subject seriously is shown by the fact that a London Bachelor of Science is not required to have any more knowledge of heat, magnetism, or electricity than candidates for degrees in Medicine are required to show at the "Preliminary Scientific (M.B.) Examination," which, in the usual course of things, is taken one year after Matriculation; and also by the fact that the papers in Mechanical and Natural Philosophy set at the Second B.Sc. Examination are identical with those set in the same subjects at the Second B.A. Examination. I have no fault to find with one side of this last arrangement; I have already given reasons for considering that Physics ought to occupy an important place in general education, and, from this point of view, the physical subjects for the Second B.A. Examination are, on the whole, not injudiciously chosen; but it is certainly strange that a degree in Science should not imply any greater acquaintance with the fundamental principles of Mechanics than is demanded of candidates for the degree of Bachelor of Arts, the examination for which is in the main literary and classical. Another fact, which may be regarded as a sort of experimental proof that the examinations of the University of London do not promote such a study of the elements of Physics as can serve as the foundation for a more advanced study, is that for the last five years a special examination for Honours in Experimental Physics has been held in connection with the First B.Sc. and Preliminary Scientific (M.B.) Examinations, at which a Medal and a Scholarship of 40*l.* a year, tenable for two years, are offered to the most deserving candidate in case of his exhibiting sufficient absolute merit, but hitherto the scholarship and medal have never been awarded, and only once has a candidate obtained a First Class at this examination.

The other examinations of the University of London into which Physics enters to a greater or less extent, are, that for the degree of M.A. in Branch II., and those for the degree of D.Sc. in certain branches; but as these examinations come at a stage of a man's career at which it may be supposed that his methods of study are not greatly influenced by the regulations of examining bodies, and as, moreover, the Regulations of the University relative to these degrees do not go much into detail, there is no reason for dwelling upon them in connection with my present subject.

I do not propose to say much about that part of the examinations for which the Examiners, rather than the Senate, are directly responsible; but there are one or two considerations which, although sufficiently obvious, it may be worth while to point out. First of all, however, I shall venture, presumptuous as it may be thought, to make one remark on the choice of the persons best fitted to be examiners. It has more than once been claimed as a special merit of the University of London, that the examiners are not teachers, or at least that they have nothing to do with teaching the candidates whom they are called upon to examine. Fortunately, however, this is not the case. As a matter of fact, the great majority of the examiners are always teachers, and it may quite well happen, at least at some of the smaller examinations, that a majority of the candidates have been pupils of a single examiner. But I venture to think that, instead of this state of things being considered as a more or less

regrettable accident, it ought to be recognised as natural and desirable. If the real object of the examinations be to promote good teaching and sound learning, it is most important that, in setting the questions, the examiners should always keep in view their probable effect in giving direction to the studies of future candidates; and there can be no doubt that the men who are both most likely and most able to do this are those whose constant business it is to consider how the subjects in which they have to examine can be best brought before the minds of learners. Moreover, it is very difficult for examiners who are not also teachers, and teachers accustomed to pupils who are at about the same stage of advancement in their studies as the majority of the candidates, to know what amount of knowledge it is reasonable to expect. A man, however minute his own knowledge of his subject may be, generally soon forgets the exact steps by which he acquired it; and, unless he is in frequent contact with the minds of learners, he is no longer able to tell what, at any particular stage, it is creditable to know, and what it is disgraceful to be ignorant of. And again, though this perhaps is a less important consideration, the necessity which a teacher is under of periodically reviewing the whole round of his subject, is a great help towards a varied selection of questions.

With regard to the particular kind of questions which are most desirable in examinations like those of the University of London, I wish to say only a very few words. If the general considerations to which attention has been drawn in an earlier part of this lecture are of any value, it follows at once that examination questions in Physics ought to be selected with a view to testing the reasoning power and not the memory of candidates. If what are called *book-work* questions are admitted at all, they should be such as will bring out the power of reproducing trains of consecutive reasoning, and bringing facts to bear on the establishment of general conclusions, and not the power of simply recollecting individual facts. It may be said that such questions would be unfairly difficult. I can only say in reply that, if teaching were what it should be, I do not believe that this would be the case; but if it should be found to be so, I maintain that the inference is, not that any other style of examining in Physics should be adopted, but that the whole subject should be dropped. A late very distinguished member of the University once said that, in the case of candidates for Matriculation, all that could be fairly required at the examination in Physics was evidence of "correct acquisition." It would in my opinion be only a little more absurd to say that all that ought to be required at an examination in Geometry is evidence of the "correct acquisition" of Euclid. If Physics is not a subject upon which the intelligence should be exercised from the very beginning, it seems to me to be a waste of time to teach it at all.

The consideration of the kind of questions that are best fitted to be of use in promoting improved methods of teaching and learning, suggests a remark which bears upon the distinction that has often been pointed out between the subjects which it is desirable to teach and those which are most suitable for examinations. In the particular case of Physics, I am inclined to think that the very elementary parts of such branches as Heat and Electricity are not well adapted to form the subjects of examinations like those we are considering, where the examiners have no means of knowing the exact points of view from which the matters dealt with have been presented to the candidates. My reason for this opinion is the difficulty in these subjects of setting questions which require anything more on the part of candidates than mere exercise of the memory, and which at the same time are not unreasonably hard. As a practical inference, it appears to me that, if the amount of acquaintance with Heat, Electricity, and Magnetism represented by the London Regulations for the First B.Sc. Examination (supposing the regulations to be strictly interpreted) is all that can be fairly demanded at this stage of a student's progress, it is at least a question whether these subjects should not be deferred until a more advanced stage, when something more than descriptions of apparatus or the solution of arithmetical problems might be reasonably required.

If any of my audience have listened to this lecture with the consciousness that they will soon be going up to one or other of the examinations that I have been discussing, it may very possibly seem to them that I have been pleading throughout for making these examinations more difficult. To any to whom this seems to be the tendency of my remarks, I would venture to suggest one or two further considerations. In the first place, I fully admit that if examinations in Physics were to be such as I have advocated, that is, if they required candidates to *think*, while the teaching of Physics remained what too much of it now is—a mere loading of the *memory*—candidates would, no doubt, have a hard time of it; but the whole intention of what I have said is that examinations should be improved *in order* that teaching may be improved through their influence; and I believe that if teaching were what it should be, good examinations would be found to be no more difficult than bad ones. I may also observe that after all the precise degree of difficulty which an examination presents is not the most important consideration even for an intending candidate; what it really is important, not only for candidates but still more for those who regulate examinations, to consider is, what is the permanent educational value of the work which an examination requires, and not simply what is the amount of work needed. I have many a time in reading examination papers felt sincerely sorry for the writers when I saw how much labour they had evidently gone through in order to learn nothing—nothing that is of real use—and have thought how much the same amount of labour might have accomplished if it had only been better directed; and I beg leave to assure any who look upon examinations from the under side, that I have no wish whatever to add to the quantity of work that is already required of them; but what I do wish sincerely is, that whatever work they may be required to do in preparing for examinations may be such that they will be intellectually better and stronger for having done it. It cannot be too often repeated that degrees and university distinctions are of no more value in themselves than the Queen's head upon the coin: unless the metal is genuine, the stamp only makes it into a lying counterfeit. This has been urged upon students over and over again; what I shall be glad if this lecture tends in any degree to accomplish, is to press the same truth upon the attention of our University authorities. It is important for them to remember that a man is not really either better or worse for all the degrees that they can give him; and that their boast should be, not in the length of their lists of graduates, but in the extent to which they have promoted "a regular and liberal course of education."

NOTES

One of the first results of the Transit of Venus expedition with regard to the geological aspect and vegetation of a comparatively little known island, comes to us from Rodrigues, and is contained in a communication from Mr. J. B. Balfour to Dr. Hooker, under date, from the above island, of August 23, 1874. As a proof of the inhospitable, or rather the uncivilised nature of the island, it is stated that the party belonging to the expedition were warned in Mauritius before starting for Rodrigues that they must take everything from the former island that they would be likely to require as it would be impossible to get anything at Rodrigues, and even labour is most difficult to be obtained. After providing himself with various articles of abso-

lute necessity, Mr. Balfour started from Mauritius, and after a voyage of exactly a week, landed at Rodrigues on August 18. The appearance of the island as seen from the vessel while steaming along near the coast, presented few features which could be looked upon as evidencing any large amount of granite entering into its constitution. On the contrary, the columnar structure of the cliff lines, both on the coast and in the interior, along with the terraced aspect of many of the ridges separating deep ravines, cutting far back into the island, clearly showed that, whether the main mass of the island were granite or not, certainly at some period of its history it had been the scene of very extensive volcanic action. On the 19th of August an excursion was made across the island to survey the channel on the south side. The vegetation on the island is very rank. The trees do not grow to any great size, and in most places do not form thick forest, but are scattered singly over the slope of the hills. It is only in the deep valleys and gorges that they grow into thick forest. The commonest tree seems to be the Vacoa (*Pandanus*), of which there are probably at least four species. The under-scrub is very dense and very spiny, which renders walking through it by no means a pleasant task. Neither ferns nor mosses appear to be very abundant, but lichens are pretty plentiful, especially in their pulverulent state; and in many places the basalt was nearly covered with white powdery patches. The basalt forming the rocks near Port Mathurin is, in its unweathered condition, a very beautiful compact stone, with large crystals of several minerals scattered through it. The difficulties in landing upon the island seem to be very great, owing to the extent of the coral reefs.

THE Yorkshire College of Science at Leeds was opened without ceremony on Monday, by the delivery of one of the introductory lectures by Mr. A. H. Green, the Professor of Geology and Mining. The other professors—A. W. Rücker, Dr. T. E. Thorpe, and W. Walker—give their introductory lectures during the course of the present week, and the teaching of the session will then be proceeded with. Very suitable buildings have been obtained, containing ample accommodation, which has been fully utilised for lecture-rooms, laboratories, &c., which are well furnished with the necessary appliances. Still, as Mr. H. Brown said, "they must look forward to having a noble building like that of Owens College, Manchester;" if the College is to maintain its position and to advance at all, it cannot but end in this. The number of students enrolled is as yet small, but, no doubt, will gradually increase. Prof. Green, in his address, spoke of the importance of a thorough training in abstract science as the necessary groundwork of a technical education. "Before they could understand," he said, "the practical application of a science, they must be master of the science itself. What was sometimes understood as technical education was a sheer impossibility, and a contradiction in terms. They could not explain the technical application of a science without first laying down the scientific groundwork on which it rested. A science like geology could not be taught piecemeal. Technical education in the popular sense was a misnomer, because the teaching which would limit the range of a man's vision to the subjects of which he could see the use did not deserve the name of education, the very essence of which was the strengthening of the intellect by mental exercise. It was his earnest wish that he might be able to give a teaching which in the end would have an important bearing on their practical occupations, and enable them to manage their mining, engineering, and other pursuits—in the conduct of which a knowledge of geology came in useful—better than if they knew no geology at all. But if he was to succeed in doing so, he must begin by telling them many things which at first sight would seem to be of no practical value whatever." With such a spirit as these words indicate, animating the professors of this new college, the best results may be expected from their teaching.

A MEETING of some of the friends of the late Dr. Stoliczka was held in the rooms of the Zoological Society on Friday, the 16th inst., at which it was determined to obtain, by subscription, a bust, to be presented to the Asiatic Society of Bengal, of which society Dr. Stoliczka was for some years before his death one of the honorary secretaries. A committee was appointed to act in concert with one previously formed in Calcutta, and upwards of 50*l.* was subscribed in the room for the purpose mentioned. Subscriptions, we are informed, will be received by Messrs. Grindlay and Co., 55, Parliament Street.

THE *Athenæum* announces that the *Contemporary Review* for November will contain an account of a new scientific discovery by Prof. Tyndall.

AMONGST the works which are progressing favourably at the Observatory of Paris we may mention the determination of the velocity of light, by MM. Fizeau and Cornu. These able physicists are using for their second station the Tower of Montlhéry. The light is transmitted to Montlhéry through a refracting telescope of 12 in. and returned to the Observatory with a 7 in. The distance between the Observatory and Montlhéry being 26 kilometres, the total distance traversed by the ray of light is 52 kilometres. The space of time required amounts to something less than one-thousandth of a second.

THE polishing of the great reflecting telescope is almost completed. The immense lens to be covered with silver by the Leon Foucault process, is nearly ready. It is said that everything will be finished by the beginning of May 1875.

AT Agram, the chief town of Croatia, a Croatian University was formally opened on Oct. 19 by the highest magistrate of the land, who is called the Ban, and exercises a kind of viceregal power on behalf of the Emperor of Austria. The University is to be called "Francis-Joseph," from the name of its founder. The Rector delivered a very able oration, summarising the progress of the higher studies in Croatia from the time when Maria Theresa established the Society of Sciences. Many delegates of foreign or other Austro-Hungarian Academies were present at the ceremony (Krakow, Berlin, Bologna, Pesth), and delegates from the Servian societies of learning. It is expected that the new University will play a most important part in the civilisation of the East, and be indeed the vanguard of European science in that direction.

MUCH remains to be done in this respect if the information we collect from Levantine papers be correct. It appears that in one of the principal islands of the Greek Archipelago some poor women have been imprisoned and starved, under the charge of sorcery. They were arrested for having attracted a host of locusts to their native land. The locusts not retreating, the persecution was extended to the husbands of the wretched creatures.

THE International Commission of Geodesy will hold its next meeting in Paris, in accordance with the decision come to at Dresden, where it held its sitting this year. The Government will assign it a public building for its meetings.

MR. J. E. TAYLOR, F.G.S., has discovered a buried forest in the Orwell. The forest is represented by a layer of peat containing trunks, leaves, and fruits of the oak, elm, hazel, and fir, associated with which are the remains of the mammoth. A bed of freshwater shells containing species not now living in the Orwell underlies the peat. Mr. Taylor remarks that this submarine forest is contemporaneous with others along the coast which existed previous to the depression separating England from the Continent.

MR. J. E. TAYLOR, who has done so much to create an interest in science in Ipswich, is to give a course of twenty lectures (free) in that town during the coming winter, on "Plants: their Structures and Uses."

AN important discovery has been made at Highwood, near the village of Ashill, in Norfolk, consisting of a vast collection of Roman remains in an oak-lined well, 40 ft. deep. The Norfolk and Norwich Archæological Society visited the spot on the 16th inst., when the well, under the superintendence of Mr. Barton, was emptied of its contents by a number of workmen. The well contains a great variety of articles, the most abundant being urns, of which about 100 have been obtained; more than fifty of these are perfect, and many of most beautiful form and ornamentation. There is considerable doubt as to the purpose which these wells were intended to serve; there are other two at Ashill, and others have been found elsewhere.

THE *New Quarterly Magazine* for October contains, with other articles of general interest, a paper by Mr. Richard Jefferies on "Small Farms." The writer notes the enormous development of science in modern farming, saying: "New plans, new inventions and discoveries follow each other in constant succession. The capabilities of agriculture seem inexhaustible. The number of clever and intellectual men who turn their attention to it multiply daily. It has its colleges, its professors, its students, and it would require a great volume to describe the machinery alone that has been contrived of late years, and is now in the market. The chemistry of agriculture would fill many more such volumes. Geology, botany, entomology, almost all the sciences, are pressing forward to its aid." Deprecating, in the present state of agricultural science, the advantages of small farms, Mr. Jefferies goes on to say: "The utility of bringing up a race of students instructed in chemistry, geology, entomology, mechanics, &c., in agricultural colleges, with the assistance of professors, if they are afterwards to be placed on small farms, is a matter of much doubt; they would have no room for the exercise of their attainments. . . . Whether it be considered from the tenant's own side, or from the labourer's, or from the landlord's, the balance of argument appears to be indisputably in favour of large farms. To the nation, to the ever-increasing population, the large farm offers a greater present produce, and possibilities of still further development. The political economist, who judges the prosperity of an occupation by the amount of capital attracted towards it, must also decide in its favour, for capital will never flow into small farms."

WE commend to the notice of the Goldsmiths' Company the letter from "A Jeweller's Assistant" in yesterday's *Times*. Let us hope that this, as well as the other wealthy City Companies, are now waking up to a sense of their responsibilities, and that they will lose no time in utilising the immense wealth at their disposal, and which has hitherto been utterly wasted, in the promotion of technical—which ultimately means scientific—education. Let them not provoke a "City Companies' Commission."

ON the 12th inst. was opened the London School of Medicine for Women. The Council had determined that no inaugural address should be given, and thus a day which the future may possibly prove to have been one of no little importance passed by unmarked more than by the fact that the first lecture had been given in a Medical School devoted exclusively to the teaching of the female sex. The school is now in full working order, and women can receive an education fitting them to practise medicine. The services obtained by this school need not stop short at preparing women for the medical profession. There are many branches of science allied to the study of Medicine, Chemistry, Botany, Comparative Anatomy, &c., in all of which a course of lectures is given as part of the medical education. These subjects are separately adopted by men as a means of gaining a livelihood. A knowledge of any one of these subjects is attainable equally by women as by men, and there is no reason why women should not achieve a scientific reputation and earn a fair competency by engaging in these studies and by imparting their knowledge to others.

IT is announced by the last Indian mail that a smart shock of earthquake was experienced in Central Ceylon early on the morning of the 19th of September, at five o'clock. The vibration was considerable, and was accompanied by a dull rumbling sound. The motion was from east to west, apparently; the rumbling was decidedly in the east. The shock appears to have been felt in the centre of the island only. Earthquakes in Ceylon are such rare events that this one has had a good deal of attention bestowed upon it.

WE would draw the attention of our readers to the excellent introductory lecture delivered by Prof. Leoni Levi at King's College, on "The Educational and Economic Value of Museums and Exhibitions," which is published in the *Society of Arts Journal* for the 16th inst. He gives many valuable suggestions as to the uses for purposes of popular teaching which might be made of our museums. He thinks that London is still deficient in museums, and states that there are at least some two hundred cities and boroughs which have taken no step to secure museums and public libraries for themselves.

THE *Augsburg Allgemeine Zeitung* of the 22nd inst. gives the following facts and statistics from the various University Calendars just published:—The University of Berlin shows the largest attendance, having had, in the summer term of 1874, 2,980 students and 187 professors. While this University had for a time the second place and Leipzig the first, the order is now reversed, and Leipzig follows with 140 professors and 2,800 students. Then comes Halle, with 1,055 students and 95 professors; Breslau, with 1,036 students and 107 professors; Munich, with 1,031 students and 114 professors; Tübingen, 921 students and 84 professors; Würzburg, 901 students and 58 professors; Heidelberg, 884 students and 104 professors; Bonn, 858 students and 98 professors; Strassburg, 667 students, and 81 professors; Königsberg, 603 students and 76 professors; Greifswald, 540 students and 58 professors; Jena, 493 students and 69 professors; Münster, 451 students and 27 professors; Erlangen, 442 students and 51 professors; Marburg, 440 students and 62 professors; Giesgen, 342 students and 58 professors; Freiburg, 297 students and 52 professors; Kiel, 210 students and 62 professors; Rostock, 132 students and 38 professors. In these numbers the non-matriculated students are also included. The German-speaking Universities outside the German Empire show the following attendance:—Basle, 163 students and 62 professors; Berne, 332 students and 63 professors; Zürich, 331 students and 75 professors; Dorpat, 708 students and 67 professors; Graz, 932 students and 68 professors; Innsbruck, 615 students and 52 professors; Prague, students (?) and 122 professors; Vienna, 3,615 students and 227 professors. Vienna, therefore, is at the present time the largest German University.

M. HURQUERLOT, a gentleman who was largely interested in railway speculations, died a few months ago and left a legacy of 24,000*l.* to the city of Paris for the purpose of establishing a railway school. But the sum, although very large, having been considered insufficient for the purpose, the Municipal Council has been reluctantly obliged to reject the money, which will revert to the lawful heirs.

MORE than 18,000 young men have gone successfully through their examinations, and have been admitted as volunteers for one year in the French army. About half of that number have been

rejected as not having received a sufficient education. The report of the examiners shows an improvement in the mean capacity of candidates. Many young men are admitted, without having to pass previous examinations, Bachelors of Arts, Sciences, or Letters, Pupils of Public Schools of Arts and Public Works and Mines, and Beaux Arts, and a few other institutions. The number of the volunteers of that class is about 4,000. Each volunteer has to pay besides a sum of 60*l.* to the Government. Education must be combined with money, in order to shorten the service in the remodelled French army.

THE study of "seaweeds" is probably affected as much by the general public as that of fish; and whether or not the great mass of people who visit the Brighton Aquarium and other similar resorts really go there with any idea of becoming more intimately acquainted with the wonders of the deep, there is no doubt that the exhibition of varieties of ocean plants would be as popular as that of fish. A seaweed growing in water is very different from seaweed cast up on the shore, and a careful selection and arrangement of specimens would greatly enhance the interest of the tanks, while at the same time their presence would prove beneficial to the fish. We recommend the hint to the notice of the authorities of the Brighton, Crystal Palace, and Southport Aquariums.

AN Industrial Exhibition is to be held at Leighton Buzzard for a short time about Whitsuntide 1875. The district to be represented is limited to a radius of twenty miles around Leighton Buzzard, and the proceeds of the exhibition will be devoted to the formation of a lecture fund for the purpose of securing courses of high class (largely scientific, we hope) public lectures in connection with the Working Men's Society, and the increase of the Society's library.

To increase the general instructiveness of their Museum, the Leeds Philosophical and Literary Society have published Descriptive Guides to the different collections of which it is composed. That on the British Birds, by Mr. L. C. Miall, is before us, containing a short and instructive account of each species exhibited. This method of combining instruction with amusement is one which it would be well if other public institutions were to adopt, instead of leaving their collections, often valuable ones, for the idle gaze of the many uninitiated, and the careful study of the but too few special students of special branches of science and art.

IN many parts of the coasts of this country where fish are abundant, enormous quantities are used as manure: in Cornwall and on the Eastern coasts this is particularly the case, but no means are adopted to convert the fish into a manufactured manure, and they are thrown, as caught, on the land. The same remarks apply to America. But recently a system has been adopted in certain localities by which the fish are prepared specially for manuring the land. At Lucages, Long Island, a factory has recently been established for preparing the surplus quantities of "Menhaden" caught near there. The oil is first extracted from the fish, and the residue is prepared in a certain manner and converted into "fish guano," which has a good reputation as a fertiliser.

ARRANGEMENTS have been made for placing on board one of the steamers running between Liverpool and New York, one of the "American Aquarium Cars," a newly invented contrivance for transporting live fish, which has succeeded very well in long overland journeys, and by means of which it is hoped to effect a useful interchange of living fish of various kinds between this country and America. There are many American fish which might with benefit be introduced into England, and we at the same time might transport to the other side of the Atlantic some varieties of fish which are not found there.

THE exhibition of insects in the Orangery of the Tuileries Gardens, Paris, has been brought to a close. The distribution of prizes took place on October 5. The higher medals were taken by a Viennese *savant* for a magnificent atlas exhibiting all the organs and forms of *Phylloxera vastatrix*; but the Phylloxera question is left open, and no reasonable solution appears to have been presented. Lectures were delivered daily on entomology, and every one of them was illustrated by projections with the solar microscope. Almost every kind of insect was thus presented to the public. The exhibition proved wonderfully successful; more than 20,000 persons paid the entrance fee, and the number of free tickets issued amounted to 30,000 in the brief space of twelve days.

WE have received a lecture on "The Life and Works of Dr. Priestley," delivered in Paris at the time of the celebration of the Priestley Centenary by M. W. de Fonvielle. It is published by Auguste Ghio, and is dated 1875.

THE additions to the Zoological Society's Gardens during the past week include a Bengalese Leopard Cat (*Felis bengalensis*) and a Common Paradoxure (*Paradoxurus typus*) from India, presented by Capt. W. Reynolds; a Great Eagle Owl (*Bubo maximus*), European, presented by Lord Londesborough; an Indian Fruit Bat (*Pteropus medius*) from India, presented by Dr. Stafford; a Monteiro's Galago (*Galago monteiri*) from Angola; a Tooth-billed Pigeon (*Didunculus strigirostris*) from the Samoan Islands, deposited; two Geoffroy's Doves (*Peristera geoffroyi*) from the Island of Fernando de Noronha, and a Gentoo Penguin (*Pygosceles taeniatus*) from the Falkland Islands, new to the collection, purchased.

KENT'S CAVERN*

BEFORE entering on this, their tenth Report, the committee desire to express their deep sense of the great loss they have sustained in the decease of Prof. Phillips. No member was more regular in his attendance at the meetings of the Committee or felt a livelier interest in the investigation with which they are charged. On March 18, 1874—little more than a month before his lamented death—though suffering from a severe cold, he visited the cavern, when he carefully inspected those branches of it which had been explored, and expressed his admiration of the clearness and importance of the evidence bearing on the question of human antiquity which had been obtained.

The investigation has been pursued without intermission during the entire period which has elapsed since the meeting at Bradford in 1873; the mode of operation has been that described in previous Reports and followed from the commencement; the work has been performed in the most satisfactory manner by the same workmen; and the superintendents have continued their daily visits and carefully recorded the results from day to day.

The interest felt in the exploration by the inhabitants and visitors of Torquay has suffered no abatement, and the superintendents have conducted a large number of persons through the cavern, including the members of the South-western Branch of the British Medical Association during a meeting of that body held at Torquay, and also the members of the Birmingham Natural History and Microscopical Society whilst on a scientific excursion to South Devon.

During May 1874, an arrangement was made with the superintendents by Prof. A. Newton of Cambridge, for Mr. Slater, one of the naturalists of the Rodrigues Transit Expedition, to spend some time in the cavern, studying the mode of exploration followed there; it being probable that he might have to explore some very interesting caves which exist in the island. Mr. Slater reached Torquay on the 1st of June, when everything was done to facilitate his purpose, and he spent some days watching the men at work.

Live rats continue to present themselves in the cavern from time to time, and prove occasionally to be very troublesome. Thus, in October 1873, one carried off six candles during the afternoon from a spot selected because it was believed to be in-

* Tenth Report of the Committee for Exploring Kent's Cavern, Devonshire. (Abstract.)

accessible even to rats, and which had been used as the candle store during a period of three years without any previous loss of the kind; and in the same month another ate through one of the workmen's basket between the hours of nine and one, and carried off his dinner. A large number have been captured during the last twelve months.

During summer, bees have frequently been seen and heard in the innermost branches of the cavern, very far beyond any glimmering of day-light.

The branches of the cavern in which the researches have been carried on since the ninth Report was presented in 1873, are those known as the Long Arcade, Underhay's Gallery, the Cave of Inscriptions, and Clinnick's Gallery. The exploration of the former two has been completed, but the work is still in progress in the latter. The deposits have been, in descending order, like those reported last year: first, or uppermost, the Granular Stalagmitic Floor, from 12 to 30 inches in thickness; second, the Cave Earth, which has nowhere been more than two feet deep, but has rarely exceeded one foot, and has occasionally thinned out altogether; third, the Crystalline Stalagmitic Floor, usually exceeding the Granular Floor in thickness, but which had, in certain places, been partially broken up and removed by some natural agency before the deposition of the cave earth; and, fourth, or lowest known, the Breccia, consisting of materials not derivable from the cavern hill, and which appear to have been introduced through openings or mouths of the cavern at present choked up and unknown. The depth of this deposit has not been ascertained, as its bottom has nowhere been reached.

In the Long Arcade the surface of the upper or granular stalagmite was occupied with large natural "basins," some of them 12 inches deep, such as have been described in previous Reports. The following points of interest were noted respecting them during the progress of the work:—

1. The stalagmite forming their walls was harder and tougher than that surrounding them; whilst that composing their bottom was comparatively soft and friable.

2. The walls were traceable through the entire thickness of the Stalagmitic Floor; in other words, during the entire deposition of the floor, basins had existed in it, the bottom rising with the walls, but at a slower rate.

3. The water which filled them in rainy seasons passed down through the bottom in three or four hours at most.

4. Immediately beneath most of the basins there was an almost continuous interspace of about half an inch in height between the bottom of the stalagmite and the top of the cave earth; caused, no doubt, by the finer particles of the deposit being carried by the percolating water through interstices to a lower level.

It happened that the exploration of that part of the Arcade in which the basins were thus numerous was carried on during a wet season, when the water, passing through the Stalagmitic Floor, as just mentioned, caused two or three slips of the deposits beneath. In the largest of these a well-rolled flint nodule was found with some remains of animals. No such specimen had been previously seen within the cavern.

At the junction of the Long Arcade, the Cave of Inscriptions, and Clinnick's Gallery, there is a huge boss of stalagmite, in the form of the frustrum of an oblique cone, 43 feet in basal circumference, 14 feet along the slant side—which forms an angle of 40 degrees with the horizon, and thus gives a vertical height of fully 13 feet for the mass—and contains probably no less than 630 cubic feet of stalagmite. Its base consists of the older or crystalline stalagmite, and the upper portion, without any intervening cave earth, of the granular variety, which not only surrounded and completely encased the former, but, by flowing in copious sheets, formed the thick Granular Floor, spreading without a break and for great distances in every direction. Though inscriptions exist in various parts of the cavern, this mass is, with perhaps the exception of the almost inaccessible Crypt of Dates, more thickly scored with names, initials, and dates than any other equal area within the cavern; and hence it has acquired the name of the Inscribed Boss of Stalagmite. The inscriptions occupy its outer or most exposed semi-surface, where in certain places they form a network. Letters of all sizes, from some fully three inches in height to others as small as ordinary writing, cross each other and thus add to the difficulty of decipherment. Some of them were cut with great care and finish, and must have occupied a large amount of time, whilst others were but hasty scratches. It seems to have been somewhat fashionable to surround the inscriptions with rectangular parallelograms, varying from 6·5 to 3·75 inches in length, by 5·5 to 3·5 in breadth. In at least one or two cases the cutting of the parallelogram preceded that of the inscription, as the latter extends beyond the boundary. Not unfrequently several names occur together, whether within a parallelogram or not, and in each such case the entire work seems to have been performed by the same hand. At least four of them belong to the seventeenth century, and the earliest of the series, so far as at present known, is that of "Peter Lemaire, Rich. Colby, of London, 1615." Amongst the names is that of "Deluc," probably the well-known geologist, "Champernowne," that of a well-known old Devonshire family, and several prevalent in the immediate district.

In 1846 the Torquay Natural History Society appointed a committee of three of its members, including the two superintendents of the present exploration, to make some very limited researches in the cavern. One of the spots which that committee selected was in Clinnick's Gallery, immediately adjacent to the incribed boss, where they made a very small excavation. The materials dug up on that occasion were, as usual at that time, thrown on one side, where they remained until removed in May last when they were taken out of the cavern by the present committee. Before this was done, the surface of the mass was carefully examined to ascertain what thickness had been reached by the stalagmite which, as the superintendents well knew, had been accreting on it during the last twenty-eight years. The result was a small film not thicker than ordinary writing-paper, and limited to two examples, each covering not more than two or three square inches.

Underhay's Gallery was found, when the work of exploration was completed, to be about 20 feet long, from 2·5 to 7 feet wide, and from 6 to 7·5 feet in height, the latter measurement being taken from the bottom of the excavation. Before the committee commenced their operations there, its mouth was almost entirely closed with large masses of limestone. Notwithstanding this, the late Mr. Underhay, for several years guide to the cavern, forced himself into the gallery about fourteen years ago, even though after passing the entrance, he must have found the Granular Stalagmitic Floor within a foot of the roof in certain places. Here he found *on* and *sticking into* the stalagmite a few small bones which he succeeded in bringing out, when they were found to be phalanges of human feet. Though these specimens did not appear to be of an antiquity at all approaching that of the cave-hyæna and his contemporaries, the superintendents, who were familiar with them, very carefully watched the progress of the work, in the hope of finding some further traces of the skeleton; and on reaching Mr. Underhay's very limited diggings they met with a series of bones, all *on* and *in* the stalagmite, some of which were certainly human, whilst others were as clearly not so. The whole were at once sent to Mr. George Busk, a member of the committee, who has been so good as to forward a report on them to the effect that twenty-eight of the specimens are human, and include an astragalus, a navicular bone, a trapezium, a patella, a metatarsal, an ecto-cuneiforme, phalanges of fingers and toes, and fragments of humeri, ribs, and vertebræ; that they appear to be the remains of an adult individual of small size and delicate make, and probably of a female, on which point, however, it is impossible to speak positively; that the bones are not necessarily of any very remote antiquity; that the remaining specimens are not human, but belong to small sheep or goat, probably the former, which must have been of the smallest Welsh type.

When the very contracted character of this gallery, prior to its excavation by the committee, is borne in mind, it is difficult to understand how the remains were introduced. There were neither potsherds nor charcoal, nor, in short, anything suggesting that the bones were the remnants of a body disposed of by cremation, such as were met with in another branch of the cavern in 1872; nor were there any marks of teeth on the bones such as might have been expected had they been taken thither by a carnivorous animal, or the relics of a skeleton buried or secreted there, of which all other portions had been carried off by some carnivore.

The only noteworthy objects met with in the Granular Stalagmitic Floor during the year were a tooth of bear, fragments of bone, one considerable "find" of coprolites, and charred wood on two occasions, all of which occurred in the Long Arcade.

The Cave Earth has yielded during the period under notice 187 teeth of various kinds of mammals, of which 94 occurred in Underhay's Gallery, 63 in the Long Arcade, 20 in the Cave of Inscriptions, and 10 in Clinnick's Gallery; 102 belonged to hyæna, 36 to bear, 27 to horse, 8 to elephant, 8 to fox, 4 to rhinoceros, 1 to lion, and 1 probably to wolf. There were also

numerous bones and fragments of bone, of which some were gnawed, and a few appear to have been burnt. Coprolites were very abundant, 69 distinct "finds" having been met with during the twelvemonth. They sometimes, though rarely, consisted of a solitary ball, whilst at others upwards of 20 were lying together and not unfrequently cemented into large lumps. Occasionally the amount of matter of this kind found in a single day was sufficient to fill a large basket.

Fifteen specimens of flint and chert were also met with in the cave earth, 6 of them occurring in the Cave of Inscriptions, 5 in Underhay's Gallery, 2 in the Long Arcade, and 2 in Clinnick's Gallery. The finest of the series is No. 6324, found December 30, 1873, in the second foot-level, beneath the floor of granular stalagmite from 2 to 2·5 feet thick. It is a very symmetrical tongue-shaped tool, fashioned with much labour out of a chert nodule, and worked to an edge all round the perimeter except at the butt end, where portions of the original surface remain on both faces. It is 3·8 inches long, 2·3 inches in greatest breadth, 1·5 in greatest thickness, and convex on both faces, from each of which several flakes have been struck. Though fashioned out of a nodule, which is very rarely the case amongst the cave-earth implements, its symmetrical form and comparatively high finish are highly characteristic of the era to which it belongs.

No object of interest of any kind has been found in the Crystalline Stalagmitic Floor during the year; but the Breccia lying beneath it has been by no means unproductive. In this oldest of the cavern deposits the remains have been, as heretofore, exclusively those of bear, so far at least as is at present known, and in addition to a large number of bones, including a considerable portion of a skull, 441 teeth have been met with in it, of which 149 were in the Long Arcade, 115 in Underhay's Gallery, 91 in the Cave of Inscriptions, and 86 in Clinnick's Gallery.

Twentys-six pecimens of flint and chert have also been found in this deposit, of which 10 occurred in the Long Arcade, 6 in Clinnick's Gallery, 5 in Underhay's Gallery, and 5 in the Cave of Inscriptions.

The finest of the series (No. $\frac{1}{6411}$) and indeed one of the finest the cavern has yielded from the commencement, was found April 23, 1874, in the fourth or lowest foot-level, with 1 tooth of bear, fragments of bone, and a small chert flake (No. $\frac{2}{6411}$) which had probably been rolled. It measures 4·5 inches in length, 3 inches in greatest breadth, 1·1 inch in greatest thickness, is very convex on one face, slightly so on the other, re.ains a portion of the original surface near the butt end, and is rudely quadrilateral in form, with the angles rounded off. Several flakes have been struck off each face, and the edge to which it has been reduced along its entire margin, except at the butt end, is by no means sharp; its surface is almost completely covered with an almost black, probably manganesic smut, whilst a slight chip near the pointed end shows it to consist of a very light-coloured granular chert. Several lines betokening planes, probably of structural weakness or perhaps of fracture, entirely surround it. If it has really been fractured, it must have occurred where the tool was found, and the parts have been naturally reunited without being faulted. Its character as well as its position shows that this fine implement belonged to the era of the Breccia.

This specimen is of considerable interest, both on account of the lines which cross its surface and of the position it occupied.

Amongst the flint implements found in Brixham Cavern that known as No. 6—8 has attracted considerable attention, and has been described and figured by Mr. John Evans, both in his "Ancient Stone Implements" and in the "Report on the Exploration of Brixham Cave." It was found in two pieces, the first on the 12th of August, 1858, the second, 40 feet from it, on the 9th of the following September; and it was not until some time after the latter date that the late Dr. Falconer discovered that the two fragments fitted each other, and when united formed a massive spear-shaped implement. The lines on the Kent's Cavern specimen just described show that it had either been fractured where it was found, or, what seems more probable, that it is traversed by planes of structural weakness, such that a slight blow would break it into two or more pieces, which a stream of water would easily remove and probably separate, and thus produce a repetition of the Brixham case.

The Kent's Cavern tool was found in a small recess in the wall, just within the outer or wider entrance of Clinnick's Gallery, within a very few feet of the Inscribed Boss of Stalagmite, and, as has already been stated, in the fourth foot-level of the Breccia; that is, at the greatest depth in the oldest of the cavern deposits to which the present exploration has been carried, and is thus wonderfully calculated to take the mind step by step back into antiquity.

First, very near the spot occupied by the specimen, there rises a vast cone of stalagmite, which an inscription on its surface shows has undergone no appreciable augmentation of volume during the last two-and-a-half centuries.

Second, prior to that was the period spent in raising the greater portion of this cone, which measures upwards of 40 feet in basal girth, reaches a height of fully 13 feet, and contains more than 600 cubic feet of stalagmitic matter.

Third, still earlier was the era during which the cave earth was introduced, in a series of successive small instalments with protracted periods of intermittence, when the cavern was alternately the home of man and of the cave hyæna, and the latter dragged thither piecemeal so many portions of extinct mammals as to convert the cave into a crowded palæontological museum.

Fourth, further back still, was the period during which the base or nucleus of the cone or boss was laid down in the form of crystalline stalagmite.

Fifth, and earliest of all, was the time when materials not derivable from the immediate district were carried into the cavern, through openings now probably choked up, entirely unknown, and the direction in which they lie but roughly guessed at, when apparently the cavern-haunting hyæna had not yet arrived in Britain. At an early stage in this earliest era man occupied Devonshire; for prior to the introduction of the uppermost four feet of breccia, one of his massive unpolished tools, rudely chipped out of a nodule of chert, found its way into a recess in the cavern, and having a character such as to show that it must have lain undisturbed in the same spot until it was detected by a committee of the British Association.

SCIENTIFIC SERIALS

THE *Journal of the Chemical Society* for September contains the following papers communicated to the Society:—On the products of the decomposition of castor oil, No. 3. On the decomposition by excess of alkaline hydrate, by E. Neison. The action of sodium hydrate mixed with water gives rise to the formation of a mixture of an alcohol and a ketone on distillation. The alcohol is an octylic alcohol, which the author regards as the secondary alcohol methyl-hexyl carbinol $H\left\{\begin{array}{l} C_6H_{13} \\ CH_3 \\ H \\ OH \end{array}\right.$ The ketone is methyl-hexyl ketone. The olefine derived from the alcohol has been examined. The supposed heptylic alcohols of Städeler and Petersen turn out to be a mixture of octylic alcohol with methyl-hexyl ketone.—On the action of nitrosyl-chloride on organic bodies, Part I. On phenol, by Dr. W. A. Tilden. The phenol is oxidised to quinone, which substance is then converted into chloramil, the nitrosyl-chloride being completely reduced—a certain amount to ammonium chloride.—Aniline and its homologues, &c., in coal-tar oils, by Watson Smith.—On the action of chlorine, bromine, &c., upon isodinaphthyl, by Watson Smith and James M. Poynting. The action of chlorine gives rise to the formation of a tetrachlorinated derivative, $C_{20}H_{10}Cl_4$. Bromine replaces seven atoms of hydrogen, giving rise to the compound $C_{20}H_7Br_7$. With concentrated sulphuric acid a conjugate acid is formed, of which the barium and sodium salts have been examined. Both the chlorinated and brominated derivatives are amorphous powders.—On hydrogen persulphide, by William Ramsay. The persulphide was prepared by first saturating alcohol with ammonia gas, and then passing sulphuretted hydrogen through the solution. The ammonium sulphide thus produced was shaken up with sulphur and a solution of strychnine in alcohol added. White crystals having the formula $C_{21}H_{22}N_2O_2H_2S_3$ separate out on standing. These crystals treated with sulphuric acid yield hydrogen persulphide in the form of oily globules, but the yield is small, and the separation from the sulphuric acid extremely difficult. The author finally adopts the old method of pouring calcium persulphide into hydrochloric acid. Analyses of the compound thus obtained gave results indicating a formula between H_2S_7 and H_2S_{10}. The properties of the persulphide have been examined in some detail.—The journal contains its usual valuable collection of abstracts.

Geological Magazine, Oct. 1874.—The original articles contained in this number are (1) a continuation of Mr. Lechmere Gupp's article on West Indian Tertiary Fossils; (2) Notes on

the impression of *Falæontina oolitica* in the Jermyn Street Museum, by A. G. Butler, including a discussion on its zoological place; (3) The structure of Lambay Porphyry, by Prof. Hull, a paper read before the Geological Society of Ireland; (4) Geology of West Galway and South-west Mayo, by S. H. Kinahan, an epitome of a communication made to the British Association; (5) Note on the Phonolite of the Wolf-rock, by S. Allport.

Zeitschrift der Œsterreichischen Gesellschaft für Meteorologie, Sept. 15.—This number contains a description of the self-acting printing barometer, invented some years ago by Mr. Hough, director of the Observatory at Albany, U.S., but not very well known in Europe. By the employment of electricity, the barometer will record movements as slight as ·0005 in., and will print not only curves, but a register as well, at any required intervals per hour. The apparatus does not require frequent attention.—Among the *Kleinere Mittheilungen*, we have a notice of M. Goulier's aneroid, provided with a scale of heights beside the scale of millimetres. It is contended against this arrangement that two scales make a correct reading less easy, that the precision of the scale of heights, where the intervals between the lines are not equal, must be doubtful, and that the correction proper to each aneroid would not be easily applied to the scale of heights.—M. Mühry has an article On differences of temperature as a cause of latitudinal oceanic circulation. He maintains that two causes are at work, each of which tends to produce latitudinal circulation, namely, the diminution of the force of gravity towards the equator, and the increase of temperature with consequent expansion and diminished specific gravity. The lower strata of cold water rise at the equator towards the surface, and a corresponding descent of warm upper strata must take place in polar regions. With regard to the debated question on the point of greatest density of sea-water, he holds it to be the same as that of fresh water, and late experiments bear out his argument on this subject.

Bulletins de la Société d'Anthropologie de Paris, fascicule vi. tome 8, 1874.—In the closing number of the Society's last year's Reports, the remains found at Solutré, near Macon (in August 1873), formed a large proportion of the subjects of the papers. The assumed find at Solutré of a metallic ring, enamelled green, on one of the phalanges of the skeleton which had been uncovered in the presence of MM. de Quatrefages, Broca, and nearly fifty other persons, has been rejected by the Society as unworthy the consideration of scientific men; while M. Broca, in a detailed report of the investigation in which he on that occasion took the principal share, has clearly shown the impossibility of such a ring escaping his notice had it been present. M. Broca in another paper considers at length the characteristics of the various crania which have been found at Solutré since the spot was first examined by MM. de Ferry, Arcelin, de Freminville, Lortet, and others, and described by the two first-named in their work "Le Mâconnais Préhistorique" (1870): and he draws attention to the various prehistoric and historic epochs at which interments have been made at Solutré, and by which the question of the true age of these remains has been surrounded with greater difficulties than belong to the palæontological character of any other similar spot in France. The prehistoric crania at Solutré are in a very bad condition; but they present a large capacity of nearly 1,600 cubic centimetres, with an index of only 82·87. Platycnemic tibiæ, with the characteristic columnar femures, were found, but M. Broca seems on the whole to assume that the earliest discovered men of Solutré belonged to a mixed race similar to those of the Belgian caves of La Lesse. M. Hamy has demonstrated that brachicephalic crania supervene at Solutré on the dolichocephalic, as at Cro-Magnon.—M. Topinard read a paper on the systems of craniometry, in which he endeavoured to show by the contradictory cranial determinations arrived at in reference to the Solutré and other recent finds, how important it is to show a definite method of cranial measurement. In the discussion which followed, M. Rochet opposed the notion that craniometry in art is based upon individual fancy more than scientific accuracy; while M. Broca admitted the defects of the present methods.—A note by M. P. Bert, on the twin monster known as the double-headed nightingale, led to a general discussion on double or twin monsters, and to the inquiry whether they were produced from two distinct embryos or from one germ endowed *ab initio* with the property of doubling or reproducing certain parts. It was generally admitted that external circumstances have no power to induce embryonic duality.—Madame C. Royer, in a very original paper on the origin of different human races, protested against the hypothesis which derives all European races from Asia, and endeavoured to show by the geological history of the earth that man must have appeared first on the great Austral continent, and radiated thence to the other continents. Her novel views were received with marked attention, and it was felt that if she should be able to adduce sound geological proof of her statements, her hypothesis of primary human migrations will be as important as it is original. Till she fulfils her promise of clearly expounding her theory, her arguments cannot, however, be accepted as more than ingenious speculations.

Revue d'Anthropologie, tome iii. No. 3.—M. Paul Broca supplies us in this number of the review, of which he is sole editor, with a comprehensive history of the course of observations which have led to the enunciation of the theory propounded by him (in the *Bulletins de la Soc. d'Anthrop. de Paris* for January and February 1874) in regard to the hygrometric properties of fossil crania. After considering the important but inadequately appreciated experiments made in 1859 by M. Welcker in reference to this point, he enters at great length into the consideration of the numerous carefully conducted series of observations and measurements by which he was led to the conclusions which he has adopted, and his paper constitutes, therefore, a most valuable *résumé* of the physical as well as the palæontological bearings of the subject.—M. Bérenger-Feraud, surgeon in the French navy, gives, as the result of personal investigation, an account of the different tribes who occupy the shores of the Casamanca in Intertropical Africa. This stream, on which the Portuguese and French have a few scattered trading stations, is one of the numerous rivers of Western Africa which take their source on the western slope of the Fonta-Djalon mountain-ranges. The author considers the Casamanca peoples under the three heads of primary or autochthonic, invading, and immigrating races; the first including the Feloups and Bagnouns, the second the Belantes, Mandingues, and Peuls, and the last the Onolofs, Saracolais, Machouins, Taumas, &c.; and passing each in review, he describes their habits, the form of fetichism followed by each, and their general social condition. Among the Balantes he notes the singular custom of making the duration of marriage responsibilities dependent on the conservation of the "pagua" or festive garment given to the wife by the husband on the occasion of their wedding. The woman who wishes to secure a divorce has merely to wear out her pagua as fast as she can, and then present it in a tattered condition to her family, on which she obtains her release from the power of her husband. Among the same people a charge of sorcery, which is very common with them, can only be met by a public appeal to the ordeal of the "mançone" or "ago broumedion," which is said to be a decoction from the bark of a poisonous tree, and which it would appear is always fatal unless rich gifts have secured the copious watering of the draught by those to whom its preparation is confided.—MM. Daleau and Gassies give a report of the appearances presented by a cavern at Jolias, in the canton of Bourg (Gironde), which, on its recent exploration, yielded in a stratum of red diluvium below a solid calcareous bed, a rich deposit of bones, many of which had been cleft, but none of which belonged to extinct species, numerous flint implements similar to those found at Moustier and Solutré, but no remains of pottery, except in the upper part of the cavern, where they had probably been thrown aside long after the disuse of the cavern.

Zeitschrift für Ethnologie, heft vi. 1873.—The first article in this number gives some interesting details in regard to the almost unknown Red Indian tribe of the Tulus of Panama, believed to be the descendants of the Churchures, who successfully resisted the attempts made by the Spanish Conquistadores for their subjection. Representatives of these people appeared last year at Bogota with the object of making complaints against the collectors of caoutchouc, cacao, and elephant nuts, who had come to their woods and been guilty of violence against the tribe, and it was from his examination of these men that the author drew up his report.—In a suggestive article by Prof. Bastian on the nature of ethnology and its relations to geography, the author points out how essential the knowledge of physical laws is to the right comprehension of ethnology, which is in itself less a zoological history of man than a history of the geographical distribution of man considered in relation to physical habits, which, like the physical characteristics of different faunas and floras, depend primarily upon geographical position, and secondarily on climatic, geognostic, and other analogous conditions.—Herr Virchow laid before the society several skulls of the Goldi, a hitherto almost unknown tribe, who occupy the shores of the Amoor at the point where

the Sangari and the Ussuri join the main stream. He is of opinion that these people are more nearly allied to the Tunguses than to the Esquimaux, the crania in his possession being remarkable for their high brachicephalic form and large cranial capacity.—In a letter from Dr. Bleek, addressed to the society, the writer draws attention to the peculiarity evinced by the Bushmen of becoming fairer and lighter in skin after they have for a time enjoyed good and abundant food, with the comforts of civilised life. This special characteristic he regards as a proof of the difference between these peoples and the negro races of South Africa, and as an evidence of their nearer affinity with more northern tribes. Dr. Bleek at the same time expresses his opinion that the dances by moonlight, which are systematically practised by the South African tribes, are connected with some form of moon-worship; while Dr. Fritsch, on the other hand, believes that these dances are in no way religious, and are simply called forth by the charm of tropical moonlit nights.—Herr Virchow exhibited some stone implements or wedges precisely similar to the so-called flint knives, which we are accustomed to assign to the Stone Age; yet these were of modern fabrication, being made in the present day in Syria, where they are used, amongst other purposes, to keep the different parts of the Syrian threshing machine (*tribulum*) in their places.

Astronomische Nachrichten, No. 2,007, contains the observations of position and magnitude of 148 comparison stars and 13 minor planets, made with the meridian circle at Berlin.—No. 2,008 contains the positions of 108 more stars, reduced to the mean equinox of 1870, and the positions of 20 planets, made by the same instrument. With the Berlin refractor the positions of some 58 planets have been determined, and some of them have been observed on a number of nights.—In No. 2,009 L. Schulhof gives an ephemeris and the following elements of Comet III. 1874, discovered by Coggia on the 19th of August:—

$$T = \text{July } 5{\cdot}16629 \text{ Berlin time.}$$
$$\pi = 347^\circ\ 20'\ 2''$$
$$\Omega = 213^\circ\ 12'\ 15''$$
$$i = 28^\circ\ 25'\ 41''$$
$$\log. q = 0{\cdot}15831$$

M. Geelmuyden gives elements of Coggia's first comet of 1874, and assigns a period of 10,445 years.—D'Arrest contributes a number of spectroscopic observations of Secchi's types III. and IV.—Ormond Stone gives a note on certain expressions of the distance of a comet from the earth, and a paper on Brünnow's method of correcting the orbit of a comet.—Dr. Holetschek gives an ephemeris of Borrelly's comet, the two last positions of which are—

	R.A.	DEC.
Oct. 29 ...	6h. 21m. 9s.	+ 50° 37′·6
Nov. 2 ...	6h. 5m. 11s.	+ 47° 36′·7

and an ephemeris of Coggia's comet of the 19th of August—

Oct. 29 ...	5h. 0m. 41·8s.	− 0° 12′ 55″
Nov. 2 ...	4h. 48m. 46·4s.	− 1° 49′ 50″

Memoria della Società degli Spettroscopisti Italiani, August.—Father Secchi contributes a paper discussing the theory of solar spots set forth by Galileo, and he compares the theories and observations of Wilson, Kirchhoff, Faye, and Gautier. Tacchini adds a note discussing M. Faye's theory of the formation of solar spots, and opposing it on the ground that spots and faculæ seem to accompany eruptions. Tacchini also gives notes on the positions of the chromosphere where magnesium vapour was observed in January last, and he also mentions the position of prominences accompanying spots at the limb, and containing metallic vapours. The magnesium line and 1474 occur most frequently.—Notes and measurements of the comet (Coggia) made by E. Dembwoski with a 7-inch Merz, together with drawings of the nucleus, appear in this number.—Schiaparelli contributes a note on the new star observed in Sagittarius in 1690. He thinks it the same as the variable star S Sagittarius, R.A. 287° 40′, Dec. 19° 18′.—Tacchini gives a table with notes showing the number of meteors, with their brightness, observed in each fifteen minutes from 10h. 30m. to 13h. 15m. on the 9th, 10th, and 11th of August last. The radiant point

	R.A.		DEC.
On the 9th, of 35, was	2h. 52m.	...	54° 56′
„ „ of 3, „	2h. 14m.	...	55° 43′
„ 10th, of 71, „	2h. 53m.	...	54° 40′
„ „ of 11, „	2h. 14m.	...	56° 14′
„ 11th, of 14, „	2h. 53m.	...	54° 43′
„ „ of 10, „	2h. 14m.	...	56° 20′

SOCIETIES AND ACADEMIES

MANCHESTER

Literary and Philosophical Society, Oct. 6.—Rev. William Gaskell, M.A., vice-president, in the chair.—On the ossiferous deposit at Windy Knoll, near Castleton, by Mr. Rooke Pennington, LL.B.—On some teeth from a fissure in Waterhouses Quarry, in Staffordshire. Mr. Pennington called attention to some teeth of a bison (*Bos priscus*) from a fissure in a quarry at Waterhouses. The animal had evidently fallen in while coming to drink at the river Hamps. It had been erroneously described as an Irish elk.—On the extent and action of the heating surface for steam boilers, by Prof. Osborne Reynolds, M.A.—Dr. Joule made a further communication respecting his mercurial air pump described in the Proceedings for Dec. 24, 1872, and Feb. 4, Feb. 18, and Dec. 30, 1873. He had successfully made use of the glass plug proposed in the Proceedings for Feb. 4, 1873. This he constructs by blowing out the entrance tube and grinding the bulb thus formed into the neck of the thistle-shaped glass vessel. To collect the pumped gases he now employs an inverted glass vessel attached to the entrance tube and dipping into the mercury in the upper part of the thistle glass.

WINCHESTER

The Winchester and Hampshire Scientific and Literary Society held the first meeting of its sixth session on Oct. 19; Dr. Heale, treasurer, in the chair.—The Rev. F. Howlett, F.R.A.S., delivered an introductory address, noticing many of the more important discoveries made during the past year in various departments of scientific research.

BOOKS AND PAMPHLETS RECEIVED

BRITISH.—Report of the Weather Telegraphy (E. Stanford).—Annual Report Aeronautical Society of Great Britain (Hamilton and Co.).—Journal of the Iron and Steel Institute, 1874 (Spon).—Note on the Perception of Musical Sounds: J. G. McKendrick, M.D. (Neill and Co.).—Flora Cravoniensis: John Windsor, F.R.C.S., F.L.S., &c. (Cave and Co.).—The Contrast between Crystallisation and Life: John E. Howard, F.R.S., F.L.S., &c. (Hardwicke).—Atomism: Dr. Tyndall's Theory Examined and Refuted: Rev. Prof. Watts, D.D. (Mullan, Belfast).—Brixham Cavern: N. Whitely, C.E. (Hardwicke).—Philosophy, Science, and Revelation: Rev. C. B. Gibson, M.R.I.A., &c. (Longmans).

AMERICAN.—Nomenclature of Diseases: J. M. Woodworth, M.D. (Washington).—Proceedings of the American Association for the Advancement of Science.—Notes on Ophidiidæ, &c.: F. W. Putnam.

FOREIGN.—L'Astronomie Pratique: C. André and G. Rayet (Gauthier-Villars, Paris).—Einige Bemerkungen über den Werth, welcher im Allgemeinen den Angaben in Betreff der Herkunft menschlicher Schädel aus dem ostindischen Archipel beizumessen ist: Dr. Meyer (Wien).—Uber neue und ungenügend Vögel von New Guinea und den Inseln der Gelvincks Bai: Dr. Meyer.—Manuel de la Cosmographie der Moyen Age: A. F. Mehren (Copenhagen).—Neues Handwörterbuch der Chemie: Dr. H. von Fehling (Viewig and Son).—Die Geologie: Franz Ritter von Haner (A. Holder, Wien).—Normale Zeiten für den Zug der Vögel: K. Fritsch (Wien).—Fosselen Bryozoen: Prof. Dr. A. E. Roon Reuss (Wien).—I precursori di Copernico nell' antichita: G. V. Schiaparelli (W. Koepli).—Osservazioni Astronomische e Fisiche: G. V. Schiaparelli (W. Koepli).

CONTENTS

INDEX